Savitribai Phule Pune University

(Formerly University of Pune)

Two Year Degree Program in Computer Science

(Faculty of Science & Technology)

Revised Syllabi for

M.Sc. (Computer Science) Part-I

(For Colleges Affiliated to Savitribai Phule Pune University)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2019-2020

Title of the Course: M.Sc. (Computer Science)

Preamble:

This syllabus is the extension of the existing syllabus which is currently being taught to M.Sc. (Computer Science) of Savitribai Phule Pune University for the last few years, but modified to be placed within the credit based system to be implemented from the academic year 2019-2020. However, there are few changes incorporated in the existing syllabus.

It is believed that the proposed changes as part of the credit based system will bring a qualitative change in the way M.Sc. (Computer Science) is taught, which will offer a more enriched learning experience. It aims to provide technology-oriented students with the knowledge and ability to develop creative solutions, and better understand the effects of future developments of computer systems and technology on people and society.

The syllabus is about developing skills to learn new technology, grasping the concepts and issues behind its use and the use of computers.

Course Structure:

Year/ Sem	Course Type	Course Code	Course Name	Credit	% of Assessment		
					IA	UE	Total
I Year Sem-I	Core Compulsory Theory Paper	CSUT111	Paradigm of Programming Language	4	30	70	100
		CSUT112	Design and Analysis of Algorithms	4	30	70	100
		CSUT113	Database Technologies	4	30	70	100
	Choice Based Optional Paper	CSDT114A	Cloud computing	2	15	35	50
		CSDP114A	Cloud Computing Practical	2	15	35	50
		OR					
		CSDT114B	Artificial Intelligence	2	15	35	50
		CSDP114B	Artificial Intelligence Practical	2	15	35	50
		OR					
		CSDT114C	Web Services	2	15	35	50
		CSDP114C	Web Services Practical	2	15	35	50
	Core Compulsory Practical Paper	CSUP115	PPL and Database Technologies Practical	4	30	70	100

Year/ Sem	Course Type	Course Code	Course Name	Credit	% of Assessment		
					IA	UE	Total
I Year Sem-II	Core Compulsory Theory Paper	CSUT121	Advanced Operating System	4	30	70	100
		CSUT122	Mobile Technologies	4	30	70	100
		CSUT123	Software Project Management	4	30	70	100
	Choice Based Optional Paper	CSDT124A	Project	2	15	35	50
		CSDP124A	Project related Assignments	2	15	35	50
		OR					
		CSDT124B	Human Computer Interaction	2	15	35	50
		CSDP124B	Human Computer Interaction Practical	2	15	35	50
		OR					
		CSDT124C	Soft Computing	2	15	35	50
		CSDP124C	Soft Computing Practical	2	15	35	50
	Core Compulsory Practical Paper	CSUP125	Practical on Advanced OS & Mobile Technologies	4	30	70	100

Year/ Sem	Course Type	Course Code	Course Name	Credit	% of Assessment		
					IA	UE	Total
II Year Sem-III	Core Compulsory Theory Paper	CSUT231	Software Architecture and Design Pattern	4	30	70	100
		CSUT232	Machine Learning	4	30	70	100
		CSUT233	Evolutionary Algorithms	4	30	70	100
	Choice Based Optional Paper	CSDT234A	Big Data	2	15	35	50
		CSDP234A	Big Data Practical	2	15	35	50
		OR					
		CSDT234B	Web Analytics	2	15	35	50
		CSDP234B	Web Analytics Practical	2	15	35	50
		OR					
		CSDT234C	Project	2	15	35	50
		CSDP234C	Project related Assignments	2	15	35	50
	Core Compulsory Practical Paper	CSUP235	Practical on Software Architecture and Design Pattern and Machine Learning	4	30	70	100

Year/ Sem	Subject	Paper	Title of Paper	Credit	% of Assessment		
					IA	UE	Total
II Year Sem-IV	Core	CSUIT241	Industrial Training /Institutional project	20			

IA :- Internal Assessment, UE :- University Examination

Equivalence of Previous Syllabus:

Old Subject	New Subject
Principles of Programming Languages	Paradigm of Programming Language
Advanced Networking	No Equivalence
Distributed Database Concepts	Database Technologies
Design and Analysis of Algorithms	Design and Analysis of Algorithms
Network Programming	No Equivalence
Digital Image Processing	No Equivalence
Advanced Operating Systems	Advanced Operating Systems
Data Mining and Data Warehousing	Big Data
Project	Project
Programming With DOT NET	No Equivalence
Artificial Intelligence	Artificial Intelligence
Advance Design and Analysis of Algorithms	Evolutionary Algorithms
Software Metrics & Project Management	Software Project Management
Mobile Computing	Mobile Technologies
Soft Computing	Soft Computing
Project	Project
Web Services	Web Services
Database and System Administrator	No Equivalence
Functional Programming	No Equivalence
Business Intelligence	No Equivalence
Industrial Training /Institutional project	Industrial Training /Institutional project
Parallel Computing	No Equivalence
Embedded System	No Equivalence
Software Quality Assurance	No Equivalence
Modeling and Simulation	No Equivalence

Practical paper implementation strategy:

Subject	Platform
PPL	Linux
Database Technologies	Linux
AI	Linux
Web Services	Linux/Windows
Cloud Computing	Linux

Note : Any version of Linux (Fedora/ Redhat/ Ubuntu etc) can be used as per your comfort.

Detailed Syllabus:

Course Code: **CSUT111**	**Course Name:** **Paradigm of Programming Language**	**Total Lectures** **(48 Hours)**
Teaching Scheme : **4 hrs/week**	**Examination Scheme:** **IA: 30 Marks** **UE: 70 Marks**	**No. of Credits** **4**
Course Prerequisites:	Student should have basic knowledge of: • Procedural Language like C • Object-Oriented Languages (C++ and Java) • Concepts of Operating Systems • Basic Data Structures and Algorithms.	
Course Objectives:	To Prepare student to think about programming languages analytically: • Separate syntax from semantics • Compare programming language designs • Understand their strengths and weaknesses • Learn new languages more quickly • Understand basic language implementation techniques • Learn small programs in different programming Languages	
Chapter	**Course Contents**	**No. of Lectures**
1	**Introduction** • The Art of Language Design • The Programming Language Spectrum • Why Study Programming Languages? • Compilation and Interpretation • Programming Environments	2
2	**Names, Scopes, and Bindings** • The Notion of Binding Time • Object Lifetime and Storage Management • Static Allocation, Stack-Based Allocation, Heap-Based Allocation, Garbage Collection Scope Rules • Static Scoping, Nested Subroutines, Declaration Order, Dynamic Scoping The meaning of Names in a Scope • Aliases, Overloading, Polymorphism and Related Concepts, the Binding of Referencing Environments • Subroutine Closures, First-Class Values and Unlimited Extent, Object Closures Macro Expansion •	5

3	**Control Flow** • Expression Evaluation , Precedence and Associativity, Assignments, Initialization, Ordering Within Expressions, Short-Circuit Evaluation • Structured and Unstructured Flow, Structured Alternatives to goto • Sequencing • Selection - Short-Circuited Conditions, Case/Switch Statements Iteration • Iteration - Enumeration-Controlled Loops, Combination Loops, Iterators, Logically Controlled Loops Recursion • Recursion - Iteration and Recursion, Applicative- and Normal-Order Evaluation	5
4	**Data Types** • Introduction • Primitive Data Types • Numeric Types : Integer, Floating point, Complex , Decimal, Boolean Types, Character Types • Character String Types • Design Issues, Strings and Their Operations, String Length Operations, Evaluation, Implementation of Character String Types • User defined Ordinal types Enumeration types, Designs Evaluation Subrange types, Ada's design Evaluation Implementation of user defined ordinal types • Array types • Design issues, Arrays and indices, Subscript bindings and array categories, Heterogeneous arrays, Array initialization, Array operations, Rectangular and Jagged arrays, Slices, Evaluation, Implementation of Array Types • Associative Arrays • Structure and operations, Implementing associative arrays, • Record types • Definitions of records, References to record fields, Operations on records, Evaluation, Implementation of Record types • Union Types • Design issues, Discriminated versus Free unions, Evaluation, Implementation of Union types	8

	• Pointer and Reference Types • Design issues, Pointer operations, Pointer problems, Dangling pointers, Lost heap dynamic variables, Pointers in C and C++, Reference types, Evaluation • Implementation of pointer and reference types - Representation of pointers and references Solution to dangling pointer problem Heap management	
5	**Subprograms and Implementing Subprograms** • Introduction • Fundamentals of Subprograms • Design Issues for subprograms • Local Referencing Environments • Parameter-Passing Methods • Parameters That Are • Subprograms • Overloaded Subprograms • Generic Subroutines, Generic Functions in C++, Generic Methods in Java • Design Issues for Functions • User-Defined Overloaded Operators • Coroutines • Implementing Subprograms • The General Semantics of Calls and Returns • Implementing "Simple" Subprograms • Implementing Subprograms with Stack-Dynamic Local Variables • Nested Subprograms • Blocks • Implementing Dynamic Scoping	5
6	**Data Abstraction and Object Orientation** • Object-Oriented Programming • Encapsulation and Inheritance Modules, Classes, Nesting (Inner Classes), Type Extensions, Extending without Inheritance • Initialization and Finalization Choosing a Constructor, References and Values, Execution Order, Garbage Collection • Dynamic Method Binding • Virtual- and Non-Virtual Methods, Abstract Classes, Member Lookup, Polymorphism, Object Closures • Multiple Inheritance • Semantic Ambiguities, Replicated Inheritance,	8

	Shared Inheritance, Mix-In Inheritance	
7	**Concurrency** • Introduction : Multiprocessor Architecture Categories of concurrency, Motivations for studying concurrency • Introduction to Subprogram-level, concurrency Fundamental concepts, Language Design for concurrency, Design Issues • Semaphores - Introduction Cooperation synchronization, Competition Synchronization, Evaluation • Monitors - Introduction, Cooperation synchronization, Competition Synchronization, Evaluation, • Message Passing Introduction- The concept of Synchronous Message Passing • Java Threads - The Thread class –Priorities, Competition Synchronization Cooperation Synchronization, Evaluation	5
8	**Functional Programming in Scala** • Strings • Numbers • Control Structures • Classes and Properties • Methods • Objects • Functional Programming • List, Array, Map, Set	10

References:

Sr. No.	Title of the Book	Author/s	Publication
1	Programming Language Pragmatics, 3e	Michel L. Scott	Kaufmann Publishers, An Imprint of Elsevier, USA
2	Concepts of Programming Languages, Eighth Edition	Robert W. Sebesta	Pearson Education
3	Scala Cookbook	Alvin Alexander	O'REILLY publication

Course Code: CSUT112	**Course Name: Design and Analysis of Algorithm**	**Total Lectures (48 Hours)**
Teaching Scheme : 4 hrs/week	**Examination Scheme: IA: 30 Marks UE: 70 Marks**	**No. of Credits 4**
Course Prerequisites:	• Basic knowledge of algorithms and programming concepts • Data Structures and Advanced Data Structures • Basic Knowledge of Graphs and Algorithms	
Course Objectives:	• To design the algorithms • To select the appropriate algorithm by doing necessary analysis of algorithms • To learn basic Algorithm Analysis techniques and understand the use of asymptotic notation • Understand different design strategies • Understand the use of data structures in improving algorithm performance • Understand classical problem and solutions • Learn a variety of useful algorithms • Understand classification of problems • To provide foundation in algorithm design and analysis • To develop ability to understand and design algorithms in context of space and time complexity.	
Chapter	**Course Contents**	**No. of Lectures**
1	**Basics of Algorithms** • Algorithm definition and characteristics • Space complexity • Time complexity, worst case-best case-average case • complexity, asymptotic notation • Recursive and non-recursive algorithms • Sorting algorithms (insertion sort, heap sort, bubble sort) • Sorting in linear time: counting sort, concept of bucket and radix sort • Searching algorithms: Linear, Binary	8
2	**Divide and conquer strategy** • General method, control abstraction • Binary search • Merge sort, Quick sort • Comparison between Traditional Method of Matrix Multiplication vs. Strassen's Matrix Multiplication	5

3	**Greedy Method** • Knapsack problem • Job sequencing with deadlines, • Minimum-cost spanning trees: Kruskal and Prim's algorithm • Optimal storage on tapes • Optimal merge patterns • Huffman coding • Shortest Path :Dijkstra's Algorithm	7
4	**Dynamic Programming** • Principle of optimality • Matrix chain multiplication • 0/1 Knapsack Problem i)Merge & Purge ii)Functional Method • Bellman Ford Algorithm • All pairs Shortest Path Floyd- Warshall Algorithm • Longest common subsequence, • String editing, Travelling Salesperson problem	10
5	**Decrease and Conquer** • Definition of Graph Representation of Graph • By Constant - DFS and BFS • Topological sorting • Connected components and spanning trees • By Variable Size decrease Euclid's algorithm • Articulation Point and Bridge edge	5
6	**Backtracking** • General method • Fixed Tuple vs. Variable Tuple Formulation • n- Queen's problem • Graph coloring problem • Hamiltonian cycle • Sum of subsets	5
7	**Branch and Bound** • Introduction • FIFO BB Search, LIFO Search • Definitions of LCBB Search • Bounding Function, Ranking Function • Traveling Salesman problem Using Variable tuple	5

	• Formulation using LCBB • 0/1 knapsack problem using LCBB	
8	**Problem Classification** • Nondeterministic algorithm • The class of P, NP, NP-hard and NP - Complete problems • Cook's theorem	3

References:

Sr. No.	Title of the Book	Author/s	Publication
1	Computer algorithms	Ellis Horowitz, Sartaj Sahni & Sanguthevar Rajasekaran	Galgotia Publication
2	T. Cormen, C. Leiserson, & R. Rivest	Algorithms	MIT Press
3	A. Aho, J. Hopcroft & J. Ullman	The Design and Analysis of Computer Algorithms	Addison Wesley
4	Donald Knuth	The Art of Computer Programming	Addison Wesley
5	Steven Skiena	The Algorithm Manual	Springer
6	Jungnickel	Graphs, Networks and Algorithms	Springer

Course Code: CSUT113	**Course Name: Database Technologies**	**Total Lectures (48 Hours)**
Teaching Scheme : 4 hrs/week	**Examination Scheme: IA: 30 Marks UE: 70 Marks**	**No. of Credits 4**
Course Prerequisites:	• Knowledge of file system concepts • Strong foundation of Related database Concepts (Basic & Advanced) • A firm foundation of any RDBMS package	
Course Objectives:	• Provide an overview of the concept of NoSQL technology. • Provide an insight to the different types of NoSQL databases • Make the student capable of making a choice of what database technologies to use, based on their application needs.	

Chapter	**Course Contents**	**No. of Lectures**
1	**Introduction to NOSQL (Core concepts)**	18
	Why NoSQL	
	Aggregate Data Models	
	Data modeling details	
	Distribution Models	
	Consistency	
	Version stamps	
	Map-Reduce	
2	**Implementation with NOSQL databases**	14
	Key-Value Databases (Riak)	
	Document Databases (Mongodb)	
	Column-Family stores (Cassandra)	
	Graph databases (Neo4j)	
3	**Schema Migrations**	5
4	**Polygot Persistence (Multi model types)**	5
5	**Beyond NoSQL**	3
6	**Choosing your database**	3

References:

Sr. No.	**Title of the Book**	**Author/s**	**Publication**
1	NoSQL Distilled	Pramod Sadalge, Martin Fowler	
2	NoSQL for Dummies	A Willy Brand	
3	http://nosql-database.org		

Note: For Database Technologies implementation of databases/assignments can be done in all, but for university practical examination only MongoDB and Neo4j will be used/considered. Other can be for self learning/demonstration.

Course Code: CSDT114A	**Course Name: Cloud Computing**	**Total Lectures (30 Hours)**
Teaching Scheme : 4 hrs/week	**Examination Scheme: IA: 15 Marks UE: 35 Marks**	**No. of Credits 2**
Course Prerequisites:	Operating System Fundamentals of Computer Networks Good Understanding of Object Oriented Programming Concepts	
Course Objectives:	• To understand the principles and paradigm of Cloud Computing • To appreciate the role of Virtualization Technologies • Ability to design and deploy Cloud Infrastructure • Understand cloud security issues and solutions	

Chapter	**Course Contents**	**No. of Lectures**
1	**Introduction to Cloud Computing** Overview, Layers and Types of Cloud, Desired Features of a Cloud, Benefits and Disadvantages of Cloud Computing, Cloud Infrastructure Management, Infrastructure as a Service Providers, Platform as a Service Providers, Multitenant Technology. Cloud-Enabling Technology: Broadband Networks and Internet Architecture, Data Center Technology, Virtualization Technology. Infrastructure as a Service, Platform as a Service, Software as a Service, Cloud Deployment Models.	8
2	**Abstraction and Virtualization** Introduction to Virtualization Technologies, Load Balancing and Virtualization, Understanding Hyper visors, Virtual Machines Provisioning and Manageability Virtual Machine Migration Services, Provisioning in the Cloud Context Virtualization of CPU, Memory , I/O Devices, Virtual Clusters and Resource management	7

3	**Programming, Environments and Applications** Features of Cloud and Grid Platforms, Programming Support of Google App Engine, Programming on Amazon AWS and Microsoft Azure, Emerging Cloud Software Environments, Applications: Moving application to cloud, Microsoft Cloud Services, Google Cloud Applications, Amazon Cloud Services, Cloud Applications.	8
4	**Security In The Cloud** Security Overview – Cloud Security Challenges and Risks – Software-as-a-Service Security – Security Governance – Risk Management – Security Monitoring – Security Architecture Design – Data Security – Application Security – Virtual Machine Security - Identity Management and Access Control, Disaster Recovery in Clouds.	7

References:

Sr. No.	Title of the Book	Author/s	Publication
1	Cloud Computing: Technologies and Strategies of the Ubiquitous Data Center	Brian J.S. Chee and Curtis Franklin	CRC Press, ISBN :9781439806128
2	Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi	Mastering Cloud Computing: Foundations and Applications Programming	McGraw Hill, ISBN: 978 1259029950, 1259029956
3	Kai Hwang, Geoffrey C Fox, Jack G Dongarra	Distributed and Cloud Computing, From Parallel Processing to the Internet of Things	Morgan Kaufmann Publishers, 2012.

CSDP114A: Cloud Computing Practical Assignments

Sr. No	Assignment
1.	Working and Implementation of Infrastructure as a service.
2.	Working and Implementation of Software as a service.
3.	Working and Implementation of Platform as a services.
4.	Practical Implementation of Storage as a Service.
5.	Working of Google drive to make spreadsheet and notes.
6.	Working and Implementation of identity management.
7.	Write a program for web feed.
8.	Execute the step to Demonstrate and implementation of cloud on single sign on.
9.	Practical Implementation of cloud security.
10.	Installing and Developing Application Using Google App Engine.
11.	Implement VMWAreESXi Server
12.	Using OpenNebula to manage heterogeneous distributed data center Infrastructure.
13.	Implementation of Cloud Failure Cluster.
14.	Managing and working of cloud xen server.
15.	Working with Aneka and demonstrate how to Managing cloud computing Resources .
16.	Installation and configuration of cloud Hadoop and demonstrate simple query.
17.	Create a sample mobile application using Amazon Web Service (AWS) account as a cloud service. Also provide database connectivity with implemented mobile application.

Course Code: CSDT114B	**Course Name: Artificial Intelligence**	**Total Lectures (30 Hours)**
Teaching Scheme : 4 hrs/week	**Examination Scheme: IA: 15 Marks UE: 35 Marks**	**No. of Credits 02**
Course Prerequisites:	• Concepts of Data structures and Design and Analysis of algorithms. • Strong data analytics skills. • Strong will to learn machine learning languages.	
Course Objectives:	• To learn various types of algorithms useful in Artificial Intelligence (AI). • To convey the ideas in AI research and programming language related to emerging technology. • To understand the numerous applications and huge possibilities in the field of AI that goes beyond the normal human imagination.	
Chapter	**Course Contents**	**No. of Lectures**
1	**Introduction to Artificial Intelligence:** Introduction and Intelligent systems, What Is AI, The Foundations of Artificial Intelligence, The History of Artificial Intelligence, Applications of AI, Early work in AI and related fields, AI problems and Techniques.	**2**
2	**Searching:** -Defining AI problems as a State Space Search: example, Search and Control Strategies, Problem Characteristics, Issues in Design of Search Programs, Production System. Blind Search Techniques : -BFS, DFS, DLS, Iterative Deepening, Search, Bidirectional Search, Uniform cost Search. Heuristic search techniques: -Generate and test ,Hill Climbing, Best First search, Constraint Satisfaction, Mean-End Analysis, A*,AO*.	**8**

3	**Knowledge Representation:** Representations and Mappings, Approaches to Knowledge Representation, Knowledge representation method, Propositional Logic, Predicate logic, Representing Simple facts in Logic, Resolution, Forward and backward chaining . Game Playing- Minimax Search Procedures, Adding alpha-beta cutoffs.	**8**
4	**Introduction to AI with Python:** Introduction to Python , why python with AI, Features of Python, Basics of Python, Python statements, Methods & Functions using python, Basic and advanced modules &Packages, Python Decorators and generators .Advanced Objects & Data structures.	**6**
5	**Machine Learning:** Why Machine learning, Types of Machine Learning: Supervised learning- Classification & Regression. Random Forest, KNN Algorithm. Unsupervised learning-Clustering & Association. Reinforcement learning.	**6**

References:

Sr. No.	Title of the Book	Author/s	Publication
1	Computational Intelligence	Eberhart	Elsevier Publication
2	Artificial Intelligence: A New Synthesis	Nilsson	Elsevier Publication
3	Artificial Intelligence with Python	PrateekJoshi	Packt Publishing Ltd
4	Reinforcement and Systematic Machine Learning for Decision Making,	Parag Kulkarni	Wiley-IEEE Press Edition
5	Artificial Intelligence	Saroj Kausik	Cengage Learning
6	Introduction to Machine Learning	EthemAlpaydin	PHI 2nd Edition

CSDP114B: Artificial Intelligence Practical

Sr. No.	Assignment
1	Subject teacher should conduct first lab practical on basic programs using python for introducing and using python environment such as, a) Program to print multiplication table for given no. b) Program to check whether the given no is prime or not. c) Program to find factorial of the given no and similar programs.
2	Write a program to implement List Operations(Nested list, Length, Concatenation, Membership ,Iteration ,Indexing and Slicing), List Methods(Add, Append, Extend & Delete)
3	Write a program to Illustrate Different Set Operations.
4	Write a program to implement Simple Chatbot.
5	Write a program to implement Breadth First Search Traversal.
6	Write a program to implement Depth First Search Traversal.
7	Write a program to implement Water Jug Problem.
8	Write aprogram to implement K -Nearest Neighbor algorithm.
9	Write a program to implement Regression algorithm.
10	Write a program to implement Random Forest Algorithm.

Course Code: CSDT 114C	**Course Name: Web Services**	**Total Lectures (30 Hours)**
Teaching Scheme : 4 hrs/week	**Examination Scheme: IA: 15 Marks UE: 35 Marks**	**No. of Credits 2**
Course Prerequisites:	• Strong knowledge about Java programming. • Good Understanding of Object Oriented Programming concepts. • Must be familiar with XML.	
Course Objectives:	• To understand the details of web services technologies like WSDL,UDDI, SOAP • To learn how to implement and deploy web service client and server • To explore interoperability between different frameworks • To understand the concept of RESTful system.	
Chapter	**Course Contents**	**No. of Lectures**
1	**Web Service and SOA fundamentals** **Introduction to Web Services** — The definition of web services, basic operational model of web services, tools and technologies enabling web services, benefits and challenges of using web services. **Web Services Architecture** — Web services Architecture and its characteristics, core building blocks of web services, standards and technologies available for implementing web services, web services communication models, basic steps of implementing web services.	6
2	**SOAP: Simple Object Access Protocol** Inter-application communication and wire protocols, SOAP as a messaging protocol, Structure of a SOAP message, SOAP communication model, Building SOAP Web Services, developing SOAP Web Services using Java, Error handling in SOAP, Advantages and disadvantages of SOAP.	8

3	**Unit III : Describing and Discovering Web Services** **WSDL -** WSDL in the world of Web Services, Web Services life cycle, anatomy of WSDL definition document, WSDL bindings, WSDL Tools, limitations of WSDL, Service discovery, role of service discovery in a SOA, service discovery mechanisms, **UDDI** – UDDI Registries, uses of UDDI Registry, Programming with UDDI, UDDI data structures, support for categorization in UDDI Registries, Publishing API, Publishing information to a UDDI Registry, searching information in a UDDI Registry, deleting information in a UDDI Registry, limitations of UDDI.	8
4	**Unit IV : The REST Architectural style :** Introducing HTTP, The core architectural elements of a RESTful system, Description and discovery of RESTful web services, Java tools and frameworks for building RESTful web services, JSON message format and tools and frameworks around JSON, Build RESTful web services with JAX-RS APIs, The Description and Discovery of RESTful Web Services, Design guidelines for building RESTful web services, Secure RESTful web services	8

References:

Sr. No.	Title of the Book	Author/s	Publication
1	Building Web Services with Java, 2nd Edition	S. Graham and others	Pearson Edn., 2008.
2	J2EE Web Services	Richard Monson-Haefel	Pearson Education.
3	Java Web Services Programming,	R.Mogha,V.V.Preetham	Wiley India Pvt.Ltd.
4	XML, Web Services, and the Data Revolution	F.P.Coyle	Pearson Education

CSDP114C: Web Services Practical Assignments

Pre-requisites

- Strong knowledge about Java programming / PHP / .Net Framework
- Good Understanding of Object Oriented Programming concepts.
- Must be familiar with XML.

Objectives

- To understand how to develop web services using Java/PHP/.Net

Sr. No.	Assignment
1.	Create 'Dynamic Web Project', which will host your web service functionality to greet the user according to server time and create 'Dynamic Web Project', which will host the client application that will send user name and test the web service.
2.	Create 'Dynamic Web Project', which will host your web service functionality to convert Celsius to Fahrenheit and create 'Dynamic Web Project', which will host the client application that will send Celsius and test the web service.
3.	Create 'Dynamic Web Project', which will host your web service functionality to find the factorial of given number and create 'Dynamic Web Project', which will host the client application that will send positive integer number and test the web service.
4.	Create 'Dynamic Web Project', which will host your web service functionality to validate email id (use regular expression) and create 'Dynamic Web Project', which will host the client application that will send email id and test the web service.
5.	Create 'Dynamic Web Project', which will host your web service functionality to validate user name and password (use database for storing username and password) and create 'Dynamic Web Project', which will host the client application that will send user name and password and test the web service.
6.	Create 'Dynamic Web Project', which will host your web service functionality to select employee details (use database for storing emp details (eno, ename, designation, salary)) and create 'Dynamic Web Project', which will host the client application that will send employee name and display the details.
7.	Create 'Dynamic Web Project', which will host your web service functionality to select Movie details (Movie(mno, mname,release_year) and Actor(ano,aname), 1 : M cardinality) and create 'Dynamic Web Project', which will host the client application that will send actor name and display the details.
8.	Create 'Dynamic Web Project', which will host your web service functionality to validate mobile no (use regular expression: should contain only 10 numeric no) and create 'Dynamic Web Project', which will host the client application that will send mobile no and test the web service.
9.	Create 'Dynamic Web Project', which will host your web service functionality to convert Rupees to Dollar, Pound, Euro,….. and create 'Dynamic Web Project', which will host the client application that will send amount in Rupees & type of conversion and tests the web service.

10.	Create 'Dynamic Web Project', which will host your web service functionality to give the suggestion for given key word and create 'Dynamic Web Project', which will host the client application that tests the web service.
11.	Create 'Dynamic Web Project', which will host your web service functionality to find area and volume of the circle and create 'Dynamic Web Project', which will host the client application that tests the web service.
12.	Create 'Dynamic Web Project', which will host your web service functionality to find number of vowels in the given string and create 'Dynamic Web Project', which will host the client application that tests the web service.
13.	Create 'Dynamic Web Project', which will host your web service functionality to convert decimal number to Binary, Octal, Hexa Decimal and create 'Dynamic Web Project', which will host the client application that will send decimal number & type of conversion and test the web service.
14.	Create 'Dynamic Web Project', which will host your web service functionality to validate user name and password (use database for storing username and password) and create 'Dynamic Web Project', which will host the client application that will send user name and password and test the web service.
15.	Create 'Dynamic Web Project', which will host your web service functionality for returning book price and create 'Dynamic Web Project', which will host the client application that will send Book Name

CSUP115: PPL and Database Technologies Practical

LIST OF SCALA PROGRAMS (PPL)

Control Structures

1. Write a program to calculate average of all numbers between n1 and n2(eg.100 to 300 Read values of n1 and n2 from user)
2. Write a program to calculate factorial of a number.
3. Write a program to read five random numbers and check that random numbers are perfect number or not.
4. Write a program to find second maximum number of four given numbers.
5. Write a program to calculate sum of prime numbers between 1 to 100
6. Write a program to read an integer from user and convert it to binary and octal using user defined functions.

Arrays

1. Write a program to find maximum and minimum of an array
2. Write a program to calculate transpose of a matrix.
3. Write a program to calculate determinant of a matrix,
4. Write a program to check if the matrix is upper triangular or not.
5. Write a program to sort the matrix using insertion sort.
6. Write a program for multiplication of two matrices(Validate number of rows and columns before multiplication and give appropriate message)

String

1. Write a program to count uppercase letters in a string and convert it to lowercase and display the new string.
2. Write a program to read a character from user and count the number of occurrences of that character.
3. Write a program to read two strings. Remove the occurrence of second string in first string.
4. Create array of strings and read a string from user. Display all the elements of array containing given string.

Classes and Objects

1. Define a class CurrentAccount (accNo, name, balance, minBalance). Define appropriate constructors and operations withdraw(), deposit(), viewBalance(). Create an object and perform operations.
2. Define a class Employee (id, name, salary). Define methods accept() and display(). Display details of employee having maximum salary.
3. Create abstract class Order (id, description). Derive two classes PurchaseOrder& SalesOrder with members Vendor and Customer. Create object of each PurchaseOrder and SalesOrder. Display the details of each account.
4. Create abstract class Shape with abstract functions volume() and display(). Extend two classes Cube and Cylinder from it. Calculate volume of each and display it.

5. Create class Project (id, name, location). Define parameterized constructor. Keep a count of each object created and display the details of each project.
6. Define a class Sports (id, name, description, amount). Derive two classes Indoor and Outdoor. Define appropriate constructors and operations. Create an object and perform operations.
7. Design abstract class Employee with computeSal() as abstract function. Create two subclasses Worker and Manager. Salary of worker should be calculated on hourly basis of work and Salary of Manager should be calculated on monthly basis with additional incentives.

List

1. Create Lists using five different methods(Lisp style , Java style, fill, range and tabulate methods)
2. Create two Lists and Merge it and store the sorted in ascending order.
3. Create a list of integers divisible by 3 from List containing numbers from 1 to 50.
4. Create a list of even numbers up to 10 and calculate its product.
5. Write a program to create list with 10 members using function $3n^2+4n+6$
6. Write a program to create a list of 1 to 100 numbers. Create second list from first list selecting numbers multiple of 10.
7. Create a list of 50 members using function 2n+3. Create second list excluding all elements multiple of 7.

Map

1. Write a user defined functions to convert lowercase letter to uppercase and call the function using Map.
2. Write a program to create map with Rollno and FirstName. Print all student information with same FirstName.

Set

1. Write a program to create two sets and find common elements between them.
2. Write a program to display largest and smallest element of the Set
3. Write a program to merge two sets and calculate product and average of all elements of the Set

Database Technologies: MongoDB Practical Assignment 1

1. Create a database with the name ‘Movie’.
2. A ‘Film’ is a collection of documents with the following fields:
    a. Film Id
    b. Title of the film
    c. Year of release
    d. Genre / Category (like adventure, action, sci-fi, romantic etc.) A film can belong to more than one genre.
    e. Actors (First name and Last name)
    A film can have more than one actor.
    f. Director (First name and Last name)
    A film can have more than one director.
    g. Release details (It consists of places of release, dates of release and rating of the film.)
3. An ‘Actor’ is a collection of documents with the following fields:
    a. Actor Id
    b. First name
    c. Last Name
    d. Address (Street, City, State, Country, Pin-code)
    e. Contact Details (Email Id and Phone No)
    f. Age of an actor.

Queries:

1. Insert at least 10 documents in the collection Film –
    a. Insert at least one document with film belonging to two genres.
    b. Insert at least one document with film that is released at more than one place and on two different dates.
    c. Insert at least three documents with the films released in the same year.
    d. Insert at least two documents with the films directed by one director.
    e. Insert at least two documents with films those are acted by a pair ‘Madhuri Dixit’ and ‘Shahrukh Khan’.
2. Insert at least 10 documents in the collection Actor.

    Make sure, you are inserting the names of actors who have acted in films, given in the ‘Film’ collection.
3. Display all the documents inserted in both the collections.
4. Add a value to the rating of the film whose title starts with ‘T’.
5. Add an actor named "_____" in the ‘Actor’ collection. Also add the details of the film in ‘Film’ collection in which this actor has acted in.
6. Delete the film "_____".
7. Delete an actor named "_____".
8. Delete all actors from an ‘Actor’ collection who have age greater than “____”
9. Update the actor’s address where Actor Id is “_____”.
10. Update the genre of the film directed by “_____”.

Database Technologies: MongoDB Practical Assignment 2

1. Create a database with name ‘Company’.
2. An ‘Employee’ is a collection of documents with the following fields:
    a. Employee ID
    b. First Name
    c. Last Name
    d. Email
    e. Phone No.
    f. Address (House No, Street, City, State, Country, Pin-code)
    g. Salary
    h. Designation
    i. Experience
    j. Date of Joining
    k. Birthdate
3. A ‘Transaction’ is a collection of documents with the following fields:
    a. Transaction Id,
    b. Transaction Date
    c. Name (First Name of employee who processed the transaction)
    d. Transaction Details (Item Id, Item Name, Quantity, Price)
    e. Payment (Type of Payment (Debit/Credit/Cash), Total amount paid, Payment Successful)
    f. Remark (Remark field can be empty.)

Queries:

1. Insert at least 5 documents in ‘Employee’ collection.
2. Insert multiple documents (at least 10) into the ‘Transaction’ collection by passing an array of documents to the db.collection.insert () method.
3. Display all the documents of both the collections in a formatted manner.
4. Update salary of all employees by giving an increment of Rs. 4000.
5. Update the remark for transaction id 201.
6. Update designation of an employee named “_____” from supervisor to manager.
7. Update designation of an employee having Employee Id as_____.
8. Change the address of an employee having Employee Id as_____.
9. Delete transaction made by “_____” employee on the given date.
10. Delete all the employees whose first name starts with ‘K’.

Database Technologies: MongoDB Practical Assignment 3

This assignment is based on 'Movie' database having collections 'Film' and 'Actor'.

Prerequisite: Read MongoDB Aggregate framework before executing the following assignments.

Note: It is expected that student should fill in the data relevant to the queries given in the assignment. The result set should not be empty.

1. Find the titles of all the films starting with the letter 'R' released during the year 2009 and 2011.
2. Find the list of films acted by an actor "_____".
3. Find all the films released in 90s.
4. Find all films belonging to "Adventure" and "Thriller" genre.
5. Find all the films having 'A' rating.
6. Arrange the film names in ascending order and release year should be in descending order.
7. Sort the actors in ascending order according to their age.
8. Find movies that are comedies or dramas and are released after 2013.
9. Show the latest 2 films acted by an actor "_____".
10. List the titles of films acted by actors "_____" and "_____".
11. Retrieve films with an actor living in Spain.
12. Retrieve films with actor details.

Note: Similarly, additional queries can be executed based on these collections for practice.

Database Technologies: MongoDB Practical Assignment 4

This assignment is based on ‘Company’ database having collections ‘Employee’ and ‘Transaction’.

Prerequisite: Read MongoDB Aggregate framework before executing the following assignments.

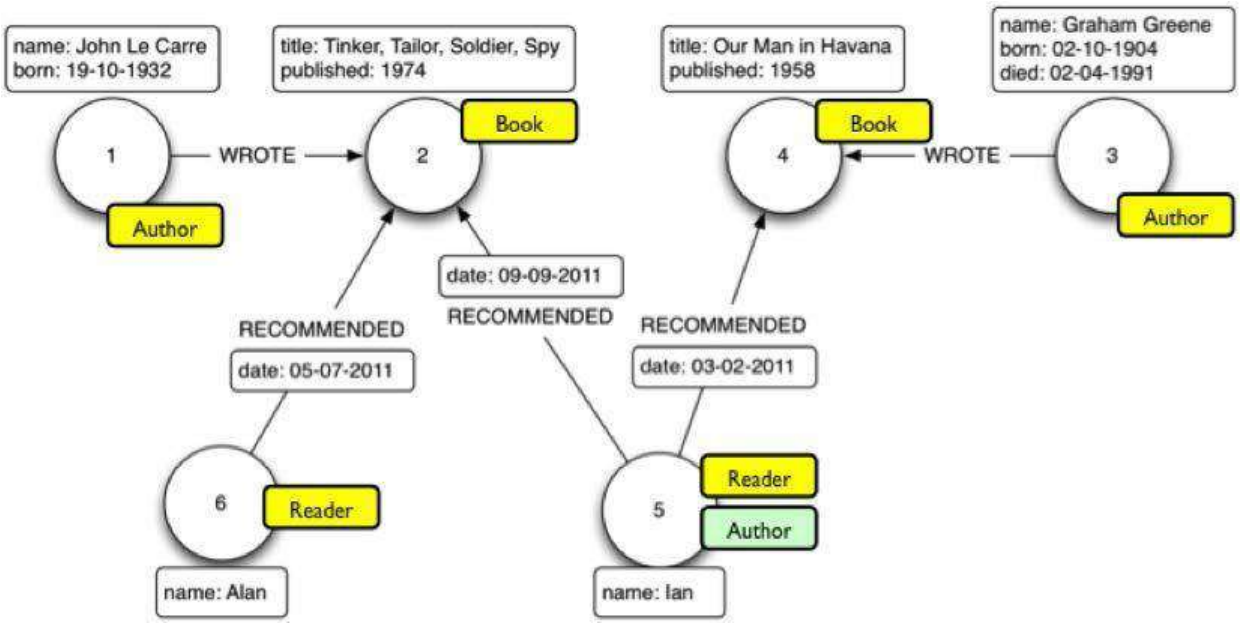
Note: It is expected that student should fill in the data relevant to the queries given in the assignment. The result set should not be empty.

1. Find employees having designation as either ‘manager’ or ‘floor supervisor’.
2. Find an employee whose name ends with "_____" and print the output in json format.
3. Display the name of an employee whose salary is greater than _____ using a MongoDB cursor.
4. Sort the employees in the descending order of their designation.
5. Count the total number of employees in a collection.
6. Calculate the sum of total amount paid for all the transaction documents.
7. Calculate the sum of total amount paid for each payment type.
8. Find the transaction id of the latest transaction.
9. Find designation of employees who have made transaction of amount greater than Rs. 500.
10. Find the total quantity of a particular item sold using Map Reduce.

Database Technologies: Neo4j Practical Assignment 1

Create the following databases as graph models. Visualize the models after creation, Return properties of nodes, Return the nodes labels, Return the relationships with its properties.
NB: You may assume and add more labels , relationships, properties to the graphs

1. Create a library database , as given below.



There are individual books, readers, and authors that are present in the library data model.. A minimal set of labels are as follows:
Book: This label includes all the books
Person: This label includes authors, translators, reviewers, Readers, Suppliers and so on
Publisher: This label includes the publishers of books in the database

A set of basic relationships are as follows:
PublishedBy: This relationship is used to specify that a book was published by a publisher
Votes: This relationship describes the relation between a user and a book, for example, how a book was rated by a user.
ReviewedBy : This relationship is used to specify that a book was reviewed and remarked by a user.
TranslatedBy: This relationship is used to specify that a book was translated to a language by a user.
IssuedBy: This relationship is used to specify that a book was issued by a user.
ReturnedBy: This relationship is used to specify that a book was returned by a user

Every book has the following properties:
Title: This is the title of the book in string format

Tags: This is an array of string tags useful for searching through the database based on topic, arguments, geographic regions, languages, and so on
Status: the book status , specifying whether its issued or in library.
Condition: book condition, new or old
Cost : Cost of book
Type: book is a Novel, Journal, suspense thriller etc

2. Consider a Song database, with labels as Artists, Song, Recording_company, Recoding_studio, song author etc.
Relationships can be as follows
Artist ⟶ [Performs] ⟶ Song ⟶ [Written by] ⟶ Song_author.
Song ⟶ [Recorded in] ⟶ Recording Studio ⟶ [managed by] ⟶ recordingCompany
Recording Company ⟶ [Finances] ⟶ Song
You may add more labels and relationship and their properties, as per assumptions.

3. Consider an Employee database, with a minimal set of labels as follows Employee: denotes a person as an employee of the organization Department: denotes the different departments, in which employees work. Skillset: A list of skills acquired by an employee
Projects: A list of projects in which an employee works.
A minimal set of relationships can be as follows: Works_in : employee works in a department Has_acquired: employee has acquired a skill Assigned_to : employee assigned to a project Controlled_by: A project is controlled by a department Project_manager : Employee is a project_manager of a Project

4. Consider a movie database, with nodes as Actors, Movies, Roles, Producer, Financier, Director. Assume appropriate relationships between the nodes, include properties for nodes and relationships.

5. Create a Social network database , with labels as Person, Affiliations, Groups, Story, Timeline etc. Some of the relationships can be as follows:
Person ⟶ [friend of] ⟶ Person ⟶ [affiliated to] ⟶ affiliations
Person ⟶ [belongs to] ⟶ Groups, Person ⟶ [create] ⟶ Story ⟶ [refers to] ⟶ Person
Person ⟶ [creates] ⟶ Timeline ⟶ [reference for] ⟶ Story ,
Timeline ⟶ [contains] ⟶ Messages

Database Technologies: Neo4j Practical Assignment 2 Simple Queries.

1. Library Database :
   a) List all people, who have issued a book "……"
   b) Count the number of people who have read " …."
   c) Add a property "Number of books issued " for Mr. Joshi and set its value as the count
   d) List the names of publishers from pune city.

2. Song Database:
   a) List the names of songs written by ":….."
   b) List the names of record companies who have financed for the song "…."
   c) List the names of artist performing the song "….."
   d) Name the songs recorded by the studio " ……."

3. Employee Database:
   a) List the names of employees in department "…….."
   b) List the projects along with their properties, controlled by department "……"
   c) List the departments along with the count of employees in it
   d) List the skillset for an employee "……."

4. Movie Database:
   a) Find all actors who have acted in a movie "……."
   b) Find all reviewer pairs, one following the other and both reviewing the same movie, and return entire subgraphs.
   c) Find all actors that acted in a movie together after 2010 and return the actor names and movie node
   d) Find all movies produced by " ……."

5. Social Network Database:
   a) Find all friends of "John", along with the year, since when john knows them.
   b) List out the affiliations of John.
   c) Find all friends of john, who are born in the same year as John
   d) List out the messages posted by John in his timeline, during the year 2015.

Database Technologies: Neo4j Assignment 3 Complex pattern Queries:

1. Library database
   a) List all readers who have recommended either book "…" or "……..." or "……..."
   b) List the readers who haven't recommended any book
   c) List the authors who have written a book that has been read / issued by maximum number of readers.
   d) List the names of books recommended by "……." And read by at least one reader
   e) List the names of books recommended by "……" and read by maximum number of readers.
   f) List the names of publishers who haven't published any books written by authors from Pune and Mumbai.
   g) List the names of voracious readers in our library

2. Song Database:
   a) List the names of artists who have sung only songs written by "……"
   b) List the names of artists who have sung the maximum number of songs recorded by "……" studio
   c) List the names of songs financed by "…..", and sung by "…….."

3. Employee Database:
   a) List the names of employees having the same skills as employee "……."
   b) List the projects controlled by a department "……." and have employees of the same department working in it.
   c) List the names of the projects belonging to departments managed by employee "……."

4. Movie Database:
   a) List the names of actors that paired in multiple movies together.
   b) List all pairs of actor–movie subgraphs along with the roles played.
   c) List all reviewers and the ones they are following directly or via another a third Reviewer
   d) List the names of movies that have the most number of reviews.

4. Social Network Database:
   a) List out the people, who have created maximum timeline messages.
   b) List all friends of John's friend, Tom
   c) List the people with maximum friends
   d) List the people who are part of more than 3 groups.

Course Code: CSUT121	**Course Name: Advanced Operating System**	**Total Lectures (48 Hours)**
Teaching Scheme : 4 hrs/week	**Examination Scheme: IA: 30 Marks UE: 70 Marks**	**No. of Credits 4**
Course Prerequisites:	• Working knowledge of C programming. • Basic Computer Architecture concepts. • Basic algorithms and data structure concepts.	
Course Objectives:	This course teaches Advanced Operating Systems Concepts using Unix/Linux. This course strikes a delicate balance between theory and practical applications In fact, most Units start with the theory and then switches focus on how the concepts are implemented in a C program. This course describes the programming interface to the Unix/Linux system - the system call interface. It is intended for anyone writing C programs that run under Unix/Linux. This course provides an understanding of the functions of Operating Systems. It also provides provide an insight into functional modules of Operating Systems. It discusses the concepts underlying in the design and implementation of Operating Systems.	
Chapter	**Course Contents**	**No. of Lectures**
1	**Introduction to UNIX/LinuxKernel** • System Structure, User Perspective, Assumptions about Hardware, Architecture of UNIX Operating System (TextBook-1: Chapter Topics: 1.2, 1.3, 1.5, 2.1) • Concepts of Linux Programming- Files and the Filesystem, Processes, Users and Groups, Permissions, Signals, Interprocess Communication (TextBook-3: Chapter 1- relevant topics)	04
2	**File and Directory I/O** • Buffer headers, structure of the buffer pool, scenarios for retrieval of a buffer, reading and writing disk blocks, inodes, structure of regular file, open, read, write, lseek, close, pipes, dup (TextBook- 1: Chapter Topics: 3.1-3.4, 4.1, 4.2, 5.1-5.3, 5.5-5.7, 5.12, 5.13) • open, creat, file sharing, atomic operations, dup2, sync, fsync, and fdatasync, fcntl, /dev/fd, stat, fstat, lstat, file types, Set-User-ID and Set-Group-ID, file access permissions, ownership of new files and directories, access function, umask function, chmod and fchmod, sticky bit, chown, fchown, and lchown, file size, file truncation, file systems, link, unlink, remove, and rename functions, symbolic links, symlink and readlink functions, file times, utime, mkdir and rmdir, reading directories, chdir, fchdir, and getcwd, device special files (TextBook-2: Chapter Topics: 3.3, 3.4, 3.10-3.14, 3.16, 4.2-4.23)	15

3	**Process Environment, Process Control and Process Relationships** • Process states and transitions, layout of system memory, the context of a process, saving the context of a process, sleep, process creation, signals, process termination, awaiting process termination, invoking other programs, the user id of a process, changing the size of the process, The Shell, Process Scheduling (TextBook-1: Chapter Topics: 6.1-6.4, 6.6, 7.1-7.8, 8.1) • Process termination, environment list, memory layout of a C program, shared libraries, environment variables, setjmp and longjmp, getrlimit and setrlimit, process identifiers, fork, vfork, exit, wait and waitpid, waitid, wait3 and wait4, race conditions, exec, changing user IDs and group IDs,system function, user identification, process times (TextBook-2: Chapter Topics: 7.3, 7.5-7.7, 7.9-7.11, 8.2-8.11, 8.13, 8.15, 8.16)	15
4	**Memory Management** • The Process Address Space, Allocating Dynamic Memory, Managing Data Segment, Anonymous Memory Mappings, Advanced Memory Allocation, Debugging Memory Allocations, Stack-Based Allocations, Choosing a Memory Allocation Mechanism, Manipulating Memory, Locking Memory, Opportunistic Allocation (TextBook-3: Chapter 8) • Swapping, Demand Paging (TextBook-1: Chapter Topics: 9.1, 9.2)	06
5	**Signal Handling** • Signal concepts, signal function, unreliable signals, interrupted system calls, reentrant functions, SIGCLD semantics, reliable-signal technology, kill and raise, alarm and pause, signal sets, sigprocmask, sigpending, sigsetjmp and siglongjmp, sigsuspend, abort, system function revisited, sleep (TextBook-2: Topics: 10.2-10.13, 10.15-10.19)	08

References:

Sr. No.	Title of the Book	Author/s	Publication
1	The Design of the UNIX Operating System	Maurice J. Bach.	PHI
2	Advanced Programming in the UNIX Environment	Richard Stevens	Addison-Wesley
3	Linux System Programming	Robert Love	O'Reilly

Course Code: CSUT122	**Course Name: Mobile Technologies**	**Total Lectures (48 Hours)**
Teaching Scheme : 4 hrs/week	**Examination Scheme:** **IA: 30 Marks** **UE: 70 Marks**	**No. of Credits 4**
Course Prerequisites:	• Concepts of Networking • Conversant with OS internals • Familiar with the network Protocol stack • Gain knowledge about different mobile platform and application development • Brief History of wireless communication	
Course Objectives:	• To impart basic understanding of the wireless communication systems. • To expose students to various aspects of mobile and ad-hoc networks. • Understand the issues relating to Wireless applications • Understand the Mobile security	
Chapter	**Course Contents**	**No. of Lectures**
1	**Introduction to Mobile Computing** • Introduction and need for Mobile computing • Mobility and portability • Mobile and Wireless devices • Mobile Applications • Mobile Operating system – IOS, BlackBery, Windows phone, Plam OS, Symbian OS,PhoneGap	03
2	**Android Fundamentals** • Introduction to Android - Overview and evolution of Android , Features of Android, Android architecture • Components of an Android Application, Manifest file • Android Activity • Service Lifecycle	07
3	**Android UI Design** • Basic UI Designing (Form widgets ,Text Fields , Layouts ,[dip, dp, sip, sp] versus px) • Intent(in detail) • All components (e.g Button , Slider, Image view, Toast) Event Handling • Adapters and Widgets • Menu	07

4	**Android Thread and Notification** • Threads running on UI thread (runOnUiThread) • Worker thread • Handlers & Runnable • AsynTask (in detail) • Broadcast Receivers • Services and notifications • Toast • Alarms	07
5	**Advanced Android Programming** • Content Providers – SQLite Programming • JSON Parsing • Accessing Phone Service(Call, SMS, MMS) • Location based services	05
6	**PhoneGap Programming** • Why Use PhoneGap? • How PhoneGap Works • Designing for the Container • Writing PhoneGap Applications • Building PhoneGap Applications • PhoneGap Limitations • PhoneGap Plug-Ins • Hello, World! Program • PhoneGap APIs –1 **Accelerometer:** • Querying Device Orientation, • Watching a Device's Orientation, • Creating a Contact, Searching for Contacts, Cloning Contacts, Removing Contacts.	12
7	**iOS Fundamentals** • **Introduction** - What is IOS ,IOS Architecture, Frameworks, Application Life Cycle, Features • **Swift -** Introduction to Swift ,General Concepts of Swift • **Xcode -** Introduction to Xcode , Navigator, Editor Utility, Tools, Console, Document, Simulator, Instruments • **Startup -** Application Templates, Introduction to Storyboard , Hello World Application, How 'Hello World' Working, Debugging Database, Plist, Preference, Sqlite Web Service, Restful Web Service (JSON & XML)	08

References:

Sr. No.	Title of the Book	Author/s	Publication
1	A Course in Machine Learning	Hal Daumé III	
2	IOS Apprentice	Matthijs Hollemans	
3	PhoneGap: Beginner's Guide	Giorgio Natili, Purusothaman Ramanujam	PACKT Publication
4	Beginning Android Application Development	Wei-Meng Lee Wiley	

Course Code: CSUT123	Course Name: Software Project Management	Total Lectures (48 Hours)
Teaching Scheme : 4 hrs/week	**Examination Scheme:** **IA: 30 Marks** **UE: 70 Marks**	**No. of Credits** **4**
Course Prerequisites:	Software Engineering Basic testing concepts	
Course Objectives:	• Software Metrics and Project Management covers skills that are required to ensure successful medium and large scale software projects. • It examines Requirements Elicitation, Project Management, Verification &Validation and Management of Large Software Engineering Projects. • Students learn to select and apply project management techniques for process modeling, planning, estimation, process metrics and risk management; perform software verification and validation using inspections, design and execution of system test cases.	
Chapter	**Course Contents**	**No. of Lectures**
1	**Introduction to Project Management** What is a Project? What is Project management? Project phases and project life cycle Organizational structure Qualities of Project Manager WBS	4
2	**Project Management Components** Project Integration Management-Project plan development and execution Change controls CCB Configuration management	6
3	**Scope Management** Strategic planning Scope planning, definition Verification and control	4
4	**Time management** Activity planning Schedule development and control GANTT Chart	2
5	**Cost Management** Cost estimation and Control COCOMO model BASIC COCOMO NUMERICALS	2
6	**Quality Management** • Quality planning and assurance	2

7	**Human Resource Management** • Organizational planning • Staff acquisition	2
8	**Communication Management** • Information distribution • Reporting	2
9	**Risk Management** • Risk identification • Quantification and control	2
10	**Procurement Management** • Solicitation management and control • Contract administration	2
11	**Software Metrics** • The scope of software metrics • Size- oriented metrics • Function oriented • Software metrics data collection • Analyzing software data	6
12	**Software Reliability** • Measurement and prediction • Resource measurement • Productivity, teams and tools	6
13	**Planning a measurement program** • What is metrics plan? • Developing goals, questions and metrics • Where and When: Mapping measures to activities • How: Measurement tools • Who: Measurers , analyst, tools revision plans	4
14	**Quality Standards** • CMM levels • KPA's • PSP/TSP	4

References:

Sr. No.	Title of the Book	Author/s	Publication
1.	Software Engineering	Roger Pressman	McGraw-Hill
2.	Software Metrics for Project Management and process improvement	Robert B. Grady	Prentice hill

CSDT124A: Project Guidelines

CSDP124A: Project Related Assignments

Assignment 1

Assignment 2

Assignment 3

Assignment 4

Course Code: CSDT124B	**Course Name: Human Computer Interaction**	**Total Lectures (30 Hours)**
Teaching Scheme : 4 hrs/week	**Examination Scheme:** **IA: 15 Marks** **UE: 35 Marks**	**No. of Credits 2**
Course Prerequisites:	• Foundations of Human Computer Interaction • Be familiar with the design technologies for individuals and persons with disabilities • Be aware of mobile HCI • Learn the guidelines for user interface.	
Course Objectives:	• Design effective dialog for HCI. • Design effective HCI for individuals and persons with disabilities. • Assess the importance of user feedback. • Explain the HCI implications for designing multimedia/ ecommerce/ e-learning Web sites. • Develop meaningful user interface.	
Chapter	**Course Contents**	**No. of Lectures**
1	**FOUNDATIONS OF HCI** The Human: I/O channels – Memory – Reasoning and problem solving; The computer: Devices – Memory – processing and networks; Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms.	6
2	**DESIGN & SOFTWARE PROCESS** Interactive Design basics – process – scenarios – navigation – screen design – Iteration and prototyping. HCI in software process – software life cycle – usability engineering – Prototyping in practice – design rationale. Design rules – principles, standards, guidelines, rules. Evaluation Techniques – Universal Design	7
3	**MODELS AND THEORIES** Cognitive models –Socio-Organizational issues and stake holder requirements –Communication and collaboration models-Hypertext, Multimedia and WWW.	5
4	**MOBILE HCI** Mobile Ecosystem: Platforms, Application frameworks Types of Mobile Applications: Widgets, Applications, Games- Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools.	6

5	**WEB INTERFACE DESIGN** Designing Web Interfaces – Drag & Drop, Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow, Case Studies.	6

References:

Sr. No.	Title of the Book	Author/s	Publication
1	Human Computer Interaction, (Chapter 1 , 2 & 3)	Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale	3rd Edition, Pearson Education, 2004
2	Mobile Design and Development (Chapter 4)	Brian Fling	First Edition O‟Reilly Media Inc., 2009
3	Designing Web Interfaces (Chapter 5)	Bill Scott and Theresa Neil	First Edition, O‟Reilly, 2009

CSDP124B: Human Computer Interaction Practical Assignments

Note: Any tool or technology can be used for implementation e.g., VBDOTNET, JAVA, PHP, etc.

1) Understand the trouble of interacting with Computers - Redesign interfaces of applications. Select any application, like land-line phone application, registration etc and understand the trouble of interacting with that application. Comment on design of that application as good or bad design based on whether interaction principles are matching with users mental model or not. Redesign the interface for mention the change in design and reason.

2) Know your client: Select anyone category of user and develop application understanding the user who will be using your system. Comment on the category of user selected and specific features given for the users and identify what kinds of interfaces will they like and why?. Compare with existing system analyze and rate them.Analyze user models and develop user centric interfaces for :

   a. Children (4-5 years of age): An application to teach math.
      Perform analysis of children behavior e.g. their preferences, interests etc

   b. Teenagers: Design a digital diary for young teens to help them overcome various social pressures they deal with during their teen years. The diary should also be like a self help tool which would help them deal with incidents like bullying, peer pressure, etc.. This is an open project and you can think in any direction to make the children sail through their teen years while trying to discover life around them.
      Perform analysis of teenagers e.g. their problems, interests, needs, etc

   c. Older generation: Folks from the older generation has been very wary of using their credit card on the Internet. They have various concerns when it comes to paying their bills. Also because of their old age, it will be beneficial for them to use the internet and pay their phone, electricity, gas, etc. bills
      Analysis of old people e.g. their nature, interests, needs, etc

   d. Rural people: ATVM for train ticketing in rural area
      Perform analysis of rural people e.g. their problems, interests, needs, language etc

   e. Mentally disabled: Design the interface of a game for mentally disabled children.
      Analysis of mentally disabled e.g. their behavior, problems, interests…

   Any tool or technology can be used for implementation e.g., VB, DOTNET, JAVA, PHP, etc.

3) Identify 5 different websites catering to one specific goal (eg. Goal – on-line shopping and 5 different websites – ebay, amazon, flipkart, zovi, myntra) and perform a competitive analysis on them to understand how each one caters to the goal, the interactions and flow of the payment system and prepare a report on the same. Consider any 8 HCI principles and prepare the following table evaluating the websites.

Sr. No	Principles	Poor	Average	Good	Good Very	Excellent
1.	Aesthetically pleasing					
2.	..					

4) To achieve simplicity one needs to optimize the number of elements on a screen, within limits of clarity. And minimize the alignment points, especially horizontal or columnar

1. Calculate Screen Complexity for existing Graphical User Interface (GUI).
2. Redesign the Screen by applying various guidelines to lower the complexity of selected Graphical User Interface (GUI) to achieve simplicity

Method for Measuring Complexity:

1. Draw a rectangle around each element on a screen, including captions, controls, headings, data, title, and so on.
2. Count the number of elements and horizontal alignment points (the number of columns in which a field, inscribed by a rectangle, starts).
3. Count the number of elements and vertical alignment points (the number of rows in which an element, inscribed by a rectangle, starts).
4. Calculate number of bits required by horizontal (column) alignment points and number of bits required by vertical (row) alignment points by applying following formula for calculating the measure of complexity.

$$C = -N \sum_{n=1}^{m} p_n \log_2 p_n$$

C, complexity of the system in bits
N, total number of events (widths or heights)
m, number of event classes (number of unique widths or heights)
pn, probability of occurrence of the nth event class (based on the frequency of events within that class)

5. Calculate overall complexity by adding the number bits required by horizontal alignment points and vertical alignment points.

5) Design/Redesign web user interface based on Gestalt theories and comment on the principle applied and justify. Alsoanalyze one image in which Gestalt principle is applied and comment.

Example: Take a look at old IBM logo:

You recognize the letters as an I, a B, and an M, no problem there. But they aren't letters at all; the whole thing is a compilation of bright blue horizontal lines arranged to create the perception of a set of letters. Gestalt Property used here is Closure. Closure means that we "close" objects that are themselves not complete; not only completing the figure in our

perception, but perceiving the figure as having an extra element of aesthetic design; we look for a simple, recognizable pattern.

6) Design an application which consists of different types of menus such as Menu bar, Pull-Down Menu, Cascading Menu, Pop-up Menus,Tear-off Menus. Apply and explain general menu design guidelines applied for formatting, ordering, phrasing, selecting choices, and navigating menus for application which is designed.

7) Implement different Kinds of Windows such as message boxes, palette Windows, Pop-up Windows, primary window, secondary window, dialog boxes, message box etc. For every window designed for the application explain:
- Purpose
- Description
- Components
- Kind window

8) Identify separate lines of business, e.g., medical, greeting cards, law etc. Design an application using proper guidelines for icons. Comment on design of icons and their relevance in the system.

Icon design is an important process. Meaningful and recognizable icons will speed learning and recall and yield a much more effective system. Poor design will lead to errors, delays, and confusion. Looks different from all other icons.
- Is obvious what it does or represents. - Is recognizable when no larger than 16 pixels square.
- Looks as good in black and white as in color. Icon Size

Supply in all standard sizes.
- 16 × 16 pixels.
- 16- and 256-color versions. - 32 × 32 pixels
- 16- and 256-color versions. - 48 × 48 pixels
- 16- and 256-color versions.
- Use colors from the system palette.
- Use an odd number of pixels along each side.
- Provides center pixel around which to focus design.
- Minimum sizes for easy selection:
-With stylus or pen: 15 pixels square.
- With mouse: 20 pixels square.
- With finger: 40 pixels square. - Provide as large a hot zone as possible. Choosing Images
- Use existing icons when available.
- Use images for nouns, not verbs.
- Use traditional images.
- Consider user cultural and social norms.

The Design Process of Icons
- Define purpose:

To begin the design process, first define the icon's purpose and use. Have the design team brainstorm about possible ideas, considering real-world metaphors.
- Collect, evaluate, and sketch ideas:

Start by designing on paper, not on the computer. Ask everyone to sketch his or her ideas.

- Draw in black and white: Many icons will be displayed in monochrome. Color is an enhancing property; consider it as such.
- Test for expectation, recognition, and learning. Choosing the objects and actions, and the icons to represent them, is not a precise process, and will not be easy. So, as in any screen design activity, adequate testing and possible refinement of developed images must be built into the design process. Icon recognition and learning should both be measured as part of the normal testing process.
- Test for legibility.

Verify the legibility and clarity of the icons in general. Also, verify the legibility of the icons on the screen backgrounds chosen. White or gray backgrounds may create difficulties. An icon mapped in color, then displayed on a monochrome screen, may not present itself satisfactorily. Be prepared to redraw it in black and white, if necessary.

- Register new icons in the system's registry.

Create and maintain a registry of all system icons. Provide a detailed and distinctive description of all new icons.

Course Code: CSDT124C	**Course Name: Soft Computing**	**Total Lectures (30 Hours)**
Teaching Scheme : 4 hrs/week	**Examination Scheme:** **IA: 15 Marks** **UE: 35 Marks**	**No. of Credits 2**
Course Prerequisites:	• A strong mathematical background • Proficiency with algorithms • Critical thinking and problem solving skills	
Course Objectives:	• To introduce the ideas of soft computational techniques based on human experience. • To generate an ability to design, analyze and perform experiments on real life problems using various Neural Learning Algorithms. • To conceptualize fuzzy logic and its implementation for various real world applications. • To apply the process of approximate reasoning using Neuro-Fuzzy Modeling. • To provide the mathematical background to carry out optimization using genetic algorithms.	

Chapter	**Course Contents**	**No. of Lectures**
1	**Introduction to Soft Computing** Neural Networks: Definition, Advantages, Applications, Scope. Fuzzy logic: Definition, Applications. Genetic Algorithms: Definition, Applications.	2
2	**Neural Network** Fundamental Concept: Artificial Neural Network, Biological Neural Network, Brain vs. Computer-Comparison Between Biological Neuron and Artificial Neuron (Brain vs. Computer), Artificial Neurons, Neural Networks and Architectures: Neuron Abstraction, Neuron Single Functions, Mathematical Preliminaries, Neural Networks Defined, Architectures: Feedforward and Feedback, Salient Properties of NeuralNetworks Geometry of Binary Threshold Neurons and Their Networks: Pattern Recognition and Data Classification, Convex Sets, Convex Hulls and Linear Separability, Space of Boolean Functions, Binary Neurons are Pattern Dichotomizers, Non-linearly Separable Problems, Capacity of a Simple Threshold Logic Neuron, Revisiting the XOR Problem, Multilayer Networks, How Many Hidden Nodes areEnough? Learning and Memory: An Anecodatal Introduction, Long Term Memory, The Behavioral Approach to Learning, The Molecular Problem of Memory, Learning Algorithms, Error Correction and Gradient	15

	Descent Rules, Learning Objective for TLNs, Pattern Space and Weight Space. Linear Seperabilty, Hebb Network, Perceptron Network. α- Least Mean Square Learning.	
3	**Fuzzy Set Theory** Brief Review of Conventional Set Theory, Introduction to Fuzzy Sets, Properties of Fuzzy Sets, Operations on Fuzzy Sets, Crisp Relation, Fuzzy Relation, Tolerance and equivalence relation, Fuzzy Tolerance and equivalence relation, Fuzzy Max-Min and Max-Product Composition, Membership Functions, Fuzzification, Defuzzification to crisp sets, λ-Cuts for fuzzy Relations, Fuzzy (Ruled-Based) system, Graphical technique of inference, Membership value assignment-Intuition, Inference.	9
4	**Genetic Algorithms** What are Genetic Algorithms? Why Genetic Algorithms? Traditional Optimization and Search Techniques,Simple GA, Terminologies and Operators in GA, Encoding, Selection, Crossover, Mutation, Search Termination, Constraints in GA	4

References:

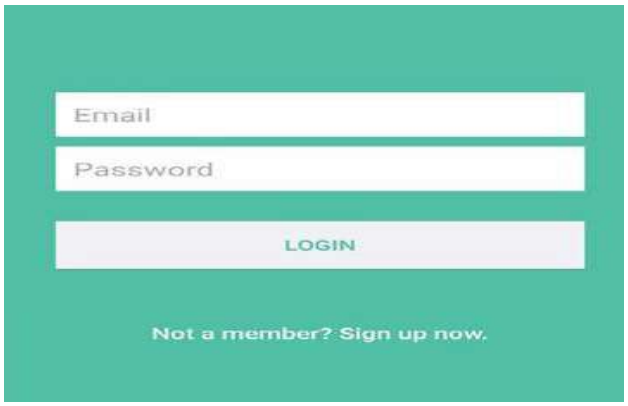
Sr. No.	Title of the Book	Author/s	Publication
1	Fuzzy Logic With Engineering Applications	Timothy Ross	Wiley Publication
2	Introduction to Soft Computing	Deepa & Shivanandan	Wiley Publication
3	Genetic Algorithms in Search, Optimization and Machine Learning	David E. Goldberg	Pearson Education
4	Fundamentals of Neural Networks – Architectures, Algorithms, And Applications	Laurene Fausett	Pearson Education
5	Neural Networks	Satish Kumar	Tata McGrawHill

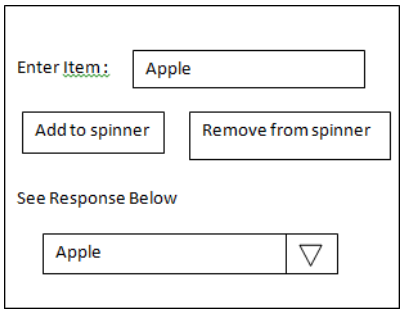
CSDP124C: Soft Computing Practical Assignment

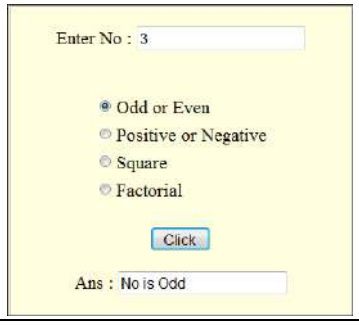
Implement the programs in C/C++/Java/MATLAB

Sr. No	Assignment
1.	Write a program to implement Fuzzy Operations Union Intersection Complement Algebraic sum Algebraic product Cartesian product
2.	Write a program to implement De Morgans law.
3.	Write a program to implement Max-Min Composition and Max-Product Composition.
4.	Write a program to implement lambda cut
5.	Write a program to implement Activation Function.
6.	Write a program to implement Perceptron Learning Rule
7.	Write a program to implement Hebb's Rule
8.	Write a program to implement Feed Forward Network
9.	Write a program for building an Artificial Neural Network by implementing the Back propagation Algorithm and test the same using appropriate data sets.
10.	Write a program for solving linearly separable problem using Perceptron Model.
11.	Write a program to develop supervised learning algorithm
12.	Write a program to study and analyze genetic life cycle

CSUP125: Practical on Advanced OS & Mobile Technologies

Sr. No.	Mobile Technologies Assignments
1.	Java Android Program to demonstrate login form with validation. 
2.	Java Android Program to demonstrate Registration form with validation.
3.	Create the simple calculator shown below also perform appropriate operation 
4.	Create an Android application which examine, that a phone number, which a user has entered is in the given format. * Area code should be one of the following: 040, 041, 050, 0400, 044 * There should 6-8 numbers in telephone number (+ area code).
5.	By using Spinner, Buttons. Write a program to draw following GUI.

	
6.	Create an Android application, which show to the user 5-10 quiz questions. All questions have 4 possible options and one right option exactly. Application counts and shows to the user how many right answers were right and shows the result to user.
7.	Construct an app to display the image on date wise.
8.	Construct image switcher using setFactory().
9.	Construct a bank app to display different menu like windrow, deposite etc.
10.	Create an Android application, where the user can enter player name and points in one view and display it in another view.
11.	Create an Android application, the user can enter 10 students information and stored it in file and display student information in second view and also search the particular student information.
12.	Write an application to accept two numbers from the user, and displays them, but reject input if both numbers are greater than 10 and asks for two new numbers.
13.	Create table Customer (id, name, address, phno). Create Application for Performing the following operation on the table. (using sqlite database) i) Insert New Customer Details. ii) Show All the Customer Details
14.	Create an application that allows the user to enter a number in the textbox named 'getnum'. Check whether the number in the textbox 'getnum' is palindrome or not. Print the message accordingly in the label control named lbldisplay when the user clicks on the button 'check'.
15.	Create Following Table: Emp (emp_no,emp_name,address,phone,salary) Dept (dept_no,dept_name,location) Emp-Dept is related with one-many relationship. Create application for performing the following Operation on the table 1) Add Records into Emp and Dept table. 2) Accept Department name from User and delete

	employee information which belongs to that department.
16.	Perform following numeric operation according to user selection of radio button 
17.	Perform following string operation according to user selection of radio button. 
18.	Java Andorid Program to Perform all arithmetic Operations using Calculators
19.	Java Android Program to Change the Image Displayed on the Screen
20.	Java Android Program to Demonstrate Alert Dialog Box
21.	Java Android Program to Demonstrate the Menu Application
22.	Java Android Program to Demonstrate List View Activity with all operations (Insert, delete, Search).
23.	Java Android Program to Display SMS from the Phone Numbers, which are in Your Contacts
24.	Java Android Program to send email with attachment.
25.	Create an Android application which will ask the user to input his name and a message, display the two items concatenated in a label, and change the format of the label using radio buttons and check boxes for selection, the user can make the label text bold, underlined or italic and change its color .include buttons to display the message in the label, clear the text boxes and label and then exit.
26.	Write a program to search a specific location on Google Map.
27.	Write a program to perform Zoom In, Zoom Out operation and display Satellite view,Terrain view of

	current location on Google Map.
28.	Digital Bio Data PhoneGap Application using HTML5.
29.	Write a PhoneGap application to display push notification.
30.	Write a PhoneGap application to create a contact, Searching for Contacts, Cloning Contacts, Removing Contacts.
31.	Write a IOS application to display “Hello World’.
32.	Write aios application to display gesture recognizer.
33.	Write a Swift program to add the last character (given string) at the front and back of a given string. The length of the given string must be 1 or more.
34.	Write a Swift program to create a new string where all the character "a" have been removed except the first and last positions.
35.	Write a Swift program to create a new string made of 2 copies of the first 2 characters of a given string. The string may be any length.
36.	Students design mobile applications for the Android or iOS platforms that uniquely meet clear needs in today’s markets. Student design documents include narratives, categorized use cases, screen rows, and database schemata
37.	Handling button events / actions in iOS
38.	Handling image in iOS using ImageView
39.	Write a iOS application to implement UI elements like ScrollView, TableView, Pickers, Switches
40.	Write a iOS application to Managing camera in iOS
41.	Write a iOS application to Handling audio, video and file in iOS
42.	Write a iOS application to Handling Accelerometer to manage change in position

Advanced OS Assignments

Write a following program in 'C

1. To create 'n' children. When the children will terminate, display total cumulative time children spent in user and kernel mode.
2. To generate parent process to write unnamed pipe and will read from it.
3. To create a file with hole in it.
4. Takes multiple files as Command Line Arguments and print their inode number.
5. To handle the two-way communication between parent and child using pipe.
6. Print the type of file where file name accepted through Command Line.
7. To demonstrate the use of atexit() function.
8. Open a file goes to sleep for 15 seconds before terminating.
9. To print the size of the file.
10. Read the current directory and display the name of the files, no of files in current directory.
11. Write a C program to implement the following unix/linux command (use fork, pipe and exec system call)
    ls –l | wc –l
12. Write a C program to display all the files from current directory which are created in particular month
13. Write a C program to display all the files from current directory whose size is greater that n Bytes Where n is accept from user.
14. Write a C program to implement the following unix/linux command
    i. ls –l > output.txt
15. Write a C program which display the information of a given file similar to given by the unix / linux command ls –l <file name>
16. Write a C program that behaves like a shell (command interpreter). It has its own prompt say "NewShell$". Any normal shell command is executed from your shell by starting a child process to execute the system program corresponding to the command. It should additionally interpret the following command.
    i) count c <filename> - print number of characters in file
    ii) count w <filename> - print number of words in file
    iii) count l <filename> - print number of lines in file
17. Write a C program that behaves like a shell (command interpreter). It has its own prompt say "NewShell$". Any normal shell command is executed from your shell by starting a child process to execute the system program corresponding to the command. It should additionally interpret the following command.
    i) list f <dirname> - print name of all files in directory
    ii) list n <dirname> - print number of all entries
    iii) list i<dirname> - print name and inode of all files

18. Write a C program that behaves like a shell (command interpreter). It has its own prompt say “NewShell$”. Any normal shell command is executed from your shell by starting a child process to execute the system program corresponding to the command. It should additionally interpret the following command.
    i) typeline +10 <filename> - print first 10 lines of file
    ii) typeline -20 <filename> - print last 20 lines of file
    iii) typeline a <filename> - print all lines of file

19. Write a C program that behaves like a shell (command interpreter). It has its own prompt say “NewShell$”.Any normal shell command is executed from your shell by starting a child process to execute the system program corresponding to the command. It should
    i) additionally interpret the following command.
    ii) search f <pattern> <filename> - search first occurrence of pattern in filename
    iii) search c <pattern> <filename> - count no. of occurrences of pattern in filename
    iv) search a <pattern> <filename> - search all occurrences of pattern in filename

20. Write a C program which receives file names as command line arguments and display those filenames in ascending order according to their sizes.
    i) (e.g $ a.out a.txt b.txt c.txt, …)

21. Write a C program which create a child process which catch a signal sighup, sigint and sigquit. The Parent process send a sighup or sigint signal after every 3 seconds, at the end of 30 second parent send sigquit signal to child and child terminates my displaying message "My DADDY has Killed me!!!”.

22. Write a C program to implement the following unix/linux command (use fork, pipe and exec system call). Your program should block the signal Ctrl-C and Ctrl-\ signal during the execution.
    i. ls –l | wc –l
23. Write a C Program that demonstrates redirection of standard output to a file.
24. Write a program that illustrates how to execute two commands concurrently with a pipe.
25. Write a C program that illustrates suspending and resuming processes using signals.
26. Write a C program that illustrates inters process communication using shared memory.

Savitribai Phule Pune University

(Formerly University of Pune)

Three Year B.Sc. Degree Program in Computer Science

(Faculty of Science & Technology)

T.Y.B.Sc. (Computer Science)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2021 – 2022

Course Structure T.Y.B.Sc. (Computer Science)

Semester V (Total credits=22)

Course type	Paper Code	Paper title	Credits		Evaluation		
			T	P	CA	UA	TOTAL
DSEC - I	CS-351	Operating Systems – I	2		15	35	50
	CS-352	Computer Networks – II	2		15	35	50
	CS-357	Practical course based on CS 351		2	15	35	50
DSEC - II	CS-353	Web Technologies – I	2		15	35	50
	CS-354	Foundations of Data Science	2		15	35	50
	CS-358	Practical course based on CS 353 and CS 354		2	15	35	50
DSEC - III	CS-355	Object Oriented Programming using Java - I	2		15	35	50
	CS-356	Theoretical Computer Science	2		15	35	50
	CS-359	Practical Course based on CS 355		2	15	35	50
SECC - I	CS-3510	Python Programming	2	0	15	35	50
SECC - II	CS-3511	Blockchain Technology	2	0	15	35	50

Semester VI (Total credits=22)

Course type	Paper Code	Paper title	Credits		Evaluation		
			T	P	CA	UA	TOTAL
DSEC - I	CS-361	Operating Systems – II	2		15	35	50
	CS-362	Software Testing	2		15	35	50
	CS-367	Practical course based on CS 361		2	15	35	50
DSEC - II	CS-363	Web Technologies – II	2		15	35	50
	CS-364	Data Analytics	2		15	35	50
	CS-368	Practical course based on CS 363 and CS 364		2	15	35	50
DSEC - III	CS-365	Object Oriented Programming using Java - II	2		15	35	50
	CS-366	Compiler Construction	2		15	35	50
	CS-369	Practical Course based on CS 365		2	15	35	50
SECC - III	CS-3610	Software Testing Tools	2	0	15	35	50
SECC - IV	CS-3611	Project	2	0	15	35	50

SavitribaiPhule Pune University
T.Y.B.Sc. (Computer Science) - Sem – V
Course Type: DSEC – I Course Code : CS - 351
Course Title : Operating Systems – I

Teaching Scheme:	No. of Credits:	Examination Scheme:
03 Lect / week	2	IE : 15 marks UE: 35 marks

Prerequisites
Data structures like stack, queue, linked list, tree, graph, hashing, file structures, any structured programming language

Course Objectives:
1. To understand the concept of operation system and its principle
2. To study the various functions and services provided by operating system
3. To understand the notion of process and threads

Course Outcomes: After completion of this course students will be able to understand the concept of
1. Processes and Thread Scheduling by operating system
2. Synchronization in process and threads by operating system
3. Memory management by operating system using with the help of various schemes

Course Contents

Chapter 1	**Introduction to Operating Systems**	**6 lectures**

- Operating Systems Overview- system Overview and Functions of operating systems
- What does an OS do?
- Operating system Operations
- Operating system structure
- Protection and security
- Computing Environments- Traditional, mobile , distributed, Client/server, peer to peer computing
- Open source operating System
- Booting
- Operating System services,
- System calls Types of System calls and their working.

Chapter 2	**Processes and Threads**	**6 lectures**

- Process Concept – The processes, Process states, Process control block.
- Process Scheduling – Scheduling queues, Schedulers, context switch
- Operations on Process – Process creation with program using fork(), Process termination
- Thread Scheduling- Threads, benefits, Multithreading Models, Thread Libraries

Chapter 3	**Process Scheduling**	**7 lectures**

- Basic Concept – CPU-I/O burst cycle, Scheduling Criteria ,CPU scheduler, Preemptive scheduling, Dispatcher
- Scheduling Algorithms – FCFS, SJF, Priority scheduling, Round-robin scheduling, Multiple queue scheduling, Multilevel feedback queue scheduling

Chapter 4	**Synchronization**	**5 lectures**

- Background
- Critical Section Problem
- Semaphores: Usage, Implementation

- Classic Problems of Synchronization – The bounded buffer problem, The reader writer problem, The dining philosopher problem

Chapter 5	**Memory Management**	**12 lectures**

- Background – Basic hardware, Address binding, Logical versus physical address space, Dynamic loading, Dynamic linking and shared libraries
- Swapping
- Contiguous Memory Allocation – Memory mapping and protection, Memory allocation, Fragmentation
- Paging – Basic Method, Hardware support, Protection, Shared Pages
- Segmentation – Basic concept, Hardware
- Virtual Memory Management – Background, Demand paging, Performance of demand paging, Page replacement – FIFO, Optimal, LRU, MFU

Reference Books:

1. Operating System Concepts, Avi Silberschatz, Peter Galvin, Greg Gagne, Student Edition, Wiley Asia
2. Operating Systems: Internals and Design Principles, William Stallings, Prentice Hall of India.
3. Advanced Concepts in Operating Systems, M Singhal and NG Shivaratri, Tata McGraw Hill Inc, 2001
4. The 'C' Odyssey, UNIX-the open boundless C, Meeta Gandhi,Tilak Shetty,Rajiv Shah, BPB publication

SavitribaiPhule Pune University
T.Y.B.Sc. (Computer Science) Sem - V
Course Code: DSEC - I Course Code : CS - 352
Course Title :Computer Networks - II

Teaching Scheme	No. of Credits	Examination Scheme
03 Lect/ week	2	IE :15 marks UE: 35 marks

Prerequisites:
Prerequisites: Basic knowledge of Networking and ISO/OSI model

Course Objectives

- To understand different protocols of application layer.
- To understand concepts of multimedia.
- Explore the different methods used for Network/INTERNET security.

Course Outcomes

On completion of the course, student will be able to–

- Student will understand the different protocols of Application layer.
- Develop understanding of technical aspect of Multimedia Systems
- Develop various Multimedia Systems applicable in real time.
- Identify information security goals.
- Understand, compare and apply cryptographic techniques for data security.

Course Contents

Chapter 1	**Application Layer**	**10 Lect**

Domain Name System

- Name space-Flat name space, Hierarchical name space
- Domain Name Space -Label ,Domain name, FQDN,PQDN
- Distribution of Domain Name Space-Hierarchy of name servers, zone, Root server, Primary and secondary servers.
- DNS in the Internet: Generic domains, Country domains,inverse domain
- Resolution-Resolver,mapping names to address,mapping addresses to names,recursive resolution,iterative resolution,caching

Electronic Mail-

- Architecture-First scenario, second scenario, Third scenario, Fourth scenario
- User agent-services of user agent, types of UA Format of e-mail
- MIME-MIME header
- Message transfer agent-SMTP
- Message Access Agent: POP and IMAP

File Transfer

FTP-Communication over data control connection,File type,data structure,Transmission mode,anonymous FTP

Chapter 2	**Multimedia**	**08 Lect**

Digitizing audio and video, Audio and Video compression

Streaming Stored audio/video

- First approach
- Second approach
- Third approach
- Fourth approach

Streaming live audio/video

Real time interactive audio/video- Characteristics, Time relationship, timestamp, Playback buffer, ordering multicasting, translation

RTP-Packet format

RTCP-Message types

Voice over IP-SIP,SIP sessionH.323-

Architecture, Protocols

Chapter 3	**Cryptography and Network Security**	**09 Lect**

Terminology: Cryptography, plain text and cipher text, cipher key, categories of cryptography-Symmetric key, asymmetric key

Encryption model

Symmetric key cryptography

- Traditional ciphers – substitution cipher, shift cipher, Transposition cipher
- Simple Modern ciphers-XOR, Rotation cipher, s-box,p-box
- Modern round ciphers-DES
- Mode of operation-ECB,CBC,CFB,OFB

Asymmetric key cryptography-RSA

Security Services

- Message confidentiality-With Symmetric key cryptography, with asymmetric key cryptography
- Message integrity-Document and fingerprint, message and message digest
- Message authentication-MAC,HMAC
- Digital signature
- Entity Authentication-Passwords, Fixed passwords challenge-response

Chapter 4	**Security in the Internet**	**09 Lect**

IPSecurity(IPSec)

- Two modes
- Two security protocols
- Services provided by IPSec
- Security association
- Internet key exchange
- Virtual private network

SSL/TLS

- SSL services
- Security parameters
- Sessions and connections
- Four protocols
- Transport layer security

PGP

- Security parameters
- Services
- PGP algorithms
- Key rings
- PGP certificates

Firewalls

- Packet filter firewall
- Proxy firewall

Reference Books:

1. Data communications and networking by Behrouz Forouzan $4^{th}/5^{th}$ edition, McGraw Hill Pvt Ltd.
2. Computer Networks by Andrew S Tanenbaum, $4^{th}/5^{th}$ edition, Pearson Education
3. Cryptography and Network Security: Principles and Practice, William Stallings, 7^{th} edition, Pearson Education
4. Network Security Essentials: Applications and Standards (For VTU), William Stallings, 3^{rd} edition, Pearson Education

Savitribai Phule Pune University
T.Y.B.Sc. (Computer Science) - Sem - V
Course Type:DSEC – II Course Code: CS - 353
Course Title : Web Technologies - I

Teaching Scheme	No. of Credits	Examination Scheme
03 Lect/ week	2	IE : 15 marks UE: 35 marks

Prerequisites

HTML basics for form designing

Course Objectives

- To Design dynamic and interactive Web pages.
- To Learn Core-PHP, Server Side Scripting Language
- To Learn PHP-Database handling

Course Outcomes

On completion of the course, student will be able to–

- Understand how to develop dynamic and interactive Web Page

Course Contents

Chapter 1	**Introduction to HTML, HTTP and PHP**	**10 Lects**

Overview of HTML and Basic Tags , Creating Forms ,Tables, HTML5 Semantics.
CSS basic concept ,Three ways to use CSS, Box Model, Navigation Bar .
Introduction to Web server and Web browser .
HTTP basics .
PHP Basics: Use of PHP, Lexical structure, Language basics .

Chapter 2	**Function and String**	**8 Lects**

Defining and calling a function
Default parameters
Variable parameters, Missing parameters
Variable function, Anonymous function
Types of strings in PHP
Printing functions
Encoding and escaping
Comparing strings
Manipulating and searching strings
Regular expressions

Chapter 3	**Arrays**	**6 Lectures**

Indexed Vs Associative arrays
Identifying elements of an array
Storing data in arrays
Multidimensional arrays
3.4Extracting multiple values
Converting between arrays and variables
Traversing arrays
Sorting
Action on entire array

Chapter 4	**Files and database handling**	**10 Lectures**

Working with files and directories
Opening and Closing, Getting information about file, Read/write to file,
Splitting name and path from file, Rename and delete files
Reading and writing characters in file
Reading entire file

Random access to file data
Getting information on file
Ownership and permissions
Using PHP to access a database
Relational databases and SQL
PEAR DB basics
Advanced database techniques

Chapter 5	**Handling email with php**	**2 Lectures**

Email background
Internet mail protocol
Structure of an email message
Sending email and validation of Email_id with php

Reference Books:

1. HTML & CSS: The Complete Reference, Fifth Edition Author: Thomas A. Powell First published: 01 Jan 2010.
2. Programming PHP By Rasmus Lerdorf and Kevin Tatroe, O'Reilly publication
3. Beginning PHP 5 , Wrox publication
4. PHP web sevices, Wrox publication
5. Mastering PHP , BPB Publication
6. PHP cookbook, O'Reilly publication
7. PHP for Beginners, SPD publication
8. Programming the World Wide Web , Robert W Sebesta(3rd Edition)
9. HTML 5 Black Book : Covers Css3, Javascript, XML, XHTML, Ajax, PHP And Jquery by Kogent Learning Solutions Inc, Published November 2011 by Dreamtech Press
10. Spurlock Jake, Bootstrap: Responsive Web development. O'Reilly Media, Inc

Ref. Links

11. www.php.net.in
12. www.W3schools.com
13. www.wrox.com
14 https://coreui.io/docs/layout/grid/#grid-options
15. https://www.tutorialrepublic.com/twitter-bootstrap-tutorial/bootstrap-grid-system.php

Savitribai Phule Pune University
T.Y.B.Sc. (Computer Science) – Sem - V
Course Type:DSEC – II Course Code: CS - 354
Paper Title : Foundations of Data Science

Teaching Scheme	No. of Credits	Examination Scheme
03 lectures / week	2	IE : 15 marks UE: 35 marks

Prerequisites

- Problem solving using computers
- Basic mathematics and statistics
- Knowledge of Databases

Course Objectives

- Provide students with knowledge and skills for data-intensive problem solving and scientific discovery
- Be prepared with a varied range of expertise in different aspects of data science such as data collection, visualization, processing and modeling of large data sets.
- Acquire good understanding of both the theory and application of applied statistics and computer science based existing data science models to analyze huge data sets originating from diversified application areas.
- Be better trained professionals to cater the growing demand for data scientists in industry.

Course Outcomes

On completion of the course, student will be able to–

- Perform Exploratory Data Analysis
- Obtain, clean/process, and transform data.
- Detect and diagnose common data issues, such as missing values, special values, outliers, inconsistencies, and localization.
- Demonstrate proficiency with statistical analysis of data.
- Present results using data visualization techniques.
- Prepare data for use with a variety of statistical methods and models and recognize how the quality of the data and the means of data collection may affect conclusions.

Course Contents

Chapter 1	**Introduction to Data Science**	**6 lectures**

Introduction to data science, The 3 V's: Volume, Velocity, Variety
Why learn Data Science?
Applications of Data Science
The Data Science Lifecycle
Data Scientist's Toolbox
Types of Data

Structured, semi-structured, Unstructured Data, Problems with unstructured data
Data sources
Open Data, Social Media Data, Multimodal Data, standard datasets
Data Formats
Integers, Floats, Text Data, Text Files, Dense Numerical Arrays, Compressed or Archived Data, CSV Files, JSON Files, XML Files, HTML Files , Tar Files, GZip Files, Zip Files, Image Files: Rasterized, Vectorized, and/or Compressed

Chapter 2	Statistical Data Analysis	10 lectures

2.1.Role of statistics in data science

2.2.Descriptive statistics

Measuring the Frequency

Measuring the Central Tendency: Mean, Median, and Mode

Measuring the Dispersion: Range, Standard deviation, Variance, Interquartile Range

2.3.Inferential statistics

Hypothesis testing, Multiple hypothesis testing, Parameter Estimation methods,

2.4.Measuring Data Similarity and Dissimilarity

Data Matrix versus Dissimilarity Matrix, Proximity Measures for Nominal Attributes, Proximity Measures for Binary Attributes, Dissimilarity of Numeric Data: Euclidean, Manhattan, and Minkowski distances, Proximity Measures for Ordinal Attributes

2.5.Concept of Outlier, types of outliers, outlier detection methods

Chapter 3	Data Preprocessing	10 lectures

Data Objects and Attribute Types: What Is an Attribute?, Nominal , Binary, Ordinal Attributes, Numeric Attributes, Discrete versus Continuous Attributes

Data Quality: Why Preprocess the Data?

3.3.Data munging/wrangling operations

Cleaning Data - Missing Values, Noisy Data (Duplicate Entries, Multiple Entries for a Single Entity, Missing Entries, NULLs, Huge Outliers, Out-of-Date Data, Artificial Entries, Irregular Spacings, Formatting Issues - Irregular between Different Tables/Columns, Extra Whitespace, Irregular Capitalization, Inconsistent Delimiters, Irregular NULL Format, Invalid Characters, Incompatible Datetimes)

Data Transformation – Rescaling, Normalizing, Binarizing, Standardizing,Label and One Hot Encoding

Data reduction

Data discretization

Chapter 4	Data Visualization	10 lectures

Introduction to Exploratory Data Analysis

Data visualization and visual encoding

Data visualization libraries

Basic data visualization tools

Histograms, Bar charts/graphs, Scatter plots, Line charts, Area plots, Pie charts, Donut charts

Specialized data visualization tools

Boxplots, Bubble plots, Heat map, Dendrogram, Venn diagram, Treemap, 3D scatter plots

Advanced data visualization tools- Wordclouds

Visualization of geospatial data

Data Visualization types

Reference Books:

1) Data Science Fundamentals and Practical Approaches, Gypsy Nandi, Rupam Sharma, BPB Publications, 2020.
2) The Data Science Handbook, Field Cady, John Wiley & Sons, Inc, 2017
3) Data Mining Concepts and Techniques, Third Edition, Jiawei Han, Micheline

Kamber, Jian Pei, Morgan Kaufmann, 2012.
4) A Hands-On Introduction to Data Science, Chirag Shah, University of Washington Cambridge University Press

SavitribaiPhule Pune University
T.Y.B.Sc. (Computer Science) Sem – V
Course Type:DSEC – III Course Code: CS - 355
Course Title: Object Oriented Programming using Java - I

Teaching Scheme	No. of Credits	Examination Scheme
03 Lect / week	2	IE : 15 marks UE: 35 marks

Prerequisites

- Knowledge of C Programming language

Course Objectives

- To learn Object Oriented Programming language
- To study various java programming concept like Interface, File and Exception Handling etc.
- To design User Interface using Swing and AWT

Course Outcomes

On completion of the course, student will be able to–

- Understand the concept of classes, object, packages and Collections.
- To develop GUI based application.

Course Contents

Chapter 1 An Introduction to Java 6 Lect

Object Oriented Programming Concepts
A short history of Java
Features OR Buzzwords of Java
Java Environment
Simple Java Program
Java Tools – jdb, javap, javadoc
Types of Comments
Data Types
Final Variable
Declaring 1D, 2D Array
Accepting Input
(Command Line Arguments, BufferedReader, Scanner)

Chapter 2 Objects and Classes 7 Lect

Defining your own classes
Access Specifiers
(public, protected, private, default)
Array of Objects
Constructors, Overloading Constructors and Use of 'this' keyword
static block, static fields And methods
Predefined Classes

- Object Class, Methods (equals(), toString(),hashcode(), getClass())
- String Class And StringBuffer Class,Formatting String data using format() method

Creating , Accessing And Using Packages
Wrapper Classes

Chapter 3	Inheritance and Interface	8 Lect

Inheritance Basics (extends Keyword) and Types of Inheritance
Superclass, Subclass and use of Super Keyword
Method Overriding and runtime polymorphism
Use of final keyword related to method and class
Use of abstract class and abstract methods
Defining and Implementing Interfaces
Runtime polymorphism using interface
Concept of Marker and Functional Interfaces

Chapter 4	Exception and File Handling	5 Lect

Dealing with errors , Exception class, Checked And Unchecked Exception
Catching Exceptions, Multiple Catch Block, Nested try block
Creating User Defined Exception
Introduction to Files And Streams
Input-OutputStream : FileInput/OutputStream, BufferedInput/OutputStream, DataInput/OutputStream
Reader-Writer : FileReader/Writer, BufferedReader/Writer, InputStreamReader, OutputStreamWriter

Chapter 5	User Interface with AWT and Swing	10 Lect

What is AWT? What is Swing? Difference between AWT and Swing
The MVC Architecture And Swing
Layouts And Layout Managers
Containers And Components – JFrame, JButton, JLabel, JText, JTextArea, JCheckBox And JRadioButton, JList, JComboBox, JMenu And related Classes
Dialogs (Message, Confirmation, Input), JFileChooser, JColorChooser
Event Handling: Event Sources, Listeners
Adapters And Anonymous Inner Class

Reference Books:

R1. Complete reference Java by Herbert Schildt(5th edition)
R2. Java 2 programming black books, Steven Horlzner
R3. Programming with Java , A primer ,Forth edition , By E. Balagurusamy
R4. Core Java Volume-I-Fundamentals, Eighth Edition, Cay S. Horstmann, Gary Cornell, Prentice Hall, Sun Microsystems Pres

Savitribai Phule Pune University
T.Y.B.Sc. (Computer Science) Sem - V
Course Type: DSEC - III Course Code: CS - 356
Paper Title: Theoretical Computer Science

Teaching Scheme	No. of Credits	Examination Scheme
3 Lect/ week	2	IE : 15 marks UE: 35 marks

Prerequisites

- Mathematical Preliminaries Sets (Subset, Set Operations), Relations (Properties of Relations, Closure of Relations) and Functions
- Discrete Mathematics- Graphs, Trees, Logic and Proof Techniques

Course Objectives

- To understand the Finite Automata, Pushdown Automata and Turing Machine.
- To understand the Regular Language, Context Free Language, Context Sensitive Language and Unrestricted Language.
- To understand the relation between Automaton and Language

Course Outcomes

On completion of the course, student will be able to–

- Understand the use of automata during language design.
- Relate various automata and Languages.

Course Contents

Chapter 1	**Finite Automaton**	**10 Lect**

Introduction: Symbol, Alphabet, String, Prefix & Suffix of Strings, Formal Language, Operations on Languages.
Deterministic finite Automaton – Definition, DFA as language recognizer, DFA as pattern recognizer.
Nondeterministic finite automaton – Definition and Examples.
NFA To DFA (Myhill Nerode Method)
NFA with ε- transitions Definition and Examples.
NFA with ε-Transitions to DFA & Examples
Finite automaton with output – Mealy and Moore machine, Definition and Examples.
Minimization of DFA, Algorithm & Problem using Table Method.

Chapter 2	**Regular Expressions and Languages**	**6 Lect**

Regular Expressions (RE): Definition & Example
Regular Expressions Identities.
Regular language-Definition and Examples.
Conversion of RE to FA-Examples.
Pumping lemma for regular languages and applications.
Closure Properties of regular Languages

Chapter 3	**Context-Free Grammars and Languages**	**10 Lect**
Grammar - Definition and Examples. Derivation-Reduction - Definition and Examples. Chomsky Hierarchy. CFG: Definition & Examples. LMD, RMD, Parse Tree Ambiguous Grammar: Concept & Examples. Simplification of CFG: Removing Useless Symbols, Unit Production, ϵ-production and Nullable Symbol. Normal Forms: Greibach Normal Form (GNF) and Chomsky Normal Form (CNF) Regular Grammar: Definition. Left linear and Right Linear Grammar-Definition and Example. Equivalence of FA & Regular Grammar Construction of regular grammar equivalent to a given DFA. Construction of a FA from the given right linear grammar		
Chapter 4	**Push Down Automata**	**5 Lect**
Definition of PDA and examples. Construction of PDA using empty stack and final State method: Examples using stack method. Definition DPDA & NPDA, their correlation and Examples of NPDA CFG (in GNF) to PDA: Method and examples		
Chapter 5	Turing Machine	**5 Lect**
The Turing Machine Model, Definition and Design of TM Problems on language recognizers. Language accepted by TM. Types of Turing Machines (Multitrack TM, Two-way TM, Multitape TM, Non-deterministic TM) Introduction to LBA (Basic Model) & CSG. (Without Problems)		
Reference Books		
1. Introduction to Automata Theory, Languages and Computation, John E. Hopcraft, Rajeev Motwani, Jeffrey D. Ullman, Third Edition, Pearson Education Publication, 2008 2. Introduction to Automata theory, Languages and computation By John E. Hopcroft and JeffreyUllman – Narosa Publishing House, 1995 3. Theory of Computer Science Automata, Languages and Computation, K.L.P. Mishra, N. Chandrasekaran, Publication- Prentice Hall of India, 2008 4. Introduction to Computer Theory Daniel I. A. Cohen – 2nd edition – John Wiley & Sons, 1996 5. Introduction to Languages and The Theory of Computation John C. Martin The McGraw-Hill, Fourth Edition, 2011		

Savitribai Phule Pune University

T.Y.B.Sc. (Computer Science) - Sem - V

Course Type: DSEC - I Course Code: CS - 357

Course Title : Practical Course based on CS - 351

Teaching Scheme:	No. of Credits:	Examination Scheme:
5 Lect/ week	2	IE : 15 marks UE: 35 marks

Course Objectives:

1. To understand the concept of process scheduling with the help of simulation.
2. To study the concept demand paging concepts in operating system.
3. To understand the working of operating system shell.

Course Outcomes: After completion of this course students will be able to understand the concept of

1. Process synchronization
2. Processes and Thread Scheduling by operating system
3. Memory management by operating system using with the help of various schemes

Guidelines:

1. Operating system platform – Linux
2. Programming language - C

List of Assignments:

- Operations on processes : (2 slot)
  (Create a child process using fork() and commands like exec(),execv() and execvp())
- Simulation of Operating System Shell and its working (commands)(2 slots)
- Simulation of CPU Scheduling Algorithms – FCFS, SJF, Priority and Round Robin(4 slots)
- Simulation of demand paging using memory page replacement algorithms – FIFO, LRU, OPT, MFU(4 slots)

Savitribai Phule Pune University

T.Y.B.Sc. (Computer Science) Sem – V

Course Type: DSEC - II **Course Code: CS - 358**

Course Title : Practical Course based on CS - 353 and CS - 354

Teaching Scheme:	No. of Credits:	Examination Scheme:
5 Lect/ week	2	IE : 15 marks
Batch Size : 12		UE: 35 marks

Course Objectives:

- To Design dynamic and interactive Web pages.
- To Learn Core-PHP, Server Side Scripting Language
- To Learn PHP- Database handling
- To apply statistical, data preprocessing and visualization techniques on data sets

Course Outcomes:

- Understand how to develop dynamic and interactive Web Page
- Prepare data for use with a variety of statistical methods and recognize how the quality of the data may affect conclusions.
- Perform exploratory data analysis

Guidelines:

Operating Environment for web technologies: HTML5.0, PHP 5.0 and above , Webserver

Operating Environment for Data Science: Linux + python

List of Assignments on web technologies:

1 : HTML and HTML5.0
2 : CSS, Box Model, Navigation Bar
3 : Bootstrap
4 : Function and String
5 : Arrays
6: Files
7: Databases (PHP-PostgreSQL)

Suggested Assignments for Foundations of Data Science

Assignment 1: The Data Science environment

Getting introduced to Python IDLE, command line, online tools like google colaboratory and essential packages like NumPy, SciPy, pandas, scikit-learn, matplotlib, jupyter, beautiful-soup, etc.

Assignment 2: Loading the dataset

Select a dataset from a list of publicly available datasets at UCI Machine Learning Repository and load it using Pandas. (Import different dataformat files like .CSV,.htm,.json etc. Briefly describe what the dataset is about and size of the dataset (e.g. number of tables, number of instances and attributes, etc.)

Assignment 3: Basic statistical operations

Apply basic statistical operations on a dataset. For example - compute the mean, median, mode, range, quartiles, and variance for one or more attributes.

Assignment 4: Data preprocessing

Apply data preprocessing techniques that are likely required for the dataset.

1) Partition them into appropriate number of bins by equal-frequency as well as equal-width partitioning.

2) Use smoothing by bin means to smooth the data based on the above partitioning,

3) Normalize the attribute based on min-max normalization and z-score normalization.

Comment on which method you would prefer to use for partitioning, smoothing, and normalization for the given attribute.

Assignment 5: Data Visualization with matplotlib

View the data using various 2-D, 3-D plots and charts, setting styles, saving the figures, customizing the legends, multiple subplots,

SavitribaiPhule Pune University
T.Y.B.Sc. (Computer Science) - Sem – V
Course Type: DSEC - III Course Code: CS - 359
Course Title : Practical Course based on CS - 355

Teaching Scheme	No. of Credits	Examination Scheme
5 Lect / week Batch Size : 12	2	IE : 15 marks UE: 35 marks

Course Objectives:

Covers the complete scope of the syllabus.

1. Bringing uniformity in the way course is conducted across different colleges.
2. Continuous assessment of the students.

Course Outcomes:

1. Use an integrated development environment to write, compile, run, and test simple object-oriented Java programs.
2. Read and make elementary modifications to Java programs that solve real-world problems.
3. Validate input in a Java program.

Guidelines:

Operating Environment :

- **Operating system :** Linux
- **Editor :** Anylinux based editor like vi, gedit and Use of IDE – Eclipse etc.
- **Compiler** : javac

Submission :

Each assignment will be assessed on a scale of 0 to 5 as indicated below.

- Not done 0
- Incomplete 1
- Late Complete 2
- Needs improvement 3
- Complete 4
- Well Done 5

Assessment :

Easy : All exercises are compulsory.
Medium : All exercises are compulsory.

List of Assignments :

Assignment 1 : Java Tools and IDE, Simple java programs [Slot – 1]

Introduction to the java environment
Use of java tools like java, javac, jdb and javadoc
Defining simple classes and creating objects.

Assignment 2 : Array of Objects and Packages [Slot – 2]

Defining a class.
Creating an array of objects.
Creating a package.

Assignment 3 : Inheritance and Interfaces [Slot – 2]

To implement inheritance in java.
To define abstract classes.
To define and use interfaces and Functional Interface.

Assignment 4 : Exception And File Handling [Slot – 2]

Demonstrate Exception Handling Mechanism in Java.
Use of try, catch, throw, throws ,finally blocks
Defining User defined Exception classes.
Creation of files and demonstration of I-O operations

Assignment 5 : GUI Designing, Event Handling [Slot – 5]

To demonstrate GUI creation using Swing Package and Layout managers.
To understand Event handling mechanism in Java.
Using Event classes, Event Listeners and Adapters

Savitribai Phule Pune University
T.Y.B.Sc. (Computer Science) - Sem – V
Course Type: SECC – I Course Code : CS-3510
Course Title: Python Programming

Teaching Scheme	No. of Credits	Examination Scheme:
03 Lect / week	2	IE : 15 marks UE: 35 marks

Course Objectives

1. To introduce programming concepts using python
2. Student should be able to develop Programming logic using python
3. To develop basic concepts and terminology of python programming
4. To test and execute python programs

Course Outcomes

On completion of the course, student will be able to–

- Develop logic for problem solving
- Determine the methods to create and develop **Python programs** by utilizing the data
- structures like lists, dictionaries, tuples and sets.
- To be familiar about the basic constructs of programming such as data, operations, conditions, loops, functions etc.
- To write python programs and develop a small application project

Course Contents

Chapter 1	**An Introduction to Python**	**3 Lect**

Introduction to Python

The Python Programming Language, History, features, Applications, Installing Python, Running Simple Python program

Basics of Python

Standard data types - basic, none, Boolean (true & False), numbers, Variables, Constants,Python identifiers and reserved words, Lines and indentation, multi-line statements and Comments,Input/output with print and input ,functions Declaration, Operations on Data such as assignment, arithmetic, relational, logical and bitwise operations, dry run, Simple Input and output etc.

Chapter 2	**Control Statements**	**4 Lect**

Sequence Control – Precedence of operators, Type conversion

Conditional Statements: if, if-else, nested if-else,

Looping- for, while, nested loops, loop control statements (break, continue, pass)

a. **Strings**: declaration, manipulation, special operations, escape character, string formatting operator, Raw String, Unicode strings, Built-in String methods.

Chapter 3	**Lists, functions, tuples and dictionaries, Sets**	**7 Lect**

Python Lists: Concept, creating and accessing elements, updating & deleting lists, traversing a List, reverse Built-in List Operators, Concatenation, Repetition, In Operator, Built-in List functions and methods.

Functions: Definitions and Uses, Function Calls, Type Conversion Functions, Math Functions, Composition, Adding New Functions, Flow of Execution, Parameters and Arguments, Variables and Parameters, Stack Diagrams, Void Functions, Anonymous functions Importing with from, Return Values, Boolean Functions, More Recursion, Functional programming tools - filter(), map(), and reduce(),recursion, lambda forms.

Tuples and Dictionaries: Tuples, Accessing values in Tuples, Tuple Assignment, Tuples as return values, Variable-length argument tuples, and Basic tuples operations, Concatenation, Repetition, in Operator, Iteration, Built-in tuple functions, indexing, slicing and matrices. Creating a Dictionary, Accessing Values in a dictionary, Updating Dictionary, Deleting Elements from Dictionary, Properties of Dictionary keys, Operations in Dictionary, Built-In Dictionary Functions, Built-in Dictionary Methods.

Sets- Definition, transaction of set(Adding, Union, intersection), working with sets

Chapter 4	**Modules ,Working with files, Exception handling**	**4 Lect**

Modules: Importing module, Creating & exploring modules, Math module, Random module, Time module

Packages: Importing package, creating package,examples

Working with files: Creating files and Operations on files (open, close, read, write), File object attributes, file positions, Listing Files in a Directory, Testing File Types, Removing files and directories, copying and renaming files, splitting pathnames, creating and moving directories

Regular Expression- Concept of regular expression, various types of regular expressions, using match function.

Exception Handling: Built-in Exceptions, Handling Exceptions, Exception with Arguments, User-defined Exceptions.

Demonstration	**Programming Assignments:**	**18 Lect**

Out of 36 lectures, 18 are assigned for demonstration. Teacher should give demonstration of various programs mentioned below in the classroom or in the laboratory as per their convenience.

Programming assignments should be done individually by the student in their respective login from the list given in Labbook. The codes should be uploaded on either the local server, Moodle, Github or any LMS.

Assignment 1 - Python Basics
Assignment 2 – Arrays, Strings, and Functions
Assignment 3 - List, Tuples, Sets, and Dictionary
Assignment 4 - File Handling and Date-Time
Assignment 5 - Exception handling and Regular expression

Reference Books:

1. An Introduction to Computer Science using Python 3 by Jason Montojo, Jennifer Campbell, Paul Gries, The pragmatic bookshelf-2013
2. James Payne, "Beginning Python: Using Python and Python 3.1,Wrox Publication
3. Introduction to Computer Science Using Python- Charles Dierbach, Wiley Publication Learning with Python ", Green Tea Press, 2002
4. Introduction to Problem Solving with Python by E balguruswamy,TMH publication-2016
5. Beginning Programming with Python for Dummies Paperback – 2015 by John Paul Mueller
6. Object-oriented Programming in Python, Michael H. Goldwasser, David Letscher, Pearson Prentice Hall-2008

Savitribai Phule Pune University
T.Y.B.Sc. (Computer Science) - Sem – V
Course Type: SECC – II Course Code : CS-3511
Course Title: Blockchain Technology

Teaching Scheme	No. of Credits	Examination Scheme:
03 Lect / week	2	IE : 15 marks UE: 35 marks

Prerequisite:
Understanding of Object Oriented Programming Concepts
Knowledge of Python

Course Objectives

1. Understand what and why of blockchain technology.
2. Explore major components of blockchain.
3. Learn about Bitcoin, Cryptocurrency and Ethereum.
4. To learn blockchain programming using Python, Flask Web Framework, and HTTP client Postman.

Course Outcomes

On completion of the course, student will be able to–
1. Learn the fundamentals of Blockchain Technology.
2. Learn Blockchain programming
3. Basic knowledge of Smart Contracts and how they function.

Course Contents

Chapter 1	**Introduction to Blockchain**	**7 Lect**

- Foundational Computing Concepts (Client-Server systems vs Peer to Peer Systems)
- Evolution of Blockchain
- Blockchain Vs Database
- Essentials of Blockchain (Blockchain generations, types of blockchain, benefits and challenges of blockchain usage)
- Types of Networks
- Layered Architecture of Blockchain Ecosystem
- Components of blockchain
- Cryptography (private and public keys, Hashing &
- Digital Signature)
- Consensus Mechanisms
- Cryptocurrency, Digital Currency Bitcoin and Ethereum
- Smart Contracts
- Blockchain use cases

Chapter 2	**How Blockchain Works?**	**5 Lect**

- Understanding SHA256 Hash
- Immutable Ledger
- Distributed P2P Network
- How Mining Works? (The NONCE and Cryptographic Puzzle)
- Byzantine Fault Tolerance
- Consensus Protocols: Proof of Work, Proof of State, Défense Against Attackers, Competing Chains
- Blockchain Demo

Chapter 3	Smart Contracts	6 Lect

- Ethereum Network
- What is a Smart Contract?
- Ethereum Virtual Machine, Ether, Gas
- DApps
- Decentralized Autonomous Organizations (DAO)
- Hard and Soft Forks
- Initial Coin Offerings
- Demo of Smart Contracts

Demonstration	Programming Assignments:	18 Lect

Out of 36 lectures, 18 are assigned for demonstration. Teacher should give demonstration of various programs mentioned below in the classroom or in the laboratory as per their convenience.

Assignment 1 –Demonstration of Blockchain
https://andersbrownworth.com/blockchain

Assignment 2 – Installation of Ganache, Flask and Postman

Assignment 3 –Write a Simple Python program to create a Block class that contains index, timestamp, and previous hash. Connect the blocks to create a Blockchain.

Assignment 4 –Demo of Remix-Ethereum IDE https://remix.ethereum.org and Test Networks

Assignment5–1. Write a Simple Smart Contract for Bank with withdraw and deposit functionality.

Assignment 6 – 2. Write a Smart Contract for storing and retrieving information of Degree Certificates.

Reference Books:

Textbook:

1. **Beginning Blockchain : A Beginner's Guide to Building Blockchain Solutions By Bikramaditya Singhal, Gautam Dhameja, Priyansu Sekhar Panda, Apress Media**

Reference Books:

2. Mastering Blockchain by Imran Bashir, Third Edition, Packt Publication
3. Waterhole, The Science of the Blockchain
4. Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System
5. Mastering Ethereum: Building Smart Contracts and DAPPS, by Andreas Antonopoulos, Dr. Gavid Wood, Oreilly Publication

Reference Web Links

1. https://www.investopedia.com/terms/b/blockchain.asp

Savitribai Phule Pune University
T.Y.B.Sc. (Computer Science) - Sem – VI
Course Type: DSEC - IV Course Code: CS - 361
Course Title : Operating Systems-II

Teaching Scheme: 03 Lect / week	No. of Credits: 2	Examination Scheme: IE : 15 marks UE: 35 marks

Prerequisites
Concepts of Operating System, Processes and Threads Scheduling, Synchronization

Course Objectives:
1. To understand the issue of Deadlocks in Process management.
2. To understand the concept of File system management & disk scheduling
3. To study the concept of distributed and mobile operating systems

Course Outcomes: After completion of this course students will be able to understand the concept of
1. Management of deadlocks and File System by operating system
2. Scheduling storage or disk for processes
3. Distributed Operating System and its architecture and the extended features in mobile OS.

Course Contents

Chapter 1	**Process Deadlocks**	**7 lectures**

- System model
- Deadlock Characterization – Necessary conditions, Resource allocation graph
- Deadlock Methods- Prevention and Deadlock Avoidance - Safe state, Resource allocation graph algorithm, Banker's Algorithm
- Deadlock Detection
- Recovery from Deadlock – Process termination, Resource preemption

Chapter 2	**File system Management**	**6 lectures**

- File concept , File attributes, File operations
- Access Methods – Sequential, Direct, Other access methods
- Directory overview, Single level directory, Two level directory, Tree structure directory, Acyclic graph directory, General graph directory
- Allocation Methods – Contiguous allocation, Linked allocation, Indexed allocation
- Free Space Management – Bit vector, Linked list, Grouping, Counting, Space maps

Chapter 3	**Disk scheduling**	**4 lectures**

- Overview, Disk Structure
- Disk Scheduling, FCFS Scheduling, SSTF Scheduling, Scan Scheduling-Scan Scheduling, Look Scheduling , Disk Management

Chapter 4	**Introduction to Distributed operating systems & Architecture**	**11 lectures**

- What is a distributed system, Design goals
- Types of distributed systems
- Architectural styles : Layered architectures , Object-based architectures, Resource-centered architectures
- System architecture – Centralized organization, Decentralized organizations, peer-to-peer systems, Hybrid architectures.

- Example architectures : Network file system(NFS), Web-based distributed systems

Chapter 5	**Mobile Operating Systems**	**7 lectures**

- Introduction
- Features
- Special Constraints and Requirements of Mobile Operating System
- Special Service Requirements
- ARM & Intel architectures – Power management
- Mobile OS architectures – Underlying OS, kernel structure & native level programming, Runtime issues, Approaches to power management
- Commercial Mobile Operating Systems - Windows Mobile, iPhone OS (iOS), Android
- A Comparative Study of Mobile Operating Systems (Palm OS, Android, Symbian OS, Blackberry OS, Apple iOS)

Reference Books:

1) Advanced Concepts in Operating Systems, M Singhal and NG Shivaratri, Tata McGraw Hill Inc, 2001 (Text Book)

2) Operating System Concepts, Avi Silberschatz, Peter Galvin, Greg Gagne, Student Edition, Wiley Asia

3) Operating Systems: Internals and Design Principles, William Stallings, Prentice Hall of India.

4) Distributed Operating Systems Concepts and Design, Pradeep K. Sinha, PHI

5) Prasant Kumar Pattnaik, Rajib Mall, "Fundamentals of Mobile Computing", PHI Learning Pvt.Ltd, New Delhi – 2012.

6) A. Tannenbum, Herbert Bos, "Modern Operating systems", Pearson Publication, 4th Edition

7) A. Tannenbum, Maarten van Steen, "Distributed systems", 3rd Edition

8) Source wikipedia, Mobile operating systems, General books, LLC,2010

Savitribai Phule Pune University
T.Y.B.Sc. (Computer Science) - Sem – VI
Course Type: DSEC - IV Course Code: CS - 362
Course Title : Software Testing

Teaching Scheme:	No. of Credits:	Examination Scheme:
3 Lect / week	2	IE : 15 marks UE: 35 marks

Prerequisites:

- Basic knowledge of algorithms, problem solving, expected inputs/outputs
- Knowledge of C and java Programming Language, compilation, debugging.

Course Objectives:

- To provide the knowledge of software testing techniques
- To understand how testing methods can be used as an effective tools in quality assurance of software.
- To provide skills to design test case plan for testing software.
- To provide knowledge of latest testing methods

Course Outcomes:

- To understand various software testing methods and strategies.
- To understand a variety of software metrics, and identify defects and managing those defects for improvement in quality for given software.
- To design test cases and test plans, review reports of testing for qualitative software.
- 4. To understand latest testing methods used in the software industries.

Course Contents

Chapter 1	**Introduction to Software Testing**	**5 lectures**

Basics of Software Testing – faults, errors and failures
Testing objectives
Principles of testing
Testing and debugging
Testing metrics and measurements
Verification and Validation
Testing Life Cycle

Chapter 2	**Software Testing Strategies & Techniques**	**10 lectures**

Testability - Characteristics lead to testable software.
Test characteristics
Test Case Design for Desktop, Mobile, Web application using Excel
White Box Testing - Basis path testing, Control Structure Testing.
Black Box Testing- Boundary Value Analysis, Equivalence partitioning.
Differences between BBT & WBT

Chapter 3	**Levels of Testing**	**10 lectures**

A Strategic Approach to Software Testing
Test strategies for conventional Software
Unit testing
Integration testing – Top-Down, Bottom-up integration
System Testing – Acceptance, performance, regression, Load/Stress testing, Security testing, Internationalization testing.
Alpha, Beta Testing

Usability and accessibility testing Configuration, compatibility testing		
Chapter 4	**Testing Web Applications**	**6 lectures**
Dimension of Quality, Error within a WebApp Environment Testing Strategy for WebApp Test Planning The Testing Process –an overview		
Chapter 5	**Agile Testing**	**5 lectures**
Agile Testing, Difference between Traditional and Agile testing, Agile principles and values, Agile Testing Quadrants, Automated Tests.		

Reference Books:

1. Software Engineering – A Practitioners Approach, Roger S. Pressman, 7th Edition, Tata McGraw Hill, 20
2. Effective Methods of Software Testing, William E Perry, 3rd Edition, Wiley Publishing Inc
3. Managing the Testing Process: Practical Tools and Techniques for Managing Hardware and Software Testing, Rex Black, Microsoft Press, 1999
4. Agile Testing: A Practical Guide for Testers and Agile Teams, Lisa Crispin and Janet Gregory, 1st Edition, Addison-Wesley Professional, 2008
5. Software Testing Principles and Practices By Srinivasan Desikan, Gopalaswamy Ramesh, Pearson

Savitribai Phule Pune University
T.Y.B.Sc. (Computer Science)- Sem - VI
Course Type:DSEC – V Course Code: CS - 363
Course Title : Web Technologies - II

Teaching Scheme	No. of Credits	Examination Scheme
3 Lect / week	2	IE : 15 marks UE: 35 marks

Prerequisites
- HTML5,CSS
- Core PHP
- Bootstrap framework utility

Course Objectives
- To Learn different technologies used at client Side Scripting Language
- To Learn XML and XML parsers.
- To One PHP framework for effective design of web application.
- To Learn Java Script to program the behavior of web pages.
- To Learn AJAX to make our application more dynamic.
- Framework has

Course Outcomes
On completion of the course, student will be able to–
- Build dynamic website.
- Using MVC based framework easy to design and handling the errors in dynamic website.

Course Contents

Chapter 1	**Introduction to Web Techniques**	**6 Lect**

Variables
- Server information
- Processing forms
- Setting response headers
- Maintaining state
- PHP error handling

Chapter 2	**XML**	**6 Lect**

What is XML?
- XML document Structure
- PHP and XML
- XML parser
- The document object model
- The simple XML extension
- Changing a value with simple XML

Chapter 3	**Java Script and Jquery**	**10 Lect**

Overview of JavaScript
- Object Orientation and JavaScript Basic Syntax(JS datatypes, JS variables)

Primitives, Operations and Expressions
Screen Output and keyboard input(Verification and Validation)
JS Control statements and JS Functions
JavaScript HTML DOM Events(onmouseup, onmousedown, onclick, onload, onmouseover, onmouseout).

JS Strings and JS String methods

JS popup boxes(alert, confirm, prompt).
Jquery library , Including jquery library in page
Jquery selector , DOM manipulation using jquery

Chapter 4	AJAX	**6 Lect**

Introduction of AJAX
AJAX web application model
AJAX –PHP framework
Performing AJAX validation
Handling XML data using php and AJAX
Connecting database using php and AJAX

Chapter 5	PHP framework CodeIgniter	**8 Lect**

CodeIgniter - Overview, Installing CodeIgnite
Application Architecture
MVC Framework , Basic concept of CodeIgniter, Libraries
Working with databases
Load external JS and CSS page & redirecting from controller , Adding JS and CSS ,
Page redirection.
Loading dynamic data on page & session management, cookies management

Reference Books:

1. **Programming PHP By Rasmus Lerdorf and Kevin Tatroe O'Reilly publication**
2. **Beginning PHP 5, Wrox publication**
3. **AJAX Black Book Kogent solution**
4. **Mastering PHP BPB Publication**
5. **Professional Codeigniter By Thomas Myer ,Wrox Publication,**
6. **Codeihniter 2 CookBook By Rob Foster ,PACKT Publication ,**
7. **JQuery CookBook, O'reilly Publication.**

Ref. Links:

1. **www.php.net.in**
2. **www.W3schools.com**
3. **https://www.tutorialspoint.com/codeigniter/index.htm**
4. **https://api.jquery.com/**
5. **http://codeigniter.com/docs**

Savitribai Phule Pune University
T.Y.B.Sc. (Computer Science) – Sem VI
Course Type:DSEC – V Course Code: CS - 364
Course Title : Data Analytics

Teaching Scheme	No. of Credits	Examination Scheme
03 lectures / week	2	IE : 15 marks UE: 35 marks

Prerequisites

- Basic of mathematics and statistics
- Basic programming Knowledge of python
- Knowledge of databases

Course Objectives

- Deploy the Data Analytics Lifecycle to address data analytics projects.
- Develop in depth understanding of the key technologies in data analytics.
- Apply appropriate analytic techniques and tools to analyze data, create models, and identify insights that can lead to actionable results.

Course Outcomes

On completion of the course, student will be able to–

- Use appropriate models of analysis, assess the quality of input, and derive insight from results.
- Analyze data, choose relevant models and algorithms for respective applications
- Understand different data mining techniques like classification, prediction, clustering and association rule mining
- Apply modeling and data analysis techniques to the solution of real world business problems

Course Contents

Chapter 1	**Introduction to Data Analytics**	**6 lectures**

Concept of data analytics
Data analysis vs Data analytics
Types of analytics
Diagnostic Analytics, Predictive Analytics , Prescriptive Analytics, Exploratory Analysis, Mechanistic Analysis
Mathematical models - Concept
Model evaluation: metrics for evaluating classifiers - Class imbalance - AUC, ROC (Receiver-Operator Characteristic) curves, Evaluating value prediction models

Chapter 2	**Machine Learning Overview**	**6 Lectures**

Introduction to Machine Learning, deep learning, Artificial intelligence
Applications for machine learning in data science
The modeling process
Engineering features and selecting a model, Training the model, Validating the model, Predicting new observations
Types of machine learning
Supervised learning, Unsupervised learning, Semi-supervised learning, ensemble techniques
Regression models
Linear Regression

Polynomial Regression
Logistic Regression

2.6. Concept of classification, clustering and reinforcement learning.

Chapter 3	Mining Frequent Patterns, Associations, and Correlations	12 lectures

What kind of patterns can be mined

Class/Concept Description: Characterization and Discrimination, Mining Frequent Patterns, Associations, and Correlations, Classification and Regression for Predictive Analysis, Cluster Analysis, Outlier Analysis

Mining frequent patterns - Market Basket Analysis.
Frequent Itemsets, Closed Itemsets, and Association Rules
Frequent Itemset Mining Methods
Apriori Algorithm
Generating Association Rules from Frequent Itemsets
Improving efficiency of apriori algorithm
Frequent pattern growth (FP-growth) algorithm

Chapter 4	Social Media and Text Analytics	12 lectures

Overview of social media analytics

Social Media Analytics Process, Seven layers of social media analytics, accessing social media data

Key social media analytics methods
Social network analysis

Link prediction, Community detection, Influence maximization, Expert finding, Prediction of trust and distrust among individuals

Introduction to Natural Language Processing
Text Analytics : Tokenization, Bag of words, Word weighting : TF-IDF, n-Grams, stop words, Stemming and lemmatization, synonyms and parts of speech tagging
Sentiment Analysis
Document or text summarization

Trend analytics

Challenges to social media analytics

Reference Books:

1) Data Science Fundamentals and Practical Approaches, Gypsy Nandi, Rupam Sharma, BPB Publications, 2020.
2) The Data Science Handbook, Field Cady, John Wiley & Sons, Inc, 2017
3) Data Mining Concepts and Techniques, Jiawei Han, Micheline Kamber, Jian Pei, Morgan Kaufmann, Third Edition, 2012.
4) A Hands-On Introduction to Data Science, Chirag Shah, University of Washington Cambridge University Press
5) The Data Science Design Manual, Steven S. Skiena, Springer, 2017
6) Introducing data science: big data, machine learning, and more, using Python tools, Cielen D., Meysman A. D., & Ali M., Manning Publications Co., 2016

Savitribai Phule Pune University
T.Y.B.Sc. (Computer Science) - Sem – VI
Course Type: DSEC – VI Course Code : CS - 365
Course Title : Object Oriented Programming using Java – II

Teaching Scheme	No. of Credits	Examination Scheme
03 Lect / week	2	IE : 15 marks UE: 35 marks

Prerequisites

- Knowledge of Core Java (CS – 355)

Course Objectives

- To learn database programming using Java
- To study web development concept using Servlet and JSP
- To develop a game application using multithreading
- To learn socket programming concept

Course Outcomes

On completion of the course, student will be able to–

- To access open database through Java programs using Java Data Base Connectivity (JDBC) and develop the application.
- Understand and Create dynamic web pages, using Servlets and JSP.
- Work with basics of framework to develop secure web applications.

Course Contents

Chapter 1	**Collections**	**6 Lect**

Introduction to the Collection framework
List - ArrayList, LinkedList
Set - HashSet, TreeSet,
Map - HashMap and TreeMap
Interfaces such as Comparator, Iterator, ListIterator, Enumeration

Chapter 2	**Multithreading**	**6 Lect**

What are threads?
Life cycle of thread
Creating threads - Thread class , Runnable interface
Thread priorities
Running multiple threads
Synchronization and interthread communication

Chapter 3	**Database Programming**	**6 Lect**

The design of jdbc
Types of drivers
Executing sql statements, query execution
Scrollable and updatable Resultset

Chapter 4	**Servlets and JSP**	**12 Lect**

Introduction to Servlet and Hierarchy of Servlet
Life cycle of servlet
Handing get and post request (HTTP)
Handling data from HTML to servlet
Retrieving data from database to servlet

Session tracking – User Authorization, URL rewriting, Hidden form fields,Cookies and HttpSession

Introduction to JSP, Life cycle of JSP
Implicit Objects
Scripting elements - Declarations, Expressions, Scriplets, Comments
JSP Directives - Page Directive, include directive
Mixing Scriplets and HTML
JSP Actions - jsp:forward , jsp:include, jsp:useBean, jsp:setProperty and jsp:getProperty

Chapter 5	**Spring Framework**	**6 Lect**

Introduction of Spring framework
Spring Modules / Architecture
Spring Applications
Spring MVC
Spring MVC Forms, Validation

Reference Books:

R1. Complete reference Java by Herbert Schildt(5th edition)
R2. Java 2 programming black books, Steven Horlzner
R3. Programming with Java , A primer ,Forth edition , By E. Balagurusamy
R4. Core Java Volume-I-Fundamentals, Eighth Edition, Cay S. Horstmann, Gary Cornell, Prentice Hall, Sun Microsystems Press
R5. Core Java Volume-II-Advanced Features, Eighth Edition, Cay S. Horstmann, Gary Cornell, Prentice Hall, Sun Microsystems Press
R6. Getting started with Spring Framework: covers Spring 5 by J Sharma and Ashish Sarin
R7. Spring 4 for Developing Enterprise Applications: An End-to-End Approach by Henry H. Liu

Savitribai Phule Pune University
T.Y.B.Sc. (Computer Science) - Sem - VI
Course Type: DSEC - VI Course Code: CS - 366
Course Title: Compiler Construction

Teaching Scheme	No. of Credits	Examination Scheme
3 Lect / week	2	IE: 15 marks UE: 35 marks

Prerequisites

- Knowledge of Automata Theory and Languages.

Course Objectives

- To understand design issues of a lexical analyzer and use of LEX tool.
- To understand design issues of a parser and use of YACC tool.
- To understand and design code generation and optimization techniques.

Course Outcomes

On completion of the course, student will be able to–

- Understand the process of scanning and parsing of source code.
- Learn the conversion code written in source language to machine language.
- Understand tools like LEX and YACC.

Course Contents

Chapter 1	**Introduction**	**4 Lect**

Definition of Compiler, Aspects of compilation.
The structure of Compiler.
Phases of Compiler – Lexical Analysis, Syntax Analysis, Semantic Analysis,
Intermediate Code generation, code optimization, code generation.
Error Handling.
Introduction to one pass & Multipass compilers, cross compiler, Bootstrapping.

Chapter 2	**Lexical Analysis (Scanner)**	**4 Lect**

Review of Finite automata as a lexical analyzer,
Applications of Regular Expressions and Finite Automata (lexical analyzer,
searching using RE), Input buffering, Recognition of tokens.
LEX: A Lexical analyzer generator (Simple Lex Program)

Chapter 3	**Syntax Analysis (Parser)**	**14 Lect**

Definition, Types of Parsers
Top-Down Parser –
Top-Down Parsing with Backtracking: Method & Problems
Drawbacks of Top-Down parsing with backtracking, 3.2.3Elimination of Left Recursion (direct & indirect) 3.2.4Need for Left Factoring & examples
Recursive Descent Parsing: Definition
Implementation of Recursive Descent Parser Using Recursive Procedures
3.4 Predictive [LL (1)] Parser (Definition, Model)
3.4.1Implementation of Predictive Parser [LL (1)]
3.4.2 FIRST & FOLLOW

Construction of LL (1) Parsing Table

Parsing of a String using LL (1) Table.

Bottom-Up Parsers

Operator Precedence Parser -Basic Concepts

Operator Precedence Relations form Associativity & Precedence

Operator Precedence Grammar

Algorithm for LEADING & TRAILING (with ex.)

Algorithm for Operator Precedence Parsing (with ex.)

Precedence Functions

Shift Reduce Parser

Reduction, Handle, Handle Pruning

Stack Implementation of Shift Reduce Parser (with examples)

LR Parser: Model, Types [SLR (1), Canonical LR, LALR]-Method & examples.

YACC (from Book 3) –program sections, simple YACC program for expression evaluation

Chapter 4	**Syntax Directed Definition**	**7 Lect**

Syntax Directed Definitions (SDD)

Inherited & Synthesized Attributes

Evaluating an SDD at the nodes of a Parse Tree, Example

Evaluation Orders for SDD's

Dependency Graph

Ordering the Evaluation of Attributes

S-Attributed Definition

L-Attributed Definition

Application of SDT

Construction of syntax trees,

The Structure of a Type

4. 4 Translation Schemes

4.4.1 Definition, Postfix Translation Scheme

Chapter 5	**Code Generation and Optimization**	**7 Lect**

Compilation of expression –

Concepts of operand descriptors and register descriptors with example.

Intermediate code for expressions – postfix notations,

Triples, Quadruples and Expression trees.

Code Optimization – Optimizing transformations – compile time evaluation, elimination of common sub expressions, dead code elimination, frequency reduction, strength reduction.

Three address code

DAG for Three address code

The Value-number method for constructing DAG's.

Definition of basic block, Basic blocks, and flow graphs

Directed acyclic graph (DAG) representation of basic block.

Issues in design of code generator.

Reference Books
1. Compilers: Principles, Techniques, and Tools, Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman, 2004 2. Principles of Compiler Design By: Alfred V. Aho, Jeffrey D. Ullman, Narosa Publication House, 2002 3. LEX & YACC, 2nd edition, O'reilly Publication, 2012

Savitribai Phule Pune University
T.Y.B.Sc. (Computer Science) - Sem – VI
Course Type: DSEC- IV Course Code: CS - 367
Course Title : Practical Course based on CS - 361

Teaching Scheme:	No. of Credits:	Examination Scheme:
5 Lect/ week	2	IE : 15 marks UE: 35 marks

Course Objectives:

1. To implement Banker's algorithm for Deadlocks in Process management.
2. To simulate File system management
3. To study and implement various algorithms of disk scheduling

Course Outcomes: After completion of this course students will be able to understand the concept of

1. Management of deadlocks by operating system
2. File System management
3. Disk space management and scheduling for processes

Guidelines:

1. Operating system platform – Linux
2. Programming language - C

List of Assignments:

- Simulation of Banker's algorithm of deadlock avoidance in processes of operating system (3 slots)
- Simulation of File Allocation methods and free space management in storage - Contiguous allocation, Linked allocation, Indexed allocation (4 slots)
- Simulation of Disk Scheduling algorithms – FCFS, SSTF, Scan, Look (2 slots)
- Assignment based on distributed and mobile OS (3 slots)

Savitribai Phule Pune University
T.Y.B.Sc. (Computer Science) - Sem – VI
Course Type: DSEC - V **Course Code: CS - 368**
Course Title : Practical Course based on CS - 363 and CS - 364

Teaching Scheme	No. of Credits:	Examination Scheme:
5 Lect/ week Batch Size : 12	2	IE : 15 marks UE: 35 marks

Course Objectives:

- To Learn different technologies used at client Side Scripting Language
- To Learn XML and XML parsers.
- To One PHP framework for effective design of web application.
- To Learn Java Script to program the behavior of web pages.
- To Learn AJAX to make our application more dynamic.

Framework has some utility features that make easy to write API in more efficient way than

Core PHP

Course Outcomes:

- Build dynamic website.
- Using MVC based framework easy to design and handling the errors in dynamic website.

Guidelines:

Operating Environment :Linux, HTML, PHP5.0 and above, Codeigniter, Python

List of Assignments based on Web Technology CS-363:

1 : Self Processing Forms, Sticky Forms, File Upload.
2 : COOKIES and SESSIONS.
3 : XML documents and DOM
4 : JavaScript
5 : Ajax
6 : PHP framework CodeIgniter

List of Assignments for Data Analytics

Assignment 1: Frequent itemset and association rule mining

Load Transactional data set. Do the needful data preprocessing. Display the set of frequent 2-itemsets and 3-itemsets. Repeat the process for different min_sup value.

Assignment 2: Linear and Logistic regression

For Given dataset predict the value of specific attribute.

Assignment 3: Text Analytics

Take text file as input. Create bag of words. Find frequent item sets. Display word cloud

Assignment 4: Sentiment analysis

SavitribaiPhule Pune University
T.Y.B.Sc. (Computer Science) - Sem – VI
Course Type: DSEC - VI Course Code: CS - 369
Course Title : Practical Course based on CS - 365

Teaching Scheme	No. of Credits	Examination Scheme
5 Lect/ week Batch Size : 12	2	IE : 15 marks UE: 35 marks

Course Objectives:

1. Covers the complete scope of the syllabus.
2. Bringing uniformity in the way course is conducted across different colleges.
3. Continuous assessment of the students.
4. Advanced Java is designed to develop web based, network centric, Enterprise level applications

Course Outcomes:

1. To Learn database Programming using Java
2. Understand and Create dynamic web pagesusing Servlets and JSP.
3. Work with basics of framework to develop secure web applications

Guidelines:

Operating Environment :

- **Operating system:** Linux
- **Editor:**Anylinux based editor like vi, gedit and Use of IDE – Eclipse etc.
- **Compiler** :javac
- **Database** :postgresql

Submission :

Each assignment will be assessed on a scale of 0 to 5 as indicated below.

- Not done 0
- Incomplete 1
- Late Complete 2
- Needs improvement 3
- Complete 4
- Well Done 5

Assessment :

Easy : All exercises are compulsory.
Medium : All exercises are compulsory.

List of Assignments:

Assignment 1 : Database Programming [Slot-2]

Study the Collection framework in java.
To Implement various Interfaces and classes through algorithms.
To Demonstrate Cursor Objects (Enumeration, Iterator, ListIterator, Comparator)

Assignment 2 : Multithreading [Slot-2]

To create and use threads in java.
To demonstrate multithreading using Thread Synchronization, Inter-thread .
Communication, Thread Priorities.

Assignment 3 : Database Programming [Slot-2]

To communicate with a database using java.
To execute queries on tables.
To obtain information about the database and tables.

Assignment 4 : Servlets [Slot-2]

To understand server-side programming.
Simple steps to create and execute servlets.
How to pass parameters using doGet and doPost methods.
Handling data from HTML to servlet .
How to connect servlet to a database .
Use of various session tracking methods like Cookies.

Assignment 5 : Java Server Pages [Slot-2]

JSP life-cycle.
Use of JSP implicit objects.
JSP Directives.
Use of Scripting Elements.
To understand actionstags in JSP.
Understanding flow of JSP custom tags.

Assignment 6 : Spring Framework [Slot-2]

To create and understand the steps to develop Spring application.

Savitribai Phule Pune University
T.Y.B.Sc. (Computer Science) - Sem – VI
Course Type: SECC - III Course Code: CS - 3610
Course Title: Software Testing Tools

Teaching Scheme:	No. of Credits:	Examination Scheme:
03 Lect / week	2	IE:15 marks UE: 35 marks

Prerequisites

- Basic knowledge of algorithms, problem solving, expected inputs/outputs
- Knowledge of C and Java Programming Language, compilation, debugging

Course Objectives:

- To provide the knowledge of software testing methods and strategies.
- To understand how testing methods can be used as an effective tool in quality assurance of software.
- To provide skills to design test case plan for testing software.
- 4.To provide knowledge of latest testing tools

Course Outcomes:

- To understand various software testing methods and strategies.
- To understand a variety of software metrics and identify defects and managing those defects for improvement in quality for given software.
- To design test cases and test plans, review reports of testing for qualitative software.
- 4. To understand latest testing tools used in the software industries.

Course Contents

Chapter 1	**Introduction to Test case design**	**4 lectures**
How to identify errors, bugs in the given application. Design entry and exit criteria for test case, design test cases in excel. Describe feature of a testing method used.		
Chapter 2	**Test cases for simple programs**	**4 lectures**
Write simple programs make use of loops and control structures. Write Test Cases for above programs.		
Chapter 3	**Test cases and Test plan**	**4 lectures**
Write Test Plan for given application with resources required. Write Test case for given application. Prepare Test report for test cases executed.		
Chapter 4	**Defect Report**	**3 lectures**
Defect Life Cycle Classification of Defect Write Defect Report		
Chapter 5	**Testing Tools**	**3 lectures**
How to make use of Automation Tools Types of Testing Tools		
Demonstration	**Programming Assignments**	**18 Lect**

Out of 36 lectures, 18 are assigned for demonstration. Teacher should give demonstration of various assignments based on above theory topics in the classroom or in the laboratory as per their convenience. Demonstration of any open source testing tool should be given.

Programming assignments should be done individually by the student in their respective login from the list given in Labbook. The code/ documentation should be uploaded on either the local server, Moodle, Github or any LMS.

Reference Books:

1. Software Engineering – A Practitioners Approach, Roger S. Pressman, 7thEdition, Tata McGraw Hill, 20
2. Effective Methods of Software Testing, William E Perry, 3rd Edition, Wiley Publishing Inc
3. Managing the Testing Process: Practical Tools and Techniques for Managing Hardware and Software Testing, Rex Black, Microsoft Press, 1999
4. Software Testing Principles and Practices by Srinivasan Desikan, Gopalaswamy Ramesh, Pearson.

Savitribai Phule Pune University
T.Y.B.Sc. (Computer Science) - Sem - VI
Course Type: SECC - IV Course Code: CS - 3611
Course Title : Project

Teaching Scheme	No. of Credits	Examination Scheme
03 Lect/ week/Batch Batch Size : 20	2	IE : 15 marks UE: 35 marks

Project Guidelines:

- Students should work in a team of minimum 3 and maximum 4 students.
- Students can choose a project topic and implement the same using any language/technology covered in the curriculum so far. The operating environment must be linux.
- The student group will work independently throughout the project work including: problem identification, information searching, literature study, design and analysis, implementation, testing, and the final reporting.
- Project guide must conduct project presentations (minimum 2) to monitor the progress of the project groups.
- At the end of the project, the group should prepare a report which should conform to international academic standards. The report should follow the style in academic journals and books, with clear elements such as: abstract, background, aim, design and implementation, testing, conclusion and full references, Tables and figures should be numbered and referenced to in the report.
- The final project presentation with demonstration (UE) will be evaluated by the project guide (appointed by the college) and one external examiner (appointed by the University).

Recommended Documentation contents:

Abstract

Introduction

- motivation
- problem statement
- purpose/objective and goals
- literature survey
- project scope and limitations

System analysis

- Existing systems
- scope and limitations of existing systems
- project perspective, features
- stakeholders
- Requirement analysis - Functional requirements, performance requirements, security requirements etc.

System Design

- Design constraints
- System Model: Using OOSE
- Data Model
- User interfaces

Implementation details

- Software/hardware specifications

Outputs and Reports Testing

- Test Plan, Black Box Testing or Data Validation Test Cases, White Box Testing or Functional Validation Test cases and results

Conclusion a*nd* Recommendations

Future Scope

Bibliography and References

Project Related Assignments

Guidelines:

- The project assignments are a compulsory part of the project course and should be carried out by each project group.
- Project assignments are to be given by the guide for continuous internal evaluation.
- The project assignments are to be allotted to each group separately by the project guide on the basis of the implementation technology. A suggested list of assignments is given below.
  1. Project Time management: plan (schedule table), Gantt chart, Roles and responsibilities, data collection, Implementation
  2. Simple assignments to evaluate choice of technology
  3. Assignments on UI elements in chosen technology
  4. Assignments on User interfaces in the project
  5. Assignments on event handling in chosen technology
  6. Assignments on Data handling in chosen technology
  7. Online and offline connectivity
  8. Report generation
  9. Deployment considerations
  10. Test cases
- Each student within the group must work actively and contribute to the assignments, project work and report writing.

Evaluation guidelines:

IA (15 marks)			**UE (35 marks)**		
First presentation	Second presentation	Assignments	Project Logic/ Presentation	Assignments and Project Documentation	Viva
05	05	05	20	10	05

Savitribai Phule Pune University

(Formerly University of Pune)

Two Year Degree Program in Zoology

(Faculty of Science & Technology)

Revised Syllabi for

M.Sc. (Zoology) Part-II

(for Colleges Affiliated to Savitribai Phule Pune University)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2020-2021

Title of the Course: M.Sc. (Zoology)

Preamble

Zoology is a major subject of Basic Sciences which deals with all aspects of animal biology. It includes an interesting range of highly diverse topics. The advancements in biological Sciences demands, a zoology student to be a master of many areas in the subject. This Postgraduate degree program has been designed by the Board of Studies in Zoology of Savitribai Phule Pune University with a tangible understanding of what is needed from zoologists and what zoologists need to pursue as a skilled career. It emulates closely the Benchmark Statement for Biosciences and the guidelines laid down by the University Grants Commission, New Delhi. This Newly designed Curriculum is an appropriate blend of the classical aspects in Zoology which has been the "backbone" knowledge required for all zoologists and the recent and specialized areas. The flexibility in the Curriculum allows the students to choose their areas of interest leading to enhanced employability. Students will be provided sufficient number of hours for their skill development through the Lab Courses and the Project component. The lab courses have differing flavours and priorities to make a good zoologist. This degree offers specialization in areas like Genetics, Animal Physiology and Entomology along with a range of core courses like Biochemistry, Molecular Biology, Comparative Animal Physiology, Developmental Biology, Environmental Biology etc. Various cross cutting issues relating to Environmental biology have been aptly included to develop the students' sense towards human wellbeing. The field trip/surveys and study tours are included to gives the student an enticing taste of what life is specially outside the walls of the classroom. On successful completion of the programme, the students are expected to understand the key life processes of human and other animal groups, the functioning of molecules, cells, tissues, organs and systems. Also the students will gain increased confidence to use initiative and judgement to make decisions in complex and changeable situations and reflect critically and analytically on personal experience and make informed decisions about further study, training and employment opportunities. The Master of Science (M.Sc.) in Zoology is a Postgraduate program under the Faculty of Science and Technology of Savitribai Phule Pune University Pune. The curriculum designed encompasses subjects like Physiology, Entomology, Genetics, Cell Biology, Developmental Biology, Endocrinology, Biochemistry, Molecular Biology, Freshwater Zoology, Environmental Biology etc. Both classical and applied subjects of Zoology have been rightly blended to offer holistic understanding of the subject.

The Choice Based Credit System (CBCS) will be implemented through this curriculum. This curriculum would certainly felicitate students to develop a strong base of the fundamentals and specialize in the desired area of their fondness and abilities. The students pursuing this program

would get a privilege to select optional subjects of their choice. A total of 210 hours for theory lectures and 180 hours for laboratory work have been prescribed in each semester including a research project (advisable to be start at the first year in consultation with the department staff) to inculcate the research culture amongst students. This newly designed curriculum will allow students to acquire the skill in handling scientific instruments planning and performing in the laboratory and exercising critical judgement, independent thinking and problem solving skills.

M.Sc. Zoology - Course structure & Distribution of Credits

M.Sc. Zoology, Part –I,

Semester-I

Sr. No.	Core Compulsory Theory Paper (CCTP)	Choice Based Optional Paper (CBOP)	Theory/ practical	Credit	Core Compulsory Practical Paper (CCPP)	Credit
1	**ZOUT 111** Biochemistry and Biochemical Techniques	-			-	4
2	**ZOUT 112** Cell Biology and Developmental Biology	-			-	4
3	**ZOUT 113** Genetics and English in Scientific Communication.	-			-	4
4	-	**ZODT 114** Theory. ---------- **ZODP 114** Practical	Biostatistics/ Freshwater Zoology Zoology Practical Paper-1	2 2	-	4
5	-	-			**ZOUP 115** Basic Zoology Lab-I	4
	Total Credit of Semester 1					**20**

M.Sc. Zoology, Part-I, Semester-II

Sr. No.	Core Compulsory Theory Paper (CCTP)	Choice Based Optional Paper (CBOP)	Theory/ practical	Credit	Core Compulsory Practical Paper (CCPP)	Credit
1	**ZOUT 121** Molecular Biology and Bioinformatics	-			-	4
2	**ZOUT 122** Endocrinology and Parasitology	-			-	4
3	**ZOUT 123** Comparative Animal Physiology and Environmental Biology.	-			-	4
4	-	**ZODT 124** Theory. ---------- **ZODP 124** Practical	Metabolic pathways / Ichthyology	2	-	4
			Zoology Practical Paper-2	2		
5	-	-			**ZOUP 125** Basic Zoology Lab- II	4
		Total Credit of Semester 2				**20**

M.Sc. Zoology, Part-II, Semester - III

Sr. No.	Core Compulsory Theory Paper (CCTP)	Choice Based Optional Paper (CBOP)	Theory/ practical	Credit	Core Compulsory Practical Paper (CCPP)	Credit
1	ZOUT 231 Special Paper (any one) Animal Physiology-I/ Entomology-I/ Genetics-I	-			-	4
2	ZOUT 232 Fundamentals of Systematics and Economic Zoology	-			-	4
3	ZOUT 233 Research Methodology and Insect Physiology and Biochemistry	-			-	4
4	-	ZODT 234 Theory --------- ZODP 234 Practical	Immunology/ Genetic Toxicology/ Zoology Practical Paper- 3	2 2	-	4
5	-	-			ZOUP 235 Special Lab I	4

M.Sc. Zoology, Part II, Semester – IV

Sr. No.	Core Compulsory Theory Paper (CCTP)	Choice Based Optional Paper (CBOP)	Theory/ practical	Credit	Core Compulsory Practical Paper (CCPP)	Credit
1	ZOUT 241 Special Paper-Any One- Animal Physiology-II/ Entomology-II/ Genetics-II	-			-	4
2	ZOUT 242 Mammalian Reproductive Physiology and Aquaculture				-	4
3	-	ZODT 243 Theory	Histology and Histochemistry/ Pest Control	2	-	4
		ZODP 243 Practical	Zoology Practical Paper-4 (Practicals corresponding to ZOUT 241and ZODT 243)	2		
4	-	ZODT 244 Theory	Pollution Biology/ Apiculture	2	-	4
		ZODP 244 Practical	Zoology Practical Paper-5 (Practicals corresponding to ZOUT 242 and ZODT 244)	2		
5	-	-			ZOUP 245 (Project)	4
	Total Credit of Semester 4					**20**

Equivalence of Previous Syllabus:

Semester-I

Old Course (2013 Pattern)	New Course (2019 Pattern)
ZY101T: Biochemistry-I	ZOUT 111 Biochemistry and Biochemical Techniques
ZY102T: Cell Biology	ZOUT 112 Cell Biology and Developmental Biology
ZY103T: Genetics	ZOUT 113- Genetics and English in Scientific Communication.
ZY104T: Biostatistics	ZODT 114 Biostatistics
ZY105T: Skills in scientific communication and Writing	ZOUT 113 Genetics and English in Scientific Communication.
ZY106T: Freshwater Zoology	ZODT 114 Freshwater Zoology
ZY101P:Practicals in Biochemistry	ZOUP 115 Basic Zoology Lab-I
ZY102P: Practicals in Cell Biology	
ZY103P: Practicals in Genetics	
ZY105P: Practicals in Skills in scientific communication and writing	
ZY106P: Practicals in Fresh water zoology	ZODP 114 Zoology Practical-1
ZY104P: Practicals in Biostatistics	
Old Course (2013 Pattern)	
ZY101T: Biochemistry-I	
ZY102T: Cell Biology	
ZY103T: Genetics	
ZY104T: Biostatistics	
ZY105T: Skills in scientific communication and Writing	
ZY106T: Freshwater Zoology	
ZY101P:Practicals in Biochemistry	
ZY102P: Practicals in Cell Biology	
ZY103P: Practicals in Genetics	
ZY105P: Practicals in Skills in scientific communication and writing	
ZY106P: Practicals in Fresh water zoology	
ZY104P: Practicals in Biostatistics	

Semester-II

Old Course (2013 Pattern)	New Course (2019 Pattern)
ZY201T: Biochemistry-II	ZODT 124Metabolic pathways
ZY202T: Molecular Biology	ZOUT 121 Molecular Biology and Bioinformatics
ZY203T: Developmental Biology	ZOUT 112 Cell Biology and Developmental Biology
ZY204T: Endocrinology	ZOUT 122 Endocrinology and Parasitology
ZY205T: Comparative Animal Physiology	ZOUT 123 Comparative Animal Physiology & Environmental Biology
ZY206T: Biochemical Techniques/Ichthyology	ZOUT 111 Biochemistry & Biochemical Techniques ZODT 124 Ichthyology
ZY201P:Practicals in Biochemistry-II	ZOUP 125 Basic Zoology Lab-II
ZY202P: Practicals in Molecular Biology	
ZY203P: Practicals in Developmental Biology	
ZY204P: Practicals in Endocrinology	
ZY205P: Practicals in Comparative Animal Physiology	

Semester-III

Old Course (2013 Pattern)	New Course (2019 Pattern)
ZY 301**T** Animal Physiology I (special)	ZOUT 231 Special Paper Animal Physiology-I
ZY 301**T** Entomology I (special)	ZOUT 231 Special Paper Entomology-I
ZY 301**T** Genetics I (special)	ZOUT 231 Special Paper Genetics-I
ZY 302**T** Immunology	ZODT 234 Immunology
ZY 302**T** Environmental Biology	---
ZY 303**T** Genetic toxicology	ZODT 234 Genetic toxicology

ZY 303**T** Aquaculture	ZOUT 242- Aquaculture
ZY 304**T** Insect Physiology and Biochemistry	ZOUT 233- Insect Physiology and Biochemistry
ZY 305**T** Research methodology	ZOUT 233- Research methodology
ZY 306**T** Parasitology	--
ZY 307**T** Fundamentals of Systematics	ZOUT 232- Fundamentals of Systematics
ZY 308**T** Insect Ecology	--
ZY 309**T** Toxicology I	--
ZY 301P Practicals in Animal Physiology I (special)	ZOUP 235 Special Lab I
ZY 301 P Practicals in Entomology I (special)	
ZY 301 P Practicals in Genetics I (special)	ZODP 234 Practical
ZY 302 P Practicals in Immunology	
ZY 302 P Practicals in Environmental Biology	
ZY 303 P Practicals in Genetic toxicology	
ZY 303P Practicals in Aquaculture	
ZY 304P Practicals in Insect Physiology and Biochemistry	
ZY 305P Practicals in Research methodology	
ZY 306**P** Practicals in Parasitology	
ZY 307P Practicals in Fundamentals of Systematics	
ZY 308P Research Project	
ZY 309P Practicals in Toxicology I	

Semester-IV

Old Course (2013 Pattern)	**New Course (2019 Pattern)**
ZY 401**T** Animal Physiology II (special)	ZOUT 241- Animal Physiology II (special)
ZY 401**T** Entomology II (special)	ZOUT 241- Entomology II (special)
ZY 401**T** Genetics II (special)	ZOUT 241- Genetics II (special)
ZY 402**T** Economic Zoology	ZOUT 232- Economic Zoology
ZY 402**T** Bacteria and phage Genetics	--

ZY 403**T** Mammalian Reproductive Physiology	ZOUT 242- Mammalian Reproductive Physiology
ZY 403**T** Biodiversity assessment	--
ZY 404**T** Histology and Histochemistry	ZODT 243 Histology and Histochemistry
ZY 405**T** Pollution Biology	ZODT 244 Pollution Biology
ZY 406**T** Apiculture	ZODT 244 Apiculture
ZY 407**T** Pest control	ZODT 243 Pest control
ZY 408**T** Toxicology II	--
ZY 401 P Practical Animal Physiology II	ZODP 243 Practical ZODP 244 Practical ZOUP 245 (Project)
ZY 401 P Practical Entomology II	
ZY 401 P Practical Genetics II	
ZY 402 P Practical Economic Zoology	
ZY 402 P Practical Bacteria and phage Genetics	
ZY 403 P Practical Mammalian reproductive physiology	
ZY 403 P Practical Biodiversity assessment	
ZY404 P Practical Histology and histochemistry	
ZY405 P Practical Pollution biology	
ZY406 P Practical Apiculture	
ZY308 P Research Project	
ZY 408 P Practicals in Toxicology II	

Detailed Syllabus with Recommended Books:

Program outcomes (POs): **After successfully completing the M.Sc. Zoology program students will be able to:**

PO1. **Zoology knowledge**: Apply the knowledge of Zoology, Life Sciences and allied subjects to the understanding of complex life processes and phenomena.

PO2. **Problem analysis**: Identify, review research literature, and analyse complex situations of living forms.

PO3. **Design/development of solutions**: Design processes/strategies that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions in real situations.

PO5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and ICT tools for understanding of the subject.

PO6. **The Postgraduate and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. **Environment and sustainability**: Understand the impact of the natural and anthropogenic activities in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. Identify a range of invertebrates and vertebrates and justify their conservation.

PO8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the work/research practice.

PO9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. **Communication**: Communicate effectively on complex life activities with the scientific community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. **Project management and finance**: Demonstrate knowledge and understanding of Zoology and management principles and apply these to one's own work, as a member and leader in a team.

PO12**. Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Following is the syllabus of each course along with the course outcomes:

M.Sc. Zoology, Part II, Semester – III

Course Code and Course Name:

ZOUT231: Animal Physiology- I (Special Paper) (4 Credits: 60 Lectures)

Semester III

After successfully completing this course, students will be able to: CO1:

CO1: Explain the membrane physiology and its dynamics.

CO2: Explain the concept of nutrition and digestion.

CO3: Explain the structure, contraction and types of contraction of muscle.

CO4: Illustrate bioluminescence and animal electricity with examples and its significance

CO5: Correlate the organisms Internal and external environments with homeostasis and biological Clocks.

CO6: Diagrammatically represent the mechanism of respiration, gas exchange and transport of O_2 and CO_2

Sr. No.	Name of the topic	Lectures allotted
1.	**External and Internal environment** 1.1 External environment: the atmosphere, aquatic & terrestrial environment 1.2 Internal environment: Extracellular and intra cellular environment 1.3 Homeostasis and regulation: tolerance and resistance, acclimatisation and acclimation, regulatory mechanism. 1.4 Biological clock and their regulation: Circadian rhythms lunar and tidal rhythm, circa annual rhythm, photoperiodism.	**(08L)**
2.	**Membrane Physiology** 2.1 Membrane structure, membrane permeation, diffusion mediated transport, dynamics of semi permeable membrane. 2.2 Resting membrane potential, diffusion, equilibrium potential, Goldman-Hodkin- Katz potential, conductance, current, capacitance 2.3 Excitable cell membrane: action potential, role of various ion channels, role of Na+ K+ pump, properties of action potentials	**(10L)**
3.	**Physiology of Digestion** 3.1 Nutritive requirements (concept of balanced diet), Regulation of hunger, satiety 3.2 Digestion and absorption in the G.I tract: carbohydrate, lipids & protein 3.3 Control and regulation of digestion 3.4 Calorimetry and BMR	**(09L)**
4.	**Respiration** 4.1 Internal and external respiration; Anatomy of respiratory system 4.2 Pulmonary respiration: Partial pressure, inspiration and expiration, Lung volume and capacities	**(10L)**

	4.3 Gas exchange across the pulmonary and systemic capillaries 4.4 Gas transport; O2 transport, CO2 transport and abnormalities in the blood gas content 4.5 Neuronal control of respiration, role of central and peripheral receptors 4.6 Other functions of respiratory system, waste elimination	
5.	**Muscle Physiology** 5.1 Structure of skeletal muscle and molecular basis of skeletal muscle contraction, types of contraction, twitch summation and tetanus, relation between muscle length and tension, velocity of contraction 5.2 Chemical basis of muscle contraction 5.3 Innervation of muscles, excitation and contraction coupling 5.4 Skeletal muscle fiber types, contractile machinery of smooth muscle	**(09L)**
6.	**Bioluminescence and Animal electricity** 6.1 Bioluminescence: phyletic distribution, structure of luminescent organs, biochemical and molecular mechanism. 6.2 Animal electricity: electro receptors electro organs and their structure and functions	**(08L)**
7.	**Buoyancy** 7.1 Definition, density reduction 7.2 Gas floats with examples 7.3 Swim bladder with example	**(06L)**

REFERENCE BOOKS:

1. Animal Physiology: Adaptation and Environment (1997) Knut Schmidt-Nielsen Publisher: Cambridge University Press.
2. Principles of Animal Physiology (2006), C. D. Moyes and P. M. Schulte. Publisher - Pearson Education Inc. and Dorling Kindersley Publishing Inc.
3. Text book of Medical Physiology 10th edition (2001), A. C. Guyton and J. E. Hall. Publisher - W. B. Saunders Company, Philadelphia. –
4. Principles of Anatomy and Physiology, 11th edition (2006), G. J. Tortora and B. Derrickson. Publisher-John Wiley and Sons Inc.
5. Endocrinology, 5th edition (2008), Mac. E. Hadley. Publisher-Pearson Education Inc. and Dorling Kindersley Publishing Inc.
6. Comparative Vertebrate Endocrinology 3rd edition (1998), P. J. Bentley. Publisher Cambridge University Press.
7. Vertebrate Endocrinology 3rd edition (1997), D. O. Norris. Publisher- Academic Press: An imprint of Elsevier.
8. The World of the Cell, 7th edition, (2005), Wayne M. Becker, Lewis J. Kleinsmith, Jeff Hardin., Publisher - Benjamin Cummings.
9. Principles of Animal Physiology (2nd Edition) (2007) Christopher D. Moyes , Patricia M.

Schulte

10. Animal Physiology, Third Edition (2012) Richard W. Hill, Gordon A. Wyse, Margaret Anderson
11. Functional Anatomy and Physiology of Domestic Animals 4th Edition (2009) William O. Reece Animal Physiology 2nd Edition Richard W. Hill Publisher: Sinauer Associates, Incorporated
12. Eckert's Animal Physiology (2004) Roger Eckert, D.J. Randall, Warren Burggren, Kathleen French Publisher: W.H.Freeman & Co Ltd
13. Principles of Animal Physiology (2013) Christopher D. Moyes, Patricia M. Schulte • Publisher: Pearson Education Limited
14. Environmental Physiology of Animals (2004) Pat Willmer, Graham Stone, Ian Johnston • Publisher: Blackwell Publishing Ltd
15. Introduction to Animal Physiology (1998) Ian Kay Publisher: Bios Scientific Publishers Ltd

Note: Use the latest editions of the recommended books

Course Code and Course Name:

ZOUT 231 : Entomology- I (Special Paper) **4 Credits: 60 Lectures**

Semester III

After successfully completing this course, students will be able to:

CO1: Define entomology and Insects and understand origin and evolution of insects and their relation to other arthropods.

CO2: Give outline of Classification of insects up to family with distinguishing characters and examples of each order and family.

CO3: Explain the structure, chemical composition and functions of Integument and Derivatives of Integument.

CO4: Explain the structure, modifications of insect body regions and their appendages.

CO5: Explain the Comparative anatomical and histological structure of various body systems.

CO6: Explain the location structure and functions of various Endocrine and Exocrine glands.

CO7: Explain the location and structure of Light and Sound producing organs in various insects

Sr. No.	Name of the topic	Lectures allotted
1.	Introduction to Entomology: Definition, Origin, Evolution and Inter-relationship of insects with other arthropods.	**(04L)**
2.	General outline of Classification and Phylogeny of insects up to family : Aptrygote insects (4 orders), Exopterygote insects (16 orders) and Endopterygote insects (9 orders).	**(19L)**
3.	Integument : Structure, chemical composition and functions. Derivatives of Integument: Cuticular appendages & Processes.	**(02L)**
4.	Comparative study of : Head and its appendages; Thorax and its appendages ; Abdomen and its appendages.	**(09L)**
5.	Comparative anatomical and histological study of the following : Digestive system, Respiratory system, Circulatory system, Excretory system, Reproductive system, Nervous system and Sense organs.	**(20L)**
6.	Endocrine and Exocrine glands and Hormonal action.	**(04L)**
7.	Light and Sound producing organs.	**(02L)**

REFERENCE BOOKS:

1. A Text book of Entomology-By H. H. Ross (John Wiley and Sons, Ins. New York,).
2. An Introduction to Entomology- By J. H. Comstock (Ithaca, New York).
3. General & Applied Entomology- By K. K. Nayar, T.N. Anathakrishnan & B.V. David, (Tata McGraw-Hill, New Delhi).

4. General Entomology, 2nd edition- By M.S. Mani Oxford & IBH Publishing Company, New Delhi.
5. Imm's text book of entomology by O. W. Richards and R. G. Davies (Methuen and com, London) vol. I and II
6. Introduction to comparative Entomology- By R. M .Fox and J. W. Fox (Reinhold, New York)
7. Modern Entomology, 2nd edition- By D. B. Tembhare (Himalaya Publication House, Bombay).
8. Principles of insect morphology- By R. E. Snodgrass (Tata Mc-Graw Hill Bombay).
9. The Insect: Structure & Function- By R. F. Chapman (E.L.B.S., & E.U.P. London).

Note: Use the latest editions of the recommended books

Course Code and Course Name:

ZOUT 231 : Genetics- I (Special Paper) (4 Credits: 60 Lectures)

Semester III

After successfully completing this course, students will be able to:

CO1: Define the basic terminologies in Genetics

CO2: Elaborate the advantages of model organisms used in genetic studies

CO3: Apply molecular methodologies in genetic analysis

CO4: Estimate gene frequencies

Sr. No.	Name of the topic	Lectures allotted
1.	Model Genetic System: Life cycles, genetic nomenclature and advantages of the following organisms commonly used in genetic studies: 1.1 T phages 1.2 *E.coli* *1.3 Saccharomyces cerevisiae* and *Schizosaccharomyces pombe* *1.4 C. elegans* *1.5 Drosophila* 1.6 Zebra fish 1.7 Mouse	6L
2.	Advanced Population Genetics: 2.1 Recapitulation of basic concepts and Hardy-Weinberg law. 2.2 Estimation of gene frequencies in population through mutation, migration and selection, selection-mutation equilibrium, derivation and genetic equations for above. 2.3 Assortative mating, inbreeding and genetic drift.	12L
3.	Quantitative genetics: 3.1 Concept of continuous variation, phenotypic variance and its partitioning into subcomponents. 3.2 Co-variance, correlation and regression, degree of genetic determination, measurement of heritability, quantitative inheritance in humans.	12L
4.	Evolutionary Genetics: 4.1 Genetic polymorphism. 4.2 Selection strategies and effects. 4.3 Genetics of speciation: classical and modern concepts. 4.5 Use of molecular information in understanding phylogenetic relationship.	12L
5.	Applications of Molecular methodologies in genetic analysis: 5.1 Introduction to gene localization on chromosomes. 5.2 Chromosomal Probes and Paints. 5.3 Gene Therapy: *Ex vivo* and *In vivo* gene therapy and two examples of gene delivery system. 5.4 Reverse Genetics.	12L

	5.5 History of Human genome project: Strategies, methodologies, and current status.	
6.	Genetics in Toxicology: 6.1 History of genetic toxicology and role of FDA, EPAand its guidelines and regulation. 6.2 Role of model organisms in genetic toxicology studies. 6.3 Screening tests: use of test systems- Bacterial, Yeast, *Drosophila* and Mammalian system.	06L

REFERENCE BOOKS:

1. An Introduction to Genetic Analysis – A.J.F. Griffiths, J. Doebley, C. Peichel, D.A. Wassarman (12th ed.) W.H. Freeman Publ. 2020.
2. Concepts of Genetics – W.S. Klug and M.R. Cummings (12th ed.) Pearson Publ. 2019.
3. Genetics : A conceptual approach – B.A. Pierce (6th ed.) W.H. Freeman Publ. 2016.
4. Lewin's GENES XII – J.E. Krebs, E.S. Goldstein, S.T. Kilpatrick. Jones and Bartlett Publ. 2018.
5. Human Molecular Genetics – T. Strachan and A. Read (5th ed.) Garland Science Publ. 2018.
6. Genetics – M.W. Strickberger (3rd ed.) Pearson India Publ. 2015
7. Principles of Genetic Toxicology – D. Brusick. Springer (reprint of Basic Book Publ) 2013.
8. Principles of Genetics – E.J. Gardner, M.J. Simmons, D.P. Snustad (8th ed.) John Wiley & Sons 2006.
9. Genetics: Analysis of Genes and Genomes – D.L. Hartl and E.W. Jones (6th ed.) Jones & Bartlett Publ. 2004.
10. Strickberger's Evolution – B. Hall (4th ed.) Jones and Bartlett Publ. 2008.

Note: Use the latest editions of the recommended books

Course Code and Course Name:

ZOUT 232 : Fundamentals of Systematics and Economic Zoology (4 Credits: 60 Lectures)

Semester III

After successfully completing this course, students will be able to: CO1:

Fundamentals of Systematics

CO1: Explain principles, methods of biological classification and diversity in kingdom Animalia.

CO2: Explain the importance of taxonomic keys and taxonomic characters.

CO3: Explain the principles of zoological classification and nomenclature

CO4: Discuss the various taxonomic procedures and molecular phylogenetics & phylogeography.
CO5: Illustrate the methodologies used in systematics.

Economic Zoology

CO1: Illustrate the lac culture, apiculture, prawn culture, vermiculture, Poultry, dairy industry and Piggery.

CO2: Explain the role of insects of economic importance.

CO3: Explain parasitic roundworms of animal and plants.

CO4: Signify the role of parasitic and soil protozoan in human welfare.

CO5: Justify the use of animals in pharmaceutical research.

CO6: Explain coral reef and its significance.

Sr. No.	Name of the topic	Lectures allotted
	Fundamentals of Systematics	
1.	Fundamental of Systematics: Biological classification, Hierarchy of Categories and taxa.	2L
2.	Taxonomic keys: Types of taxonomic keys, their merits and demerits. International code of Zoological nomenclature: Its operative principles, interpretation and application of important rules, zoological nomenclature, formation of names	7L
3.	Taxonomic procedures: taxonomic collection preservation, curetting process and identification.	3L
4.	Species concepts: Definition and types (Allopatric, sympatric, parapatric, sibling etc.)	2L
5.	Kingdoms of Life: General outline of kingdoms including Monera & Protista. Broad outline & Diversity in kingdom Animalia (Major and Minor phyla).	5L
6.	Methodologies in systematics: Morphology based taxonomy, Numerical taxonomy, Cyto-taxonomy and chemotaxonomy, Molecular systematic, DNA fingerprinting & Molecular markers for detection/evaluation of polymorphism, RFLP, RAPD etc.	8LL

7.	Molecular phylogenetics and phylogeography.	3L
	Economic Zoology	
1.	Animal husbandry: Poultry, Piggery, Dairy industry and wool industry.	08L
2.	Economic importance of insects: Apiculture, Lac culture, Sericulture, House hold insect and stored grain pest and Agricultural pest.	10 L
3.	Economic importance of amphibian, reptiles and birds.	02 L
4.	Vermiculture industry in India.	01 L
5.	Prawn culture	01 L
6.	Nematodes- parasitic roundworms of animals and plants.	01 L
7.	Helminthes as human and animal parasites.	02 L
8.	Concept of Coral reef and its significance.	01 L
9.	Sponge culture and its importance in industry.	01 L
10.	Parasitic protozoan's and their role in human welfare, soil protozoan's and their role in agriculture.	02 L
11.	Model animals in pharmaceutical industry.	01 L

REFERENCE BOOKS:

Fundamentals of Systematics :

1. Kato., The biology of biodiversity, Springer.
2. Avise J.C., Molecular markers, Natural history and evolution, Chapman and Hill, NY.
3. Wilson A.O., biodiversity, Academic Press, Washington.
4. Principals of systematic Zoology by Ernst Mayr.

Economic Zoology :

1. Economic Zoology: An Introductory Text-Book in Zoology, with Special Reference to Its Applications in Agriculture, Commerce, and Medicine, Herbert Osborn, Ulan Press (August 31, 2012)
2. Economic Zoology-Shukla and Upadhaya, Rastogi Publication, 2017
3. A Textbook of Economic Zoology, Dr Sanjeev Jain, Indian Books and Periodicals 2018.
4. Economic Zoology-Manju Yadav , Discovery Publication 2013
5. Economic Zoology-K.R.Ravindranathan , Om Publications 2013
6. Textbook of Economic Zoology- P.R.Venkitaraman Sudharsana Puubl. Kochi 1983
7. A Handbook on Economic Zoology , Dr Jawaid Ahsan And Dr Subhas Prasad Sinha S. Chand Group.
8. Encyclopedia of Economic Zoology, A.A. Khan. Anmol Publications
9. Economic Zoology by. Manju Yadav, Discovery Publishing House Pvt. Limited. Economic Zoology by Malhotra ,Prakash, Adhyayan Puhlishers & Distributers
10. Introduction to Economic Zoology, Sarkar, Kundu and Chaki, New Central Book Agency; New edition edition (14 May 2014)

Course Code and Course Name:

ZOUT 233 : Research Methodology and Insect Physiology and Biochemistry

(4 Credits: 60 Lectures)

Semester III

After successfully completing this course, students will be able to:

Research Methodology

CO1: demonstrate knowledge of research processes (reading, evaluating, and developing)

CO2: perform literature reviews using print and online databases.

CO3: select and define appropriate research problem and parameters to prepare a project proposal.

CO4: identify, explain, compare, and prepare the key elements of a research proposal/report.

CO5: compare and contrast quantitative and qualitative research paradigms

CO6: Use sampling methods, measurement scales and instruments, and appropriate uses of each.
CO7: Justify the rationale for research ethics,

Insect Physiology and Biochemistry

CO1: Explain the structure, Chemistry of integument and sclerotization.

CO2: Describe the process of digestion and metabolism

CO3: Explain the characteristics of haemolymph and types of haemocytes.

CO4: illustrate the structure, physiology and biochemistry of flight muscle.

CO5: Demonstrate the process of excretion, detoxification and water balance

CO6: Justify the role of insect hormones in physiological processes.

Sr. No.	Name of the topic	Lectures allotted
	Research Methodology	
1.	Research: Meaning, Objectives, Types of research, Planning research project – Identifying Research problems, selection of problem – formulation of a problems. Literature review- Collection of literature- Books - Journals. Digital library and search of articles - Key words and search - Internet – Google Scholar – Pub med – Inflibnet – Medline	04L
2.	Data Collection: Meaning, Methods and Tools of Data Collection Hypothesis Sampling, Data Processing, Analysis and Interpretation of Data.	03L
3.	Research Design: Meaning and Objectives, Characteristics of good research design, components of the research design & steps in scientific research process.	02L
4.	Quantitative methods**:** Biostatistics used for analysis of Biological data	02L

5.	Computer application**:** bioinformatics, databases and their applications	03L
6.	Tools and techniques**:** • Techniques used Purification and characterization of biomolecules: Recapitulation of centrifugation, chromatography and electrophoresis. • NMR, MALDI-TOF, X-ray crystallography, Circular Dichroism CD • Microscopic techniques including Fluorescence microscopy, Confocal microscopy, Atomic force microscopy and live cell imaging FACS analysis.Real time PCR, DNA microarray, New generation DNA sequencing, Protein Microarray.	10L
7.	Dissertation structure –Components - Writing Introduction – review of literature – Materials & Methods – Presentation of results – Discussion of Results based on literature – Arriving conclusions – Briefing of Summary – Arrangement and how to quote reference in thesis -Appendix.	02L
8.	Publishing of Articles in National and International Journals - Selection of Journals – ISSN Number – Peer reviewed Journals – Science citation index – impact factor and its importance.	01L
9.	Intellectual property rights and patent law – Trade Related aspects of Intellectual Property Rights – Reproduction of published material – Plagiarism - Citation and acknowledgement Patent Criteria and procedure of patenting, patenting biological material.	03L
	Insect Physiology and Biochemistry	
10.	Integument: Structure, Chemistry, sclerotization, functions.	03 L
11.	Digestion and absorption of proteins, Carbohydrates and lipids.	03 L
12.	Fat body: Structure, physiology, biochemistry, functions. Integration of carbohydrate, fat and acid metabolism	04 L
13.	Ventilatory mechanisms and their control	03 L
14.	Haemolymph: Physico-chemical characteristics of plasma: types and structure of haemocytes, functions.	03 L
15.	Muscle: structure, physiology and biochemistry of flight muscles	03 L
16.	Excretion and water balance: Structure and function of Malpighian tubules. Water balance and nitrogen excretion.	04 L
17.	Endocrines, neurosecretory hormones, chemistry, function and mechanism of hormone action, moulting and juvenile hormones; chemistry and physiology, other peptide and steroid hormones	04 L
18.	Microsomal and extra-microsomal enzymes insecticide degradation and detoxification.	03 L

REFERENCE BOOKS:

Research Methodology

1. Kothari, C.R. (1985): Research Methodology: Methods and Techniques, Wiley Eastern.
2. Dominowski, R.L. (1980): Research Methods, Prentice Hall Inc., New Jersey.
3. Mishra, R.P. (1980): Research Methodology, Handbook Concept Publishing Company, New Delhi.
4. IIPS (1996): Research Methodology, IIPS, Mumbai.
5. Research and Writtings – By-P. Ramdas , A.Wilson srunai M.J.Publisher (2009).
6. Scientific thesis writings and Paper presentations-N.Gurumani. M.J.Publisher (2010).
7. Anderson, Durston&Polle 1970: Thesis and assignment, writing Wiley Eastern Limited

8. G. Vijayalakshmi and C. Sivapragasam. (2008) Research Methods –Tip & Techniques, MJP
9. Publishers, Chennai. WWW.mjppublishers.com
10. Malter K, 1972: Statistical analysis in Biology, Chapmen Hall, London.
11. Cohen, L. Lawrence, M., & Morrison, K. (2005). Research Methods in Education (5th edition). Oxford: Oxford University Press.
12. Leedy, P. D. (1980). Practical Research: Planning and design. Washington: Mc Millan Publishing Co., Inc.
13. Singh, Y. K. (2006). Fundamental of Research Methodology and Statistics. New Delhi. New International (P) Limited, Publishers

Insect Physiology and Biochemistry

1. Fundamentals of insect physiology, Blum N.S., John Wiley and sons, NY
2. An introduction to insect physiology, Bursell, e. academic press, NY
3. Insect biochemistry and function Candy D.J. and Kilby D.A. Chapman and hall, London
4. Comprehensive insect physiology, biochemistry and pharmacology, Kerkut G.A and Gilbert L.I., Vol 1 to 13 Pergamon press, Oxford, NY
5. The Insects: Structure and Function. Forth ed., Chapman R. F. (1998), Cambridge University Press, UK.
6. Insect Physiology. Prakash, M. (2008), Discovery Publishing House Pvt. Ltd., New Delhi.
7. Physiological Systems in Insects. Second ed., Klowden, Marc (2007), Elsevier, USA
8. The Principles of Insect Physiology, Seventh ed. Wigglesworth, V.B. (1972), Chapman and Hall, London.

Course Code and Course Name:

ZODT 234 : Immunology **(2 Credits: 30 Lectures)**

Semester III

After successfully completing this course, students will be able to:

CO1: List the primary and secondary immune organs.

CO2: Explain the concepts of immunity, self-nonself immune response, autoimmune disease.

CO3: Explain the theories of antibody synthesis and generation of antibody diversity.

CO4: Explain the principle and application of the common techniques used in Immunology

CO5: Illustrate the events and dynamics of inflammation

CO6: Compare the MHC molecules and diseases associated with HLA.

CO7: Differentiate between active and passive immunization

CO8: Compare the three pathways of complement fixation pathway.

Sr. No.	Name of the topic	Lectures allotted
1.	Introduction to Immune system. 1.1. Overview of Immunology 1.2. Innate and Adaptive immunity; Humoral immunity and cell mediated immunity 1.3. Primary and secondary lymphoid organ. Tissue, cells and molecules of the human immune system. 1.4. Immediate response to infection: inflammation, cell migration, acute phase response interferons and NK cell. 1.5. Concept of immunity (self- non self, antigen) and active and passive immunization (natural and artificial)	07L
2.	Antibody structure, antibody classes, subclasses, structure-function relationship, iso, idio and allo types., T cell receptors.	04L
3.	Theories of antibody synthesis, generation of antibody diversity (molecular basis), antibody class switching.	03L
4.	MHC, HLA and disease association, immune deficiencies and disorders. Antigen processing & Immunogenetics.	05L
5.	Immunological Tolerance, Autoimmunity	02L
6.	Hypersensitivity.	01L
7.	Immunological memory, types of vaccines and vaccination	02L
8.	Immunotechniques: Antigen-antibody reaction and complement system and complement fixation test.	02L
9.	Hybridoma principle and application, ELISA, immunofluorescence, immunoelectrophoresis, RIA and monoclonal-polyclonal antibody and its application.	04L

REFERENCE BOOKS:

1. Immunology: Kindt T. J., Goldsby R.A. , Osborme B. A., Kuby J. : freeman WH publications.
2. Essential immunology, IvonRoitt, Blackwell Scientific publication, London.
3. Immunology, Roitt I. V., Butterworth Publishers, USA.

Course Code and Course Name:

ZODT 234 : Genetic Toxicology (2 Credits: 30 Lectures)

Semester III

After successfully completing this course, students will be able to:

CO1: Define genotoxicity test systems.

CO2: Describe basic toxicological principles and describe how different chemicals are taken up by, processed in and eliminated from the body

CO3: Inspect physical and chemical genotoxic agents being exposed in his/her environment

CO4: Illustrate physical and chemical genotoxic agents.

CO5: Explain efficiency mechanisms of physical chemical genotoxic agents

CO6: Relate genotoxicity and DNA repair mechanisms and relate types of mutation and DNA repair

CO7: Judge about proper genotoxicity test for mutation types

Sr. No.	Name of the topic	Lectures allotted
1.	Toxicology: Definition and its subdivisions, scope and significance of genetic toxicology	03L
2.	Mutations at molecular, functional and chromosomal levels. Mechanisms of Mutagenesis End point mutations and its function, carcinogenicity and transformation. Biological significance of mutagenesis	07L
3.	Mutagenic agents in human environment. Applications of genetic toxicology to human and environmental monitoring	05L
4.	Methodologies used in detection of mutation, functional, cytogenetic effects. Use of Ames test, mammalian systematics, Drosophila etc.	05L
5.	Screening chemicals for genotoxic properties: Screening tests, hazard assessment, Risk analysis tests. Common assays used for testing mutagenic activity using bacteria, yeasts, insects, plants, animals.	07L
6.	Genetic toxicology and its role in the study of congenital malformations	03L

REFERENCE BOOKS:

1. Chemical mutagens- principles and methods for their detection, Ed. Hollander, A. Vol. 1-5, Plenum press
2. Chemical mutagenesis in mammals and men. Eds. Vogel, F. and Rohtborn, G. Springer Verlag

3. Mutagenic effects of Environmental contaminants, Eds. Suttoa, H.E. and Harris, M.I., Academic press
4. Mutation research (section on genetic toxicology testing)
5. Genetic Toxicology: Principles and methods, Parry J.M., Parry E.M. (eds) Springer Publ. (2012)
6. Principles of Genetic Toxicology, Second Edition, David Brusick, Springer Science+Business Media New York

Course Code and Course Name:

ZODP 234 : Zoology Practical Paper-3 (Immunology) (2 Credits: 60 Hours)

Semester III

Note: A total of 15 practicals are to be conducted. 1 practical is of 4 clock hour duration.

After successfully completing this course, students will be able to:

CO1: Identify the pattern of identity of antigen- antibody reaction.

CO2: Identify the microscopic structure of the lymphoid organs.

CO3: Demonstrate immunoelectrophoresis technique.

CO4: Demonstrate the double diffusion techniques.

CO5: Detect the human blood groups by antigen -antibody reactions

CO6: Prepare the human blood smear to identify various blood cells.

Sr. No.	Name of the topic	Lectures allotted
1.	Double diffusion or Ouchterlony technique (using kit). **(Compulsory)**	(2P)
2.	Demonstration of Immunoelectrophoresis (using kit). **(Compulsory)**	(2P)
3.	Separation of e gamma globulins from the serum using native PAGE.	(2P)
4.	Histology of lymphoid organs: skin, spleen, thymus, ileum lymph node and bone marrow. **(Compulsory)**	(1P)
5.	To study the differential count of WBCs. **(Compulsory)**	(1P)
6.	Cell counting and viability testing using splenocytes (from goat spleen)	(2P)
7.	To estimate the antigen concentration by rocket electrophoresis (kit using). **(Compulsory)**	(2P)
8.	To study the immunology of blood transfusion (universal donor, universal recipient, Bombay blood group and erythroblastosis foetalis). **(Compulsory)**	(1P)
9.	Blood group analysis with reference to cross matching.	(1P)
10.	Demonstration of Various routes of egg inoculations for vaccine production using dye. (amniotic, yolk sac, allantoic and chorio-amniotic)	(1P)
11.	Enzyme detection: acid phosphatase, alkaline phosphatase, esterase	(1P)

Course Code and Course Name:

ZODP 234 : Zoology Practical Paper-3 (2 Credits: 60 Hours)

Semester III

Note: A total of 15 practicals are to be conducted. 1 practical is of 4 clock hour duration.

Sr. No.	Name of the topic	Lectures allotted
1.	Dominant lethal test in *Drosophila* **(Compulsory)**	2 P
2.	Sex linked recessive lethal test in *Drosophila* **(Compulsory)**	2 P
3.	Micronucleus test in mouse	2 P
4.	Bone marrow chromosome analysis in mouse	2P
5.	Auxotroph mutation induction in Bacteria	2P
6.	Ame's test **(Compulsory)**	2P
7.	Study of Drosophila mutants and maintaining *Drosophila* culture. **(Compulsory)**	2P
8.	DNA analysis using electrophoretic technique	2P
9	Temporary stained preparation of blood smear	1p

Course Code and Course Name:+

ZOUP 235 : Special Lab I (4 Credits: 120 Hours)

Semester III

Note: A total of 30 practicals are to be conducted. 10 practicals from each module are to be conducted. 1 practical is of 4 clock hour duration.

After successfully completing this course, students will be able to:

Module-I: Animal Physiology-I

CO1: Demonstrate the effect of body size and salinity on oxygen consumption in given animal.

CO2: Demonstrate the effect of starvation on liver and muscle glycogen in given animal

CO3: Demonstrate the effect of exercise on breathing, pulse rate and blood lactate level.

CO4: Demonstrate the effect of pH, temperature and inhibitors on salivary amylase.

CO5: Map the taste buds on human tongue

Module-II: Fundamentals of Systematics and Economic Zoology

CO1: Identify museum specimen/pictures of minor phyla, Invertebrates, Protochordates and Vertebrates.
CO2: Identify animals with the help of taxonomic keys.
CO3: Collect and preserve animal samples using common methods.

CO4: Write scientific report of field/ institutional visit.

CO5: Compare the methods of collection and curation of insects.

CO6: Identify the poultry breeds.

CO7: Identify edible freshwater fish from nearby area.

CO8: Demonstrate the apiculture equipment.

CO9: Demonstrate the methods of prawn culture.

CO10: Compare various fishing tools, crafts and gears.

Module-III: Research Methodology and Insect Physiology and Biochemistry

CO1: Use MS excel in presentation and analysis of data using common statistical tests.
CO2: Suggest a suitable title for a research article.
CO3: Write the abstract, key words, result, discussion, conclusion and citations of references.

CO4: Write a research project to seek funding.

CO5: Conduct a scientific survey.

CO6: Perform protein purification experiment.

CO7: Demonstrate the heart and haemocytes of cockroach.

CO8: Demonstrate the effect of starvation on glycogen in insects.

CO9: Demonstrate the effect of temperature on water loss in cockroach.

CO10: Detect the amino acids in insect haemolymph by chromatographic method.

CO11: Determine the oxygen consumption in dragon fly nymph

CO12: Perform the assay of amylase activity in midgut of insect

Sr. No.	Name of the Practical	No. of Practicals
	Module-I: Practical Animal Physiology-I	
1.	Body size and oxygen consumption in aquatic animals **(Compulsory)**	**1P**
2.	Estimation of Respiratory Quotient by Warburg's Respirometer	**1P**
3.	Effect of salinity on oxygen consumption in aquatic animals **(Compulsory)**	**1P**
4.	Effect of exercise on breathing rate, pulse rate and blood lactate of man **(Compulsory)**	**1P**
5.	Effect of pH, temperature and incubation on human salivary amylase activity. **(Compulsory)**	**1P**
6.	Absorption spectra of blood pigment **(Compulsory)**	**1P**
7.	Mapping of taste areas on human tongue. **(Compulsory)**	**1P**
8.	Carbohydrates in mammalian gut **(Compulsory)**	**1P**
9.	Effect of starvation on liver and muscle glycogen in mouse **(Compulsory)**	**1P**

10.	Preparation of glycerinated muscle fibers and study of its properties. **(Compulsory)**	**1P**
11.	Phosphagen kinase in mouse and crab muscle phosphagen	**1P**
12.	Effect of load on muscles contraction in frog	**1P**
13.	LDH isoenzymes isolation and detection using agarose gel electrophoresis in heart / skeletal muscle of rat	**1P**
14.	Determination of Body Mass Index (BMI)	**1P**
	Module-I: Practical Entomology- I	
1.	Method of collection, preservation & presentation of insects.	**(02P)**
2.	Study of Taxonomy and diagnostic features up to family of Apterygote, Exopterygote and Endopterygote insects (at least one insect from each order). **(Compulsory- 3)**	**(06P)**
3.	Study of generalized insect: Grasshopper/ Cockroach i. Systematic position, Habit, Habitat and Important morphological features. ii. Dissection so as to study: Digestive, Nervous and Reproductive system and Retro-cerebral complex. **(Compulsory)**	**(03P)**
4.	Temporary mounting of mouth parts, antenna, legs, wings, spiracles and tympanum of a generalized insect. **(Compulsory)**	**(01P)**
5.	Dissection of an insect pest (Plant bug or any insect pest as per local availability and legal permissibility) so as to study taxonomy, diagnostic features and anatomy pertaining to digestive, nervous and reproductive systems.	**(03P)**
6.	Study of head capsule: Structure of head capsule, head orientations and modifications. Study of types of mouthparts and antennae. **(Compulsory- 1)**	**(02P)**
7.	Study of general structure of legs and their modifications. Study of general structure of a wing and its modifications. **(Compulsory)**	**(02P)**
8.	Study of abdominal appendages.	**(01P)**
	Module-I: Practical Genetics- I	
1.	Analysis of metric trait and estimation of phenotypic variance.	**[1P]**
2.	Partitioning of phenotypic variance in genetic and non-genetic components in a simulated population. Estimation of DGD.	**[1P]**
3.	Detection of polymorphism in a population – Biochemical (Enzyme, protein etc.)	**[1P]**
4.	To study population cage experiments using *Drosophila*: a) Genetic Drift b) Artificial selection- Experimental simulation and modeling.	**[1p]**
5.	Extraction of Genomic DNA (*Drosophila*).	**[2P]**
6.	*In-silico* design of PCR primers for a gene of interest.	**[1P]**
7.	Chromatography of *Drosophila* eye colour pigments (wild type and/ or eye colour mutants).	**[1p]**
8.	Microbial genetics: Basic methodology, colony count and growth curve.	**[2P]**
9.	Microbial genetics: Isolation of Auxotroph (Estimation of frequency) Replica plate technique.	**[2P]**
10.	Microbial genetics: Bacterial transformation and blue white selection. Calculation of transformation efficiency.	**[1P]**
11.	Study of conventions of nomenclature of genes, genotypes and gene products in different model systems.	**[2P]**
12.	Sex-linked recessive lethal test in *Drosophila*.	**[1P]**

	Module-II: Practical Fundamentals of Systematics and Economic Zoology	
	Practical Fundamentals of Systematics	
1.	To Study specimens of Minor phyla. **(Compulsory)**	**1**
2.	Study of museum specimens and slides of invertebrates, (2 examples from each phyla). **(Compulsory)**	**2**
3.	Study of museum specimens (protochordates and chordates,1or 2 examples of each phyla) **(Compulsory)**	**2**
4.	Identification of animals with the help of keys-House fly, Honey bee etc. **(Compulsory)**	**1**
5.	Identification of animals with the help of keys- Cockroach, Earthworm.	**1**
6.	Method of collection, Preservation, and Curetting of any insect Specimen **(Compulsory)**	**2**
7.	Visits to Scientific Institute like Zoological Survey of India/ Animal Museum and Report writing.	**2**
	Practical Economic Zoology	
1.	Study of Prawn culture on commercial basis.	**1P**
2.	Study of Apiculture equipments. **(Compulsory)**	**1P**
3.	Study of Poultry breeds, feeding utensils in poultry. **(Compulsory)**	**2P**
4.	Study of Fishing tools: crafts and gear **(Compulsory)**	
5.	Study of economic importance of freshwater fishes- *Catla*, Rohu, *Labeo*, *Mrigala*, *Notopterus*, *Mystus* sp., Clarius, *Channa*, *Heteropneustes*, *Reba*, *Wallago*. **(Compulsory)**	**2P**
6.	Collection and identification of locally available/cultured fishes.	**2P**
7.	A visit to piggery/ poultry/ pearl culture centre/ apiculture centre/ sericulture centre and report writing **(Compulsory)**	**1P**
	Module-III: Practical Research Methodology and Insect Physiology and Biochemistry	
	Practical Research Methodology	
1.	Selecting a title for the paper, writing the abstract and key words. **(Compulsory)**	**1P**
2.	Writing the Discussion Conclusions and Results: Citation of references **(Compulsory)**	**1P**
3.	Importance of scientific surveys, primary data and secondary data in research.	**1P**
4.	Writing a project proposal to a funding agency **(Compulsory)**	**1P**
5.	Use of MS Excel in data presentation.	**1P**
6.	Examples of some common statistical tests. **(Compulsory)**	**2P**
7.	Purification of a biomolecule.	**1P**
8.	Making a ICT enabled scientific presentation. **(Compulsory)**	**1P**
9.	Microscopic techniques.	**1P**
10.	Presentation of any ONE research paper. **(Compulsory)**	**1P**
	Practical Insect Physiology and Biochemistry	
1.	Kymographic study of ventilatory movement in beetle	**1P**
2.	Oxygen consumption in dragon fly nymph **(Compulsory)**	**1P**
3.	Study of heart and haemocytes of cockroach **(Compulsory)**	**1P**
4.	To determine the trehalase activity in haemolymph of any insect	**1P**
5.	Amino acid in haemolymph of any insect by chromatographic technique	**2P**

6.	Study of fat body glycogen of cockroach and effect of starvation **(Compulsory)**	**1P**
7.	Effect of temperature on water loss in cockroach **(Compulsory)**	**1P**
8.	Von Wisselinghs test for presence of chitin in insect cuticle **(Compulsory)**	**1P**

M.Sc. Zoology, Part II, Semester – IV

Course Code and Course Name:

ZOUT 241: Animal Physiology- II (Special Paper) **(4 Credits: 60 Lectures)**

Semester IV

After successfully completing this course, students will be able to:

CO1: Explain the composition of blood, types of blood cells, vascular dynamics and clotting.

CO2: Illustrate the anatomy and physiology of heart and cardiac cycle

CO3: Describe the excretory system, nitrogenous wastes and renal regulation

CO4: Illustrate the osmoregulatory mechanism in Invertebrates and Vertebrates

CO5: Discuss the neuronal physiology and various potentials.

CO6: Justify the location and structure of eye, ear and taste buds to their functions.

CO7: Justify energy utilization in physiological and metabolic activities.

Sr. No.	Name of the topic	Lectures allotted
1.	**Blood and blood vessels:** a) Blood composition and function, Haematopoiesis b) Blood clotting and it's molecular mechanism c) Blood vessels and blood pressure: Blood vessel types, Arteries, role as pressure reservoir and arterial pressure: Aeteriole:role in distribution in cardiac output and maintainance of arterial blood pressure, Capillaries and it's functions, veins:its role as blood reservoir and venous return d) Blood pressure-Hypertension and Hypotension	(08L)
2.	**Cardiac Physiology:** a) Anatomy of heart	(09L)

	b) Electrical activity of the heart pace makers, spread of cardial coupling, action potential of cardiac cells c) Elecrocardiography d) Mechanism events of cardiac cycle, Heart sound e) Neuronal and Hormonal control of heart f) Cardiovascular response of exercise	
3.	**Excretion & Osmoregulation:** a) Nitrogenous waste- ammonia and its excretion, urea, urea cycle, uric acid and its excretion, products of nucleoprotein metabolism, miscellaneous end product of nitrogen metabolism. b) Organ of excretion and urine formation c) Renal regulation and acid –base balance. d) Maintaining water and electrolyte balance and its regulation in aquatic invertebrates & vertebrate, moist skinned animals, arthropods, terrestrial, vertebrate and marine air breathing vertebrates.	(09L)
4.	**Neuronal Physiology:** a) Nerve cells : Structure & Function b) Excitation and conduction of nerve fiber: Resting membrane potential, Action potential, all or none law, electronic potential, saltatory conduction c) Ionic basis of excitation and conduction d) Neurotransmitter types and receptors: Metabolism of neurotransmitters, Neuropeptides e) Synapse and Neuronal integration f) Impact of drugs and disease on synaptic transmission	(8L)
5.	**Sensory Physiology**: a) Receptor types, receptor potential and receptor adaptation b) Eye-structure and physiology of vision c) Ear-Hearing and equilibrium, sound waves and it's characters, structure of ear and physiology of hearing and equilibrium d) Chemical senses : Taste and smell e) Tactile sensation / response	(09L)
6.	**Energy metabolism:** a) Metabolic rate b) Energy storage: Fat and glycogen c) Effect of O2 concentration: acclimation to low O2 level, anaerobic metabolism, lactic acid and glycolysis d) Problem of diving and deep sea hydro thermal vent e) Metabolic rate and body size: mammals, birds, marsupials & monotremes f) Energy cost of locomotion: running, swimming, flying g) Effect of high altitude	(12L)
7.	**Stress & Adaptation:** a) The Autonomic nervous system & HPA axis coordinate the stress response to an acute threat. b) The HPA axis modulates the immune system. c) Chronic stress causes deleterious effects. d) Plasma glucocorticoid concentration shows seasonal variations.	(05L)

REFERENCE BOOKS:

1. Principles of animal physiology. (2006), C. D. Moyes and P. M. Schulte. Publisher - Pearson Education Inc. and Dorling Kindersley Publishing Inc.
2. Text book of Medical Physiology. 10th edition (2001),. A. C. Guyton and J. E. Hall. Publisher - W. B. Saunders Company, Philadelphia.
3. Principles of Anatomy and Physiology, 11th edition (2006), G. J. Tortora and B. Derrickson. Publisher-John Wiley and Sons Inc.
4. Endocrinology, 5th edition (2008), Mac. E. Hadley. Publisher-Pearson Education Inc. and Dorling Kindersley Publishing Inc.
5. Comparative Vertebrate Endocrinology. 3rd edition (1998), P. J. Bentley. Publisher-Cambridge University Press.
6. Vertebrate Endocrinology. 3rd edition (1997), D. O. Norris. Publisher- Academic Press: An imprint of Elsevier.
7. The World of the Cell, 7th edition, (2005), Wayne M. Becker, Lewis J. Kleinsmith, Jeff Hardin., Publisher - Benjamin Cummings.
8. Molecular Cell Biology, 6th edition (2007). Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira, Publisher-W. H. Freeman.
9. Molecular Biology of the Cell, 5th edition (2007). Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Publisher - Garland Science.
10. An Outline of Energy Metabolism in Man, Gordon L. Atkins, William Heinemann Medical Books Limited, London 1981
11. Stress Physiology in Animals, Paul H.M. Balm, Blackwell; 1 edition (20 August 1999).
12. Sensory Systems: Anatomy, Physiology and Pathophysiology, Aage R. Moller, Academic Press 2003.

Course Code and Course Name:

ZOUT 241: Entomology- II (Special Paper) (4 Credits: 60 Lectures)

Semester IV

After successfully completing this course, students will be able to:

CO1: Explain Gametogenesis, Fertilization and oviposition.

CO2: Explain embryonic developmental stages such as Cleavage, Blastoderm and Germ band formation; Gastrulation, Blastokinesis, differentiation of germ layers, Segmentation and Appendages formation and organogenesis.

CO3: Explain post-embryonic developmental stages such as Nymph, Naiad, larva, Pupa and Metamorphosis.

CO4: Explain specialized reproductive mechanisms.

CO5: Explain Hadorn's experiments with imaginal disc, Regeneration and Aging.

CO6: Explain Occurrence, Initiation, Preparations for diapauses and its Controls.

Sr. No.	Name of the topic	Lectures allotted
1.	**Gametogenesis :** Spermatogenesis, Seminal transfer and spermatophore formation; Oogenesis, Structure and Types of insect eggs. Fertilization and oviposition.	**(08L)**
2.	**Insect embryonic development:** Cleavage and Blastoderm formation, Germ band formation, Gastrulation, Embryonic membranes, Blastokinesis, Dorsal closure and dorsal organ, Fate/ differentiation of germ layers, Segmentation, Appendages formation and organogenesis in brief.	**(18L)**
3.	**The post embryonic development:** Eclosion from the egg. The developmental stages: Nymph, Naiad, larva, Pupa, Emergence from the pupa/ cocoon. Metamorphosis and Growth.	**(20L)**
4.	**Specialized reproductive mechanism:** Oviparity, viviparity, polyembryony, paedogenesis and parthenogenesis.	**(04L)**
5.	Hadorn's experiments with imaginal disc, Regeneration and Aging.	**(06L)**
6.	**Diapause:** Occurrence, Initiation and Preparations for diapauses. Diapause development and Controls.	**(04L)**

REFERENCE BOOKS:

1. 'The Insect- structure and Function'- by R.F. Chapman , ELBS, London
2. 'A Text book of Entomology'- by H. H. Ross (John Wiley and Sons, Ins. New York,
3. 'Imms' Text Book of Entomology- by O. W. Richards and R. G. Davies, (Methuen &Cc., London,), Vols. I & II.
4. 'Embryology of Insects and Myriapods'- by O. A. Johanson and F.H. Butt, (McGraw Hill, New York,).
5. 'The ecology of insect populations in theory and practice'- by L.R. Clarks P. W. Geier, R.D. Hughes, R.F. Morris (Methuen, London).
6. 'Developmental system: Insects' Vol. I and II- by S. J. Counce and C.H. Waddington (Academic Press, London,).

Course Code and Course Name:

ZOUT 241: Genetics- II (Special Paper) (4 Credits: 60 Lectures)

Semester IV

Sr. No.	Name of the topic	Lectures allotted
1.	Solving problems (Numerical: Probability estimation) of Mendelian and non-mendelian genetics.	02L
2.	Basic Human Genetics: 2.1 History of Human Genetics 2.2 Pedigree- Gathering Family history, pedigree symbols, construction of pedigrees, Autosomal inheritance- Dominant &Recessive, Monogenic traits(Sex Linked inheritance, Sex Limited & Sex-influenced traits, mitochondrial traits), MIM number. 2.3 presentation of molecular genetic data in pedigrees 2.4 Complications to the basic pedigree patterns- non penetrance, variable expressivity, pleiotropy, late onset, dominance problems, genetic heterogeneity, genomic imprinting & uniparental disomy, spontaneous mutations, mosaicism & chimerism, male lethality, X- inactivation. 2.5 Parametric and non-parametric analysis, identifying recombinants & non recombinants in pedigree, two- point mapping- LOD score analysis, genetic & physical map distances, genetic markers.	12L
3.	Clinical Genetics : 3.1 Monogenic diseases- 3.1.1 Cystic Fibrosis 3.1.2 Tay-Sachs syndrome 3.1.3 Marphan syndrome 3.2 Triplet repeat based disorders 3.3 Inborn metabolic errors-	15L

	3.3.1 Disorders of carbohydrate metabolism 3.3.2 Disorders of nucleic acid metabolism 3.3.3 Disorders of lipid metabolism 3.3.4 Lysosomal storage disorders 3.3.5 Peroxisomal disorders 3.4 Disorders of Hematopoietic systems- 3.4.1 Overview of blood cell types & haemoglobin 3.4.2 Sickle cell anemia 3.4.3 Thalassemia 3.4.4 Hemophilia's 3.5 Prenatal and pre-implantation diagnosis 3.5.1 Indications for prenatal diagnosis 3.5.2 Indications for chromosomal testing 3.5.3 Non- invasive methods 3.5.4 Invasive methods	
4.	Epigenetics: concept and applications	2L
5.	Physical mapping methods: 5.1 Low resolution mapping- cell hybrids, radiation hybrid mapping, synteny homology. 5.2 Restriction maps, clone contig maps, STS map, EST map, DNA sequence map.	3L
6.	Immunogenetics: 6.1 Genetic basis of antibody diversity. 6.2 Regeneration of TCR diversity. 6.3 HLA polymorphism and disease association.	3L
7.	Oncogenetics : 7.1 Concepts of oncogenes and tumor suppressor genes. 7.2 Role of oncogenes. 7.3 Cytogenetic studies.	3L
8.	Behavioural Genetics: 8.1 Rothenbuhler's experiment on genetics of Bee behavior (hygienic and non-hygienic Trait). 8.2 Nature-nurture and behavior- 8.2.1 Genetic experiments to investigate animal behavior- 8.2.1.1 Selection studies. 8.2.1.2 Inbred strain studies. 8.3 Identifying genes for controlling behavior- 8.3.1 Induced mutations 8.3.2 Quantitative trait loci. 8.3.3 Synteny orthology. 8.4 Twin and adoption study designs. 8.5 Environmental influence- shared and non-shared environment. 8.6 Genetics of human behavioural defects- Schizophrenia.	5L
9.	Neurogenetics: 9.1 Genetics of Circadian rhythm (sleep-wake cycle), learning and memory mutants in *Drosophila*. 9.2 Psychopathology- Alzheimer's disease	3L

10.	*Drosophila* genetics: 10.1 History of *Drosophila* genetics. 10.2 Genetic basis of Sex determination and dosage compensation in *Drosophila.* 10.3 Maternal genes and formation of body axis. 10.4 Segmentation genes. 10.5 Homeotic gene functions. 10.6 Regulation of Hox- gene expression	6L
11.	Bacterial and phage genetics: 11.1 Bacteriophage lambda: morphology and structure of nucleic acids, lytic cycle and lysogeny. 11.2 T even and odd phages: bacteriophage T2, T4 and T7 morphology, nucleic acid structure and life cycle. Special features compared to lambda 11.3 RNA phages: Q beta and MS2, replication and concept of overlapping genes	6L

REFERENCE BOOKS:

1. An Introduction to Genetic Analysis – A.J.F. Griffiths, J. Doebley, C. Peichel, D.A. Wassarman (12th ed.) W.H. Freeman Publ. 2020.
2. *i*-Genetics : A molecular Approach – P.J. Russell. Pearson Publ. 2016.
3. Concepts of Genetics – W.S. Klug and M.R. Cummings (12th ed.) Pearson Publ. 2019.
4. Lewin's GENES XII – J.E. Krebs, E.S. Goldstein, S.T. Kilpatrick. Jones and Bartlett Publ. 2018.
5. Genetics – M.W. Strickberger (3rd ed.) Pearson India Publ. 2015
6. Genetics : The continuity of Life – D.J. Fairbanks and W.R. Andersen. Thomson Brooks / Cole Publ. 1999.
7. Principles of Genetics – E.J. Gardner, M.J. Simmons, D.P. Snustad (8th ed.) John Wiley & Sons 2006.
8. Genetics: Analysis of Genes and Genomes – D.L. Hartl and E.W. Jones (6th ed.) Jones & Bartlett Publ. 2004.
9. Developmental Biology – S.F. Gilbert (10th ed.) Sinauer Associates Inc. 2013.
10. Medical Genetics – L.B. Jorde, J.C. Carey, M.J. Bamshad (5th ed.) Elsevier 2015.
11. Genetics in Medicine (Thomson & Thomson) – R.L. Nussbaum, R.R. McInnes, H.F. Willard (8th ed.) Elsevier 2016.
12. Behavioral Genetics – V.S. Knopik, J.M. Neiderhiser, J.C. DeFries, R. Plomin (7th ed.) Worth Publ. 2016. An Introduction to Genetic Analysis – A.J.F. Griffiths, J. Doebley, C. Peichel, D.A. Wassarman (12th ed.) W.H. Freeman Publ. 2020.

Course Code and Course Name:

ZOUT 242: Mammalian Reproductive Physiology and Aquaculture

(4 Credits: 60 Lectures)

Semester IV

After successfully completing this course, students will be able to:

Mammalian Reproductive Physiology

CO1: Explain the male and female reproductive systems and sexual dimorphic characteristics

CO2: Explain the sexual cycles with examples

CO3: Illustrate the reproductive dysfunctions.

CO4: Diagrammatically represent the hormonal regulation of reproductive processes like pregnancy, lactation and parturition.

CO5: Prepare the flow chart to demonstrate the hormonal coordination of reproductive Processes

CO6: Justify the artificial control of reproduction.

Aquaculture

CO1: Identify the fish diseases and the causative organisms

CO2: Mention the various composite fish culture with significance of each type.

CO3: Describe the methods of freshwater prawn culture and its management.

CO4: Explain the methods of pearl culture and pearl harvesting.

CO5: Illustrate the preparation and management of fish culture ponds.

CO6: Demonstrate the methods of packaging and transport of fish and brood fish.

CO7: Illustrate techniques of fish harvesting, preservation & processing.

CO8: Compare the techniques used in fishery development.

Sr. No.	Name of the topic	Lectures allotted
	Mammalian Reproductive Physiology	
1.	Reproductive Systems: Anatomy of Male Reproductive System, Accessory organs and their function Spermatogenesis, Function of Sertoli cells, Blood Testisbarriers, inhibin, Leydig cell, Capacitation. Functions of Androgens.	05L

	Anatomy of Female Reproductive System.	
2.	Reproductive patterns: Environmental factors and breeding, continuous and seasonal breeders.	02L
3.	Sexual cycles: puberty, oestrous and menstrual cycles and its hormonal regulation. Ovarian cycle and its hormonal regulation. Cycling of non-pregnant uterus and vagina.	04L
4.	Hormonal regulation: GnRH, pituitary gonadotropins, behavioural effects, testicular hormones, testosterone derivatives, inhibin, ovarian hormones: Pituitary gonadal axis, Oestrogen, progesterone's feedback relationships Prostaglandins and their role in reproduction.	04L
5.	Fertilization, Gamete Transportation Pregnancy: conception and blastocyst formation, implantation and delayed implantation, hormonal regulation in pregnancy.	04L
6.	Placenta: formation, types and functions,	02L
7.	Parturition; birth process, Ferguson reflex, neuroendocrine control, purperium	02L
8.	Lactation: Anatomy and growth of mammary glands, Lactogenesis and galactopoiesis. Hormonal regulation and suckling reflex	02L
9.	Reproductive dysfunctions: Aging and reproduction. Climacteric, anatomical, endocrine and genetic disorders.	01L
10.	Artificial control of reproduction: increasing reproductive potential, artificial insemination, in vitro fertilization and embryo transfer, induced breeding, physical, physiological, surgical, chemical methods of contraception in male, female. Infertility: its causes and treatment, Recent advances in female contraception. Prenatal diagnostic test for genetic disorders-foetal ultra-sonography, Amniocentesis, Chorionic villi sampling,	04L
	Aquaculture	
1.	**Aquaculture concept and its scope** Nutritional value of fish	(1L)
2.	**Physicochemical parameter of water for fish culture** pH, Calcium, Total Alkalinity, Nitrate, Ammonia, Total hardness of fresh water	(3L)
3.	**Construction and management of fish culture pond:** Construction of ponds, management of ponds, Predatory and weed fishes and their control, Aquatic weeds and their control, Aquatic insects and their control, fish feeding: natural and artificial.	(3L)
4.	**Fish breeding: natural and induced.** Natural breeding in pond water, Induced breeding- Pituitary extract, selection of breeders, injection of pituitary extract, spawning, Advantages of induced breeding.	(2L)
5.	**Transport of fish seed and Brood fish**: causes of mortality in transport, methods for packaging and transport, open systems, closed systems, use of chemicals in live fish transport, anesthetic drugs, antiseptics & antibiotics.	(3L)
6.	**Fish culture:**Selection of cultivable fish, monoculture, composite culture, culture of Indian major carps, Culture of common carps, culture of cat fishes, paddy cum fish culture, mari culture, cage culture, integrated fish farming	(7L)
7.	**Fish preservation, processing and byproducts.** Fish preservation techniques, fish biproducts.	(2L)

8.	**Fish pathology:** bacterial, fungal, protozoan and worm diseases of fish.	(2L)
9.	**Fresh water prawn culture (*Macrobracium rosenbegii)*:** Seed procurement from natural resources, breeding and larval rearing of fresh water prawn, management of cultural ponds, harvesting and marketing.	(2L)
10.	**Pearl Culture:** Composition & quality of pearl, collection of oysters, rearing of oysters, insertion of nucleus, pearl formation, harvesting of pearls.	(2L)
11.	**Technologies in Fisheries development:** Geographic Information System (GIS) technology, Use of Information Communication Technology (lCT) in fishes: production aspects, marketing aspects.	(2L)

References:

Mammalian Reproductive Physiology

1. Austin C.R.and Short R.V.,Reproduction in mammals Books 1-5,Univ. of Cambridge
2. Hogarth P.H.biology of Reproduction,Blackie and Son, Glasgow, London.
3. Nalbandov,AV,Reproductive Physiology,Lea and Febiger ,Philadelphia
4. Turner and bagnara .General Endocrinology Sixth Edition, W.B. Saunders Company,

Aquaculture

1. Agustí, S. 1991. Light environment within dense algal populations: cell size influences on self-shading. Journal of Plankton Research, 13(4): 863–871.
2. Ahamad Ali, S. 1982. Relative efficiencies of pelletized feeds compounded with different animal proteins and the effect of protein level on the growth of the prawn Penaeus indicus. Proceedings of the Symposium on Coastal Aquaculture, Marine Biological Association of India, 1: 321–328.
3. Biswas, K. P. (2002), **A Text Book of Fish, Fisheries & Techonology**, Narendra Publishing House, Delhi.
4. Jain, K.K. 2003, Indused **breeding of carps by hypophysation.** In: Carp and Cat fish breeding & culture CIFE. PUBlication, Versova. Mumbai.
5. Jyoti, M. K. & Sharma, A. 2006. **Fishes, Aid to collection, preservation and identification** daya Publishing House, New Delhi.
6. Langur, R.K., 2002. **Management of carp rearing ponds**. 62-65. In: Carp and catfish breeding & culture. C.I.F.E.,Versova, Mumbai.
7. Mark, D.L. (1983) **Fish Diseases**. T.F.H. Publication Inc. New Jersey.
8. Sharma, B.D. and Sanjappa, M. 1993., **Flora of India**. Botanical Survey of India, Calcutta.1-639.
9. Sinha, V.R.P. 1999. **Rural Aquaculture in India**. RAP Publications, 21, Bankok, Thhailand.
10. Srivastava, C.B.L. 2005, **A textbook of Fisheries and Indian Fish**.
11. Tamot/P, Mishra,R, Somdutta (2008). Proceeding of taal, 2007 : In 12th Lake Conference : 318-324.

Course Code and Course Name:

ZODT 243: Histology and Histochemistry (2 Credits: 30 Lectures)

Semester IV

After successfully completing this course, students will be able to:

CO1: Explain the fundamental tissues in details.

CO2: Describe the process of histological preparations.

CO3: Illustrate the tools used in histological preparations.

CO4: Justify the use of various stains and dyes used in histochemical detection of biomolecules.
CO5: Justify the importance of Immunohistochemistry.

CO6: Draw the structures of various tissues and label them.

Sr. No.	Name of the topic	Lectures allotted
1.	Scope and importance of Histology and Histochemistry Fundamentals of histology: Epithelial, connective, muscular, nervous and other specialized tissues.	05L
2.	Tools in histology: Principles, design and functioning of microtomes, automated microtomes, ultra-microtome, cryostat, problems and troubleshooting.	04L
3.	Techniques in histology: General principles for the preparation of Tissue for Histological studies. Fixation – Principle, Aims and Objectives of fixatives. Chemical action of fixatives on cells and tissue components Processing of fixed samples, dehydration (procedure and significance), embedding, block making, Temporary and permanent preparations, whole mount preparation	05L
4.	Staining (staining methods histochemical and immunohistologial methods) dyes and dye binding reactive groups, mordants and mordanting	02L
5.	Fundamentals of histochemical techniques: Histochemical classification of Carbohydrates and Principle for the Identification of Carbohydrates- glycogen (Periodic acid/Shift method (PAS)	02L
6.	Histochemical localization of Mucopolysaccharides by KMNO4/AB and PAS method.	02L
7.	Histochemical classification of Proteins- Principles and mechanism for the identification of total Proteins and Glycoproteins (Bromophenol Blue & Congo red method). Importance of Enzyme histochemistry. -Localization of enzymes in tissues, Alkaline and Acid phosphates.	04L
8.	Histochemical localization of Nucleic Acids, DNA and RNA (Feulgen reaction &Pyroninmethod).	02L

9.	Application of Histochemical methods for the detection of various types of Carcinoma and Immunofloroscent techniques	02L
10.	Histochemical classification of Lipids. Principle for the demonstration of Lipids in various animal tissues (Copperpthyalocyanin method and Sudan Blank- B method)	02L

Reference books: -

1. Text book of Histology Roland lesson DL. WB Saunders Company, Tokyo.
2. Histology: Roland lesson and Thomas Leesan WB Saunders company Co., Canada
3. Histochemistry Vol. I II III A G E pearse Churchill Livingstone NY
4. Histochemistry in Focus,A source book of Technics and Research needs (2007), K.Shyamasundari and K.Hanmantha Rao,MJP Puplishers,Chennai.
5. An introduction to Functional Histology, Bourne, G.H. (1988), Churchil, London.
6. Histochemical Techniqes, Cassilmann,W.G.B (1988), Methuen, London

Course Code and Course Name:

ZODT 243: Pest Control **(2 Credits: 30 Lectures)**

Semester IV

After successfully completing this course, students will be able to:

CO1: Explain the Pest, nature of damage caused by pests and pest control.

CO2: Explain medical, veterinary, Household and stored grain pests.

CO3: Explain the Principles and methods of pest control including Biological control measures.

CO4: Explain the Integrated pest management (IPM)

CO5: Explain the Non- insect pest and their control: Rat, Bandicoots, Crabs, Snails, Slugs, Birds and Squirrels.

CO5: Explain the principle and working of pesticide appliances.

Sr. No.	Name of the topic	Lectures allotted
1.	Introduction of the pest control : Pest, pest control, types of pests and their importance and damage caused by pests.	**02L**
2.	Brief outline of medical and veterinary entomology with reference to important measures to control the vectors. Household and stored grain pest and their control measures.	**06L**
3.	Principles and methods of pest control: Cultural control measures, Physical control measures, Mechanical Control measures, Chemical control measures. Types and mode of action. Insecticidal formulations and dilutions. Drawbacks of chemical control.	**12L**

	Biological control measures: History, principles and scope of biological control. Biological agents: important groups of Parasitoids, predators and pathogens. Advantages and Drawbacks of Biological control, Biological Control Management.	
4.	Autocidal control : Chemosterilants and radiations for sterilization, Male sterile Theory, Hormones and Pheromones, Attractants and Repellants. Integrated pest management (IPM) : Principles and application	**06L**
5.	Non- insect pest and their control: Rat, Bandicoots, Crabs, Snails, Slugs, Birds and Squirrels.	**02L**
6.	Pesticide- Appliances: Sprayers and Dusters, Hazards of Pesticides and Antidotes.	**02L**

Reference Books

1. "Pest control- A Survey" By A. Woods. (McGraw-Hill, London, 1974).
2. Pest control" – By W. W. Kilgore and R. L. Doutt (Academic Press, New York, 1967).
3. Integrated Pest Management- By J. L. Apple and R. E. Smith, Plenum Publication Co., New Delhi.
4. An Introduction of Biological Control- By R.V.D. Boarscho, P. S. Y. Messenger and A. P. Gaiter, Plenum Publication Co.
5. Insect Pests and their Control- By Evans J.W., Asiatic Publ., New Delhi.
6. Applied Entomology, Vol- 1, 2nd Edition- By K.P. Srivastava, Kalyani Publishers, New Delhi.

Course Code and Course Name:

ZODP 243: Zoology Practical Paper- 4 (2 Credits: 60 Hours)

Semester IV

Note: A total of 15 practicals are to be conducted. 10 practicals from module I (Practicals corresponds to ZOUT 241) and 5 practicals from module II (Practicals corresponds to ZODT 243) are to be conducted. 1 practical is of 4 clock hour duration.

After successfully completing this course, students will be able to:

Animal Physiology- II

CO1: Determine the bleeding and clotting time of human blood.

CO2: Demonstrate the invertebrate heart.

CO3: Calculate the heartbeats of Daphnia/*Drosophila* larva.

CO4: Determine serum urea and protein and glucose in human blood and urine.

CO5: Justify the effects of various physical and chemical factors on frog heart and muscle.

Entomology- II

CO1: Identify the histological structure of male and female reproductive system of insect.

CO2: Identify the eggs of different insects.

CO3: Identify the different embryonic stages of insects.

CO4: Identify the different post-embryonic stages of insects.

CO5: demonstrate various body organs, systems and appendages of housefly and butterfly.

Histology and Histochemistry

CO1: Identify the various tissues with the help of permanent slides.

CO2: Demonstrate the effect of fixatives on tissues.

CO3: Detect the biomolecules with histochemical staining methods.

CO4: Sketch and label the microscopic details of tissues.

CO5: Prepare the permanent histological slides.

Pest Control

CO1 : Identify beneficial and harmful insects.

CO2 : Identify and classify insect pest of agricultural, veterinary and public health importance.

CO3 : Know the effects of contact insecticides and fumigants on behavior of insect pests.

CO4 : Determine the LD_{50}

CO5 : Behavior of insects to repellants and attractants.

CO6 : Know the principle and working of pesticide appliances.

CO7 : Identify and know the role of biological controlling agents.

CO8 : Know the non-insect pests.

Sr. No.	Name of the Practical	No. of Practicals
	Module- I : Practical Animal Physiology- II	
1.	Determination of bleeding time and clotting time in man **(Compulsory)**	1P
2.	Study of invertebrate (earthworm and crab) heart	1P
3.	Ionic effects on perfused heart of frog (with the help of ICT tool/ Charts/diagrams.)	1P
4.	Effect of adrenalin and acetylcholine on perfused heart of frog (with the help of ICT tool/ Charts/diagrams.) **(Compulsory)**	1P
5.	Osmotic stress and volume change in earthworm	1P
6.	Effect of temperature on water loss in cockroach **(Compulsory)**	1P
7.	Detection and measuring of heart beats (Manually) in Drosophila larva/Daphnia.	1P
8.	Detection of allantoin in mammalian urine **(Compulsory)**	1P
9.	Study of Glomerular filtration rate by creatinine clearance	1P
10.	Study of Types of heart (Myogenic and Neurogenic)	1P
11.	Estimation of SGOT/SGPT from blood sample (Source of blood**:** Local recognized pathology laboratory	1P
12.	Determination of protein, glucose in Urine. **(Compulsory)**	1P
13.	Determination of protein, glucose in Urine from diabetic patient. **(Compulsory)**	1P
14.	Qualitative Analysis: 1) Preparation and study of Urine crystals. 2)Estimation of serum urea. **(Compulsory)**	1P
15.	Normal & abnormal constituents of human urine **(Compulsory)**	1P
16.	Quantitative estimation of salt gain and salt loss by fresh water Crab.	1P
17.	Total RBC, WBC and Different WBC count- A comparative study of fish, goat and human. **(Compulsory)**	1P
18.	Estimation of blood Sodium, potassium, Calcium	1P
19.	Estimation of blood alkaline & acid phosphatases	1P
20.	Estimation serum uric acid **(Compulsory)**	1P
	Module- I : Practical Entomology- II	
1.	Histological studies of male reproductive system (Testes, Vas deference, Ejaculatory duct, Accessory gland and spermatogenesis). **(Compulsory)**	**(01P)**
2.	Histological studies of female reproductive system (Ovariole, lateral oviduct, common oviduct, Accessory glands, bursa copulatrix, spermatheca). **(Compulsory)**	**(01P)**
3.	Study of types of Eggs in insects. **(Compulsory)**	**(01P)**
4.	Early embryology of insect: cleavage, blastula, germ band, gastrula, embryo- 1 day old, 2 day old and 3 day old in suitable insect.	**(01P)**
5.	Study of post embryonic development of insects: Collection and study of types of Nymph, naiads, larvae and pupae. **(Compulsory)**	**(02P)**

6.	Dissection of House fly: The digestive system, Nervous system, Male and Female Reproductive System; Temporary mountings of antenna, halter, legs and ovipositor. **(Compulsory)**	**(03P)**
7.	Dissection of butterfly: The digestive system, Nervous system, Male and Female Reproductive System, Temporary mountings of antenna, scales and ovipositor. **(Compulsory- 2)**	**(03P)**
	Module- I : Practical Genetics- II	
1.	Methodology for constructing Human Pedigree.	**[1P]**
2.	Analysis and construction of typical pedigrees for autosomal dominant and recessive genes, sex linked dominant and recessive genes.	**[1P]**
3.	Preparation of metaphase chromosomal spreads from any vertebrate model system.	**[1P]**
4.	G banding and C banding on mouse metaphase spread	**[2P]**
5.	Study of courtship behavior in wild type and mutant *Drosophila*.	**[1P]**
6.	Study of maternal effect mutants : Bicoid and Nanos.	**[1P]**
7.	Preparation of metaphase chromosomal spread of 3rd instar larva of *Drosophila* (from brain Ganglion).	**[2P]**
8.	Measurement of olfaction activity in *Drosophila* larvae and Adult Fly [The olfaction trap assay for behavioural genetics and screening].	**[1P]**
9.	Measurement of Locomotory activity in *Drosophila* larvae and Adult Fly [flight escape assay for behavioural genetics and screening].	**[1P]**
10.	Larval mechanosensation assay in *Drosophila*.	**[1P]**
11.	Concept of genetic disorder databases and demonstration of use of OMIM.	**[1P]**
12.	Open field Activity test and Elevated plus maze test for anxiety levels in laboratory mice.	**[1P]**
	Module- II : Practical Histology and Histochemistry	
1.	Study of different types of tissue with help of permanent slides **(Compulsory)**	(2P)
2.	Preparation of different reagent/stains for histology **(Compulsory)**	(2P)
3.	Block preparation and sectioning **(Compulsory)**	(2P)
4.	Effect of fixatives, fixation of tissues	(1P)
5.	Comparative study of effect of fixative on a given tissue	(1P)
6.	Mucolpolysaccharide staining, AB pH 1.5, 2.5 **(Compulsory)**	(1P)
7.	Proteins and lipid staining by Sudan black **(Compulsory)**	(1P)
8.		
9.	Nucleic acid staining: methyl green, pyronine, feulgen stain **(Compulsory)**	(1P)
10.	Effect of fixatives on tissue sections- liver	(1P)
	Module- II : Practical Pest Control	
1.	Morphological and taxonomic study of insect pest of agricultural importance. (Any 10).	**(01)**
2.	Study of insect pests of veterinary and public health importance. **(Compulsory)**	**(01)**
3.	Study of Household and stored grain pests. **(Compulsory)**	**(01)**

4.	Study of effects of contact poison on pests: Chlorinated hydrocarbons, Organophosphates and Carbamate.	**(01)**
5.	Calculation of LD_{50} and effects on behavior. **(Compulsory)**	**(01)**
6.	Study of respiratory poisons (fumigants)- Carbon tetrachloride, ethylene dichloride and Nicotine. **(Compulsory)**	**(01)**
7.	Study of Pesticide appliances: Sprayers and Dusters.	**(01)**
8.	Study of Parasitoids, predators and pathogens in biological control.	**(01)**
9.	Study of Non- insect pests : Rat, Bandicoots, Crabs, Snails, Slugs, Birds and Squirrels.	**(01)**
10.	Study of insect attractants and repellants (any two). **(Compulsory)**	**(01)**

Course Code and Course Name:

ZODT 244: Pollution Biology **(2 Credits: 30 Lectures)**

Semester IV

After successfully completing this course, students will be able to:

CO1: Explain the organization of biosphere.

CO2: Explain in details the types of pollution.

CO3: Describe the pollution monitoring strategies.

CO4: Illustrate the bioassay methods.

CO5: Elucidate the methods to study the impact of pollutants.

CO6: Justify the importance of biomedical waste management.

Sr. No.	Name of the topic	Lectures allotted
1.	Biosphere: Introduction, hydrosphere, lithosphere, atmosphere. (2L)	2L
2.	Pollution: Types of pollution (Air, Water, Agricultural), pollutants and effect of pollution on health, on biosphere and on economy. Eutrophication: Definition, Limnology of lake, process of eutrophication (3L)	3L
3.	Noise pollution: Characteristics of sound, source, effects and control measures of noise pollution.	3L
4.	Pesticide pollution: Pesticides and their kinds, possible sources and pathways of pesticide Pollution. Impact of pesticides on living organisms	2L
5.	Radioactive pollution: Types, sources and effects, radioactivity assessments and control.	3L
6.	Bioassay: Purpose of bioassay, selection and test organisms, pollutant bioassay using fish	2L
7.	Pollution monitoring: strategies for water, soil, noise.	2L
8.	Histological, biochemical and physiological methods to study Impact of pollutants on animals.	3L

9.	Bioconcentration, Bioaccumulation and Biomagnifications of pollutants- Causes and Consequences.	3L
10.	Biological methods for assessment of environmental quality.	3L
11.	Biomedical waste – Handling and Management.	2L
12.	Environment protection act 1986	2L

References

1. Ecology, E.P. Odum, Amerind publ.
2. Environmental biology, P.D. Sharma, Rastogi Publ.
3. Environmental pollution, H.M. Dix, John Wiley Publ.
4. Pesticides in aquatic environment, M.A. Q. Khar, Plenum Press.
5. Environmental pollution and its control under international law, R.A. Malviya , Chay Publ.
6. Ecology, Ricklefs, freeman, W.H.
7. Limnology, Welch McGrew Hill Publ.
8. Practical Ecology – K.S. Rao, Ujjain (M.P) Anmol Publ. New Delhi (India)

Course Code and Course Name:

ZODT 244: Apiculture (2 Credits: 30 Lectures)

Semester IV

After successfully completing this course, students will be able to:

CO1: Explain the basic concepts of apiculture like systematics, colony organization, polymorphism, morphology and foraging.

CO2: Explain the tools and management of apiary.

CO3: Explain the importance of institutions pertinent to apiculture.

CO4: Discuss the setup of beekeeping business.

CO5: Illustrate the bee keeping as occupation.

CO6: Justify the presence of bees to increase the agriculture productivity.

Sr. No.	Name of the topic	Lectures allotted
1.	Biology of Bees : History, Classification and Biology of Honey Bees. Social Organization of Bee Colony.	05L
2.	Rearing of Bees : Introduction to apiculture practices and handling of Beehives. Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth Bee Pasturage Selection of Bee Species for Apiculture Bee Keeping Equipment Methods of Extraction of Honey (Indigenous and Modern)	11L
3.	Diseases and Enemies Bee Diseases and Enemies Control and Preventive measures, Hormones in Apiculture.	06L
4.	Bee Economy : Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc.	03L

5.	Entrepreneurship in Apiculture Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens	05L

References:

1) Bees and Beekeeping D. P. Abrol ,Kalyani Publisher, New Delhi. 51
2) A Comprehensive guide to Bees and Beekeeping. D. P. Abrol. Scientific Publisher, New Delhi.
3) Honey bees and their management S. B. Withhead. Axis books Publisher, Jodhpur.
4) Honey bees: Diseases, Parasites, Pests, Predator and their management. N. Nagaraja and D. Rajagopal , M.J.P Publisher, Chennai.
5) A Handbook of Beekeeping Dharamsing and D. P. Singh (Agrobios India (Publisher), Jodhpur.
6) Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
7) Bisht D.S., Apiculture, ICAR Publication.
8) Singh S., Beekeeping in India, Indian council of Agricultural Research, NewDelhi.
9) Introduction to disease of bee –Bailey, L
10) World of honeybee –Butter C. G.
11) Beekeeping in India –Sardar Sing (ICAR).
12) The Principle of Insect Physiology-Wigglesworth, V.S.
13) Applied Zoology- B. B. Waykar, A. Y. Mahajan, B. C. More . (Prashant Publication Jalgaon)
14) D.K. Belsare Beekeeping for livelihood

Course Code and Course Name:

ZODP 244 : Zoology Practical Paper- 5 (*Practicals corresponding to ZOUT 242 and ZODT 244*)

(2 Credits: 60 Hours)

Semester IV

Note: A total of 15 practicals are to be conducted. 5 practicals from each module (**Module- I :** Practicals corresponding to ZOUT 242 MRP, **Module- II :** Practicals corresponding to ZOUT 242 Aquaculture and **Module- III :** Practicals corresponding to ZODT 244 Pollution Biology/ Apiculture) are to be conducted. 1 practical is of 4 clock hour duration.

After successfully completing this course, students will be able to:

Mammalian Reproductive Physiology

CO1: Identify the histological slides of reproductive organ/tissues.

CO2: Explain the various types of placenta in mammals.

CO3: Comment on merits and demerits of contraceptive devices/methods.

CO4: Illustrate the technique of gonadectomy.

CO5: Perform vaginal smear technique to identify the phases of oestrous cycle.

CO6: Distinguish the male and female anatomical features of reproductive system in mammals.

Aquaculture

CO1: Identify Indian oysters.

CO2: Identify the common freshwater fish used in culture farming.

CO3: Demonstrate the processing and storing methods for fish and prawn.

CO4: Test the freshness of fish/prawn by histological methods.

CO5: Test the freshness of fish/prawn by biochemical methods.

CO6: Prepare the culture of Daphnia and rotifers.

CO7: Estimate the productivity of water bodies.

Pollution Biology

CO1: Identify the bioindicators from given water sample.

CO2: Write a report on eutrophication of water body.

CO3: Determine the LC50 value for the given compound

CO4: Determine the biomass of given sample.

CO5: Analyze pH and salinity of given sample.

CO6: Estimate calcium and magnesium, sulphate from polluted water.

Apiculture

CO1: Identify the honey bees

CO2: explain the bee morphology and behaviour

CO3: Illustrate the bee enemies

CO4: Justify the rearing techniques and bee management

Sr. No.	Name of the Practical	No. of Practicals
	Module- I : Practical Mammalian Reproductive Physiology	
1.	Anatomy of male and female reproductive system in rat/Mouse **(Compulsory)**	1P
2.	Study of histological slides of male reproductive System-Testis, Vas deferens, Epididymis, Prostate, Seminal vesicle, Cowper's gland **(Compulsory)**	1P
3.	Study of histological slides of female reproductive System-Ovary, Uterus fallopian tube **(Compulsory)**	1P
4.	Vaginal smear technique in Rat	1P
5.	Study of placental types **(Compulsory)**	1P
6.	Study of Uterine smooth muscles	1P
7.	Study of contraceptive devices **(Compulsory)**	1P
8.	E-Demonstration of Orchiectomy or Vasectomy or Epididymoctomyin rat/ Mice	1P
9.	E-Demonstration of Ovariectomy in rat/Mice	1P
10.	Visit to artificial insemination Centre and family planning Centre.	1P
	Module- II : Practical Aquaculture	
1.	To Study Physico-chemical parameters of fresh water –pH, Turbidity, Calcium, Nitrate, Ammonia. **(Compulsory)**	1P
2.	Determination of total alkalinity and total hardness of fresh water.	1P
3.	Determination of dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD) of fresh water. **(Compulsory)**	1P
4.	Study of conventional method for testing the soil of fresh water pond.	1P
5.	Study of control methods of aquatic weeds.	1P
6.	Study of induced breeding techniques by using pituitary extract.	1P
7.	Study of Indian major carps, prawns, and oysters. **(Compulsory)**	1P
8.	Study of fish disease (bacterial, fungal, protozoan), head and lateral line erosion and eye disease. **(Compulsory)**	1P
9.	Use of Geographic Information Technique (GIS) and Information and communication technology (ICT).	1P
10.	Visit to fish farm/ fish industry. **(Compulsory)**	1P
	Module- III : Practical Pollution Biology	
1.	Study of bio – indicators of pollution. **(Compulsory)**	1P
2.	Analysis of CO, CO_2, NO pollution level data in collaboration with district pollution dept. of Maharashtra state.	1P
3.	Study of Eutrophic ponds /lakes /river.	1P
4.	Visit to water filtration plant/Pollution. **(Compulsory)**	1P
5.	Analysis of pH and salinity from water /soil sample.	1P
6.	Determination of LC_{50} / LD_{50} for insecticide / pollution/molluscicide etc. **(Compulsory)**	1P
7.	Estimation of Biomass by:- i)Wet weight and ii) Dry weight.	1P
8.	Estimation of calcium and magnesium in polluted water. **(Compulsory)**	1P

9.	Soil analysis for calcium carbonate. **(Compulsory)**	1P
10.	Estimation of sulphate in polluted water.	1P
	Module- III : Practical Apiculture	
1.	Study of Honey bee species, Castes and Bee morphology. **(Compulsory)**	(3P)
2.	Study of Beekeeping equipment: Bee box and tools. **(Compulsory)**	(2P)
3.	Study of Bee products: Honey, Bees wax, Pollens, Royal Jelly, Propolis and Bee venom. **(Compulsory)**	(2P)
4.	Study of diseases and enemies of honeybee. **(Compulsory)**	(2P)
5.	Study of bee flora in the locality and observations on bee foraging Behaviour. **(Compulsory)**	(1P)
6.	A compulsory visit to an Apiary or Central Bee Research and Training Institute or a Beekeeper to gain a firsthand experience in handling bees.	(2P)

Savitribai Phule Pune University

(Formerly University of Pune)

Two Year Post-Graduate Program in Chemistry

(Faculty of Science & Technology)

Choice Based Credit System Syllabus (2019 Pattern)
of

M.Sc. (Chemistry) Part-II

Physical Chemistry, Inorganic Chemistry, Organic Chemistry
Drug Chemistry and Analytical Chemistry

for

Colleges Affiliated to Savitribai Phule Pune University

Implemented from Academic Year
2020-2021

Title of the Course: M.Sc. (Chemistry) (Part-II)

1. Structure of the Course:

Basic structure/pattern (Framework) of the proposed postgraduate syllabus for the two years integrated course leading to M.Sc. (Chemistry) in the colleges affiliated to Savitribai Phule Pune University. The general structure for the M. Sc-II year Chemistry (all specializations)is as follows:

Semester - III			
Sr. No.	**Paper No**	**Description**	**Credit**
1	CCTP-7	Core Compulsory Theory Paper	4
2	CCTP-8	Core Compulsory Theory Paper	4
3	CCTP-9	Core Compulsory Theory Paper	4
4	CBOP-3	Choice Based Optional Paper - Theory	4
5	CCPP-3	Core Compulsory Practical Paper	4
Semester-IV			
6	CCTP-10	Core Compulsory Theory Paper	4
7	CCTP-11	Core Compulsory Theory Paper	4
8	CBOP-4	Choice Based Optional Paper - Theory	4
9	CBOP-5	Choice Based Optional Paper – Practical/ Project	4
10	CCPP-4	Core Compulsory Practical Paper	4

Choice of the optional papers: All colleges are encouraged to give the choice of optional papers to the students and conduct the separate classes if 40% or more students opt a different course than 60% or less students.

The specializations are:

1. **Physical Chemistry**
2. **Inorganic Chemistry**
3. **Organic Chemistry**
4. **Drug Chemistry**
5. **Analytical Chemistry**
6. **Biochemistry**

2. Teaching Hours

a) Theory – Each credit of theory is equivalent to 12 teaching hours + 3 tutorial hours. For 1 credit of theory there will be 1 L of 1 hour per week. Thus, 1 theory course will have total 15 weeks of teaching and it will be distributed as of 48 h for teaching and 12 h for tutorials and internal evaluation. In case of theory paper consisting of sections, each section is of 2 credits and time allotted will be 24 h teaching and 6 h for tutorials and internal evaluation.

b) Practical – Each credit of practical is equivalent to 24 teaching hours + 6 tutorial hours. For 1 credit of practical there will 2 L of 1 h per week. Thus, 1 practical course will have total 15 weeks of teaching and it will be distributed as of 96 h for performing practical and 24 h for tutorials and internal evaluation. i) Each experiment will be allotted 4 h time (one practical session) and for 1 course two sessions of 4 h per week should be allotted or ii) In case practical course is extended for one year, then total 30 weeks (15 week per sem.) and 4 h

(one practical session) per week should be allotted to one practical course. ***There shall not be more than 10 students in one batch of practical.***

3. Examination: Each theory and practical course carry 100 marks equivalent to 4 credits. Each course will be evaluated with Continuous Assessment (CA) and University Assessment (UA) mechanism. Continuous assessment shall be of 30 marks (30%) while university Evaluation shall be of 70 marks (70%). To pass the course, a student has to secure 40% mark in continuous assessment as well as university assessment i.e. 12 marks in continuous assessment and 28 marks in university assessment.

For Continuous assessment teacher must select variety of procedures for examination such as: i) Written test / Mid Semester test (not more than one for each course), ii) Term paper, iii) Viva-Voce, Project / survey / field visits iv) Tutorials v) Group discussion vi) Journal / Lecture / Library notes vii) Seminar presentation, viii) Short quiz ix) assignment x) research project by individual student or group of student xi) An open book test, etc.

Each practical course will be extended over the year and practical examination will be conducted at the end of academic year.

1. M.Sc. (II) Physical Chemistry

Course Structure

Sr. No.	Paper No. & Code	Course Name	Credits
Semester III			
1	CCTP-7, CHP-310	Quantum and Solid State Chemistry	4
2	CCTP-8, CHP-311	Nuclear, Radiation and Polymer Chemistry	4
3	CCTP-9, CHP-312	Physicochemical Methods of Analysis	4
4	CBOP-3, CHP-313	A) Photochemistry and Techniques in Polymer Chemistry	4
		B) Special Topics in Physical Chemistry	4
5	CBOP-3, CHP-314 Practical	Physical Chemistry **Practical : I**	4
Semester IV			
6	CCTP-10, CHP-410	Molecular Structure and Spectroscopy	4
7	CCTP-11, CHP-411	Surface Chemistry and Electrochemistry	4
8	CBOP-4, CHP-412	A) Materials Chemistry and Catalysis	4
		B) Biophysical Chemistry and Special Topics in Nuclear and Radiation Chemistry	4
9	CBOP-4, CHP-413 Practical	A) Physical Chemistry **Practical III**	4
		B) Project	4
10	CCPP-4, CHP-414 Practical	Physical Chemistry **Practical: II**	4

Equivalence to Old Syllabus

New syllabus (2020)	Old Paper (2014 pattern)
Semester III	
CCTP-7, CHP-310	CHP-310
CCTP-8, CHP-311	CHP-311
CCTP-9, CHP-312	CHP-312
CBOP-3, CHP-313(A)	CHP-313
CBOP-3, CHP-313(B)	CHP-314
CCPP-3, CHP-314 Practical-I	CHP-315 Practical
Semester IV	
CCTP-10, CHP-410	CHP-410
CCTP-11, CHP-411	CHP-411
CBOP-4, CHP-412(A)	CHP-412
CBOP-4, CHP-412(B)	CHP-413
CBOP-5, **CHP-413(A** Practical III **CHP-413(B)** Project	CHP-415 Practical/Project
CCPP-4, CHP-414: Practical: II	CHP-316 Practical

Detailed Course wise syllabus of physical Chemistry, M. Sc.-II

Semester -III

CCTP-7 CHP-310: Quantum and Solid-State Chemistry [48 L +12 T]

Section-I: Quantum Chemistry [24 L +6 T]

1. Basic postulates of quantum mechanics, properties of quantum mechanical operators, Eigen functions and Eigen values, Hermitian, linear, ladder, and angular momentum operators. Spin –orbit coupling, regular and inverted multiples. **(10L)**
2. Approximation methods: non-degenerate perturbation method and the variation method, theorem and applications. **(5L)**
3. Calculation of ground state energy and wave function of Helium atom (two electron system) using Variation principle, Pauli's exclusion principle and Slater determinant. **(6L)**
4. Calculation of wave function for multi-electron system: Hartree - Fock self consistent Method. **(3L)**

Section II: Solid State Chemistry [24 L +6 T]

1. Imperfections and related phenomenon: Defects in solids: point defects, line defects, diffusion in solids- mechanism, elastic and plastic deformations. **(4L)**
2. Crystal growth techniques: General principles, Methods of crystal growth: solution method, flux growth method, evaporation method. Theory of crystal growth. **(4L)**
3. Solid state reactions- Reactions of single solids: Thermal decomposition reactionsand their kinetic characteristics, gas solid reactions and their characteristics, Solid –Solid reactions: addition and double decomposition reactions with and without electron transfer photographic process. **(5L)**
4. Properties of Insulators: Electrical properties- Dielectric properties, Piezoelectricity, electric breakdown, Optical Properties-Colour centres in ionic crystals: types, creation. Magnetic properties- exchange interactions, Antiferromagnetism, Ferrimagnetism. **(5L)**
5. Properties of metals and semiconductors: band theory, types of solids, intrinsic and extrinsic semiconductors, p-n junctions, optical properties, photoconductivity of crystals. **(6L)**

Reference Books

1. Quantum Chemistry (4th edition), Ira N.Levine, Prentice Hall, Englewood Cliffs, N. J.
2. Quantum Chemistry, A.K. Chandra
3. Quantum Chemistry, D. A. McQuarrie,, Viva Books, New Delhi (2003)
4. Introduction of Solids L.V Azaroff , Tata McGraw Hill
5. Principles of the Solid State H. V. Keer, Wiley Eastern (1993)
6. Selected Topics in Solid State Physics Vol. 12, The growth of crystals from liquids
–J. C. Brice, North Holland/American Elsevier (1973)
7 Defects and Diffusion in Solids. S. Mrowec, Elseivier Publ.(1960)
8 Treatise on Solid State Chemistry, ED-N.B. Hannay, Plenum Press Vol –2 (1975)

CCTP-8 CHP-311: Nuclear, Radiation and Polymer Chemistry [48 L +12 T]

Section I: Nuclear and Radiation Chemistry [24 L +6 T]

1. Nuclear reactions: Bethe's notation, types of nuclear reactions, conservation in nuclear reactions, compound nucleus theory, experimental evidence, specific nuclear reactions, photonuclear and thermonuclear reactions. **(5L)**
2. Nuclear reactors :- General aspects of reactor design, thermal, fast and intermediate reactors, reactor fuel materials, reactor moderators and reflects, coolants, control materials, shield, regeneration and breeding of fissile matter, types of research reactors. **(6L)**
3. Nuclear structure-: The liquid drop model, calculation of nuclear binding energies, properties of isobars, missing elements, the nuclear shell model, magic numbers, filling of nucleon shells, the collective and unified models. **(5L)**

4. Ion beam analysis techniques: Particle induced X-ray emissions- projectile accelerator and target preparation, ionization and X-ray emission detection,analysis and applications. Rutherford back scattering – scattering reaction, surface analysis, depth profiling, channelling effects and applications **(4L)**
5. Radiation detectors: Scintillators and their properties inorganic and organic, solid state semiconductor detectors-theory, surface barrier, Li drifted and intrinsic detectors **(4L)**

Section II: Polymer Chemistry [24 L +6 T]

1. Basic concepts of polymer science, classification of polymers as biological - nonbiological, linear branched network, condensation, addition homo- and heterochain, thermoplastic - thermosetting, History of Macromolecular Science, molecular forces and Chemical bonding in polymers. (**5L)**
2. Thermodynamics of polymer solutions: Entropy and heat of mixing of polymer solutions - ideal behaviour and deviations. Experimental results, flory - Krigbaum theory - Thermochemistry of chain polymerization. **(7L)**
3. Copolymerization: Kinetics of copolymerization, the copolymer equation, monomer reactivity ratios, instantaneous composition of polymer. **(4L)**
4. Measurements of molecular weights: characterization of polymers, Molecular weight averages, fractionation and molecular weight distribution - methods for determination of average molecular weight (end group analysis) colligative property measurements, osmometry, diffusion light scattering, viscosity, ultracentrifugation. **(8L)**

Reference Books

1. Essentials of Nuclear Chemistry, H. J Arnikar, Wiley Eastern Limited, 4th Edition.(1995)
2. Nuclear and Radiochemistry, G. Friedlander, J. W. Kennedy and J. M. Miller, John Wiley (1981)
3. Introduction to Radiation Chemistry, J. W. T. Spinks and R. J. Woods, John Wiley (1990)
4. Introduction to Nuclear Physics and Chemistry, B.G. Harvey, Prentice hall (1963).
5. Sourcebook on Atomic Energy-S. Glasstone, Van Nostrand Company (1967)
6. Radiochemistry and Nuclear methods of analysis-W.D.Ehman and D.E. Vance, John Wiley (1991)
7. Textbook of Polymer Science - F. W. Billmeyer Jr., John Wiley & Sons Inc. (1971)
8. Principles of Polymer Systems - F. Rodrigues, Tata McGraw Hill Publishing Company, New Delhi
9. Principles of Polymer Chemistry - P. J. Flory, Cornell University Press, Ithaca New York (1953)
10. Polymer Chemistry - An Introduction, Seymour-Carraher, Marcel Dekker Inc, New York
11. Polymer Science - Gowarikar, Vishwanathan&Sreedhar, Wiley Eastern Ltd. New York (1988)
12. Handbook on Conducting Polymers - T. A. Skotheim, Ed., Marcel Dekker Inc, New York, 1&2 (1986)

CCTP-9 CHP-312: Physicochemical Methods of Analysis [48 L +12 T]

Section I: Physicochemical Methods of Analysis I [24L +6 T]

1. X-ray methods: Generation and properties of X-rays, X-ray absorption, Concept of absorptive edge, applications, X-ray absorptive apparatus, applications, X ray fluorescence, fundamental principles, instrumentation, wavelength dispersive and energy dispersive, qualitative and quantitative analysis, electron microprobe. **(10 L)**
2. Electron spectroscopy for chemical analysis: Theory, spectral splitting and chemical shift. ESCA satellite peaks, Apparatus used for ESCA, applications**. (7L)**
3. Thermal methods of analysis: TGA, DTA, DSC and thermometric titrations – principle, instrumentation, factors affecting TGA curve, applications. **(7L)**

Section II: Physicochemical Methods of Analysis II [24 L +6 T]

1. Amperometric Titrations: Introduction, Apparatus used for Amperometric Titrations,

Technique of Amperometric Titrations, Dead stop and point method or titration with two indicator electrode, Advantages of Amperometric Titrations, Applications of Amperometric Titrations (3L)

2. Voltammetry: Excitation signals, instrumentation, Hydrodynamic voltammetry, cyclic voltammetry, pulse voltammetry, applications. **(7L)**
3. Inductively coupled plasma atomic emission spectroscopy: principle, instrumentation, analysis and applications (**4L)**
4. Luminescence, chemiluminescence, electrochemiluminescence, apparatus,fluorescence, phosphorescence, theory, factors affecting intensity, apparatus, and analytical applications. **(5L)**
5. Coulometry: Current-voltage relationship, coulometric methods, controlled potential coulometry. **(5L)**

Reference Books

1) Introduction to Instrumental Analysis-R. D. Braun, McGraw Hill (1987).

2) Principles of Instrumental Analysis – Skoog, Holler, Nieman, 5th edition.

3) Instrumental Methods of Analysis – Willard, Merritt, Dean and Settle

4) Instrumental Methods of Chemical Analysis- Gurdeep R. Chatwal and Sham K. Anand

CBOP-3 CHP- 313:(A) Photochemistry and Techniques in Polymer Chemistry (B) Special topics in Physical Chemistry

CBOP-3 CHP- 313(A): Photochemistry and Techniques in Polymer Chemistry

[48 L +12 T]

Section I: Photochemistry [24 L +6 T]

1. Introduction: Laws of photochemistry, interaction of light with matter, theory of photoluminescence, general features of photochemical and photophysical processes **(4L)**
2. Mechanism of absorption and emission of radiation: Einstein's treatment, selection rules, Life times of excited electronic states of atoms and molecules Types of electronic transitions in organic molecules photochemical pathways, Jablonski diagram, Fluorescence, Phosphorescence **(5L)**
3. Photophysical kinetics of uni and bimolecular processes, delayed fluorescence mechanisms, kinetics of collisional quenching, Stern-Volmer equation, quenching by added substances charge transfer mechanism, energy transfer mechanism **(6L)**
4. Photolysis, Laser-general principles, types of lasers: two, three and four level lasers, solid state Ruby and Nd/YAG laser, self-phase modulation, single photon counting, experimental techniques, flash photolysis: conventional microsecond flash photolysis, Nanosecond laser flash photolysis, Actinometry **(5L)**
5. Frontiers of photochemistry: Picosecond, Femtosecond flash photolysis, Applications: Solar energy, conversion and storage, photosynthesis **(4L)**

Section II: Techniques in Polymer Chemistry

1. Morphology and rheology of polymers - configuration of polymer chains crystal structure, crystallization processes, viscous flow, rubber elasticity, viscoelasticity, the glassy state and glass transition, mechanical properties of crystalline polymers. **(8L**)
2. Polymer structure and physical properties - The crystalline melting point Tm- the glass transition temperature (Tg) - properties involving small and large deformations- polymer requirements and polymer utilization. **(4L)**
3. Polymer processing - Plastic technology - moulding, other processing techniques fibre technology - textile and fabric properties, spinning fibre after treatments, elastomer technology- natural rubber, vulcanization, reinforcement, carbon blocks**. (5L)**
4. Radiation induced polymerization - kinetics and mechanism of polymerization in the liquid and solid phases, effect of irradiation on polymers - degradation and cross-linking, block copolymerization. **(4L)**
5. Conducting polymers - Basics, synthesis, conduction mechanism, applications. **(3L)**

Reference Books

1. Fundamentals of photochemistry by K.K.Rohatgi-Mukherjee New Age International Publishers Revised Edition (Reprint 2003)
2. Chemistry and light by Paul Suppan, The Royal Society of Chemistry
3. Textbook of Polymer Science - F. W. Billmeyer Jr., John Wiley & Sons Inc. (1971)
4. Principles of Polymer Systems - F. Rodrigues, Tata McGraw Hill Publishing Company, New Delhi
5. Principles of Polymer Chemistry - P. J. Flory, Cornell University Press, Ithaca New York (1953)
6. Polymer Chemistry - An introduction, Seymour-Carraher, Marcel Dekker Inc, New York
7. Polymer Science - Gowarikar, Vishwanathan&Sreedhar, Wiley Eastern Ltd. New York (1988)
8. Handbook on Conducting Polymers - T. A. Skotheim, Ed., Marcel Dekker Inc, New York, 1&2 (1986)

CBOP-3 CHP-313(B): Special Topics in Physical Chemistry [48 L + 12 T]

Section I: Special Topics in Physical Chemistry I [24 L +6 T]

1. **Ionic equilibria and pH calculations:** Solution of an equilibrium problem, numericals, mass balance, proton condition, charge balance, exact solution, approximations on the equations, Graphical representations – the distribution diagram, the logarithmic concentration diagram. Numericals, pH concept of polyprotic acids, pH calculations. **(10L)**
2. **Data analysis:** Error and classification of error, minimisation of error, accuracy, precision, significant figure. Statistical treatment of data-Mean and standard deviation, least square analysis, correlation and its significance, correlation coefficient, Regression analysis, coefficient of determination. Permutation and combinations, probability. **(8L)**
3. **Nephelometry and Turbidimetry:** Introduction, Turbidimetry and colorimetry, Nephelometry and Fluorimetry, Choice between Nephelometry and Turbidimetry, Theory, Comparison of Spectrophotometry, Nephelometry and Turbidimetry, Instrumentation, Applications of Nephelometry and Turbidimetry **(6L)**

Section II: Special Topics in Physical Chemistry II [24 L +6 T]

1. **Nanoscience and Nanotechnology:** Introduction to Nanoworld, Metals, Semiconductor, Nanocrystals, Ceramics, Metal nanoparticles: Double layers, Optical properties & Electrochemistry, Magnetism, Chemical and catalytic aspects of Nanocrystals, Applications of nanoparticles **(8L)**
2. **Hydrogen Storage:** Fundamentals of Physisorption, temperature and pressure influence, chemisorption, adsorption energy, electrochemical adsorption. Practical adsorption-Storage of hydrogen with carbon materials, activated carbon graphene, carbon nanostructures, fullerene, carbon nanofibers and graphite. Electrochemical storage of hydrogen in carbon materials. **(10L)**
3. **Smart Materials:** Definition of smart materials (SM), Design of intelligent materials, actively smart and passively smart materials and their characteristics. e.g. - smart ceramics, oxides, smart polymers and gels, shape memory alloys, electrorheological fluids, ferrofluides, smart windows, smart sensors, smart electroceramics. Magnetostrictive materials, bio mineralisation and bio sensing. Integration to smart clothes, smart rooms. **(6L)**

Reference Books

1. Ionic Equilibrium
: A Mathematical Approach, J.N.Butler, Addison- Wesley Publishing Co. Inc.
2. Analytical chemistry by G.D. Christian, 6th edition
3. Mathematical Preparation for Physical Chemistry by Farrington Daniels
4. Principles of Physical Chemistry by Puri, Sharma, Pathania
5. Instrumental Methods of Chemical Analysis- Gurdeep R. Chatwal and Sham K. Anand

6. Introduction to Instrumental Analysis-R. D. Braun, McGraw Hill (1987).
7. Tushar K. Ghosh, Energy Resources and Systems: Volume 2: Renewable Resources, Volume 2 of Energy Resources and Systems, Energy Resources and Systems, Springer Link: Bücher, Springer, 2011
8 Strobel a, J Garche b, P Moseley c, L J Orissen b, Golfdeview Hydrogen storage by carbon materials." Journal of Power Sources (WWW.Sciencedirect.com) 159 (June 2006): 781–801.
9. Agata Godula-Jopek, Walter Jehle, Joerg Wellnitz, Hydrogen Storage Technologies: New Materials, Transport, and Infrastructure, John Wiley & Sons, 2012
10. Yury Gogotsi, Carbon Nanomaterials, illustrated Volume 1 of Advanced Materials Series, Advanced Materials and Technologies Series, CRC Press, 2006 5.Robert A.Varin, Tomasz Czujko, Zbigniew S. Wronski , Nanomaterials for Solid State Hydrogen Storage Fuel Cells and Hydrogen Energy illustrated Springer, 2009
11. Intelligent materials – Craig A. Rogers, Scientific American, 1995,p.122
12. Smart structures and materials by B.Culshaw (Artech House, Norwood,MA1998)
13. Intelligent Gels Y. Osada and S.B. Ross – Murphy-Scientific American May1993
14. Introduction to Nanoscale science &technology Massimiliano Di Ventra, Stephane Evoye and James Heflin, Springer Publication
15. Physical Chemistry- P.W. Atkins, 8th Edn.

CCPP-3 CHP-314: Physical Chemistry Practical-I (Any 24 practical)

[96 L + 24T]

1) Thermodynamic data of electrochemical cell by e.m.f. measurements.
2) Simultaneous determination of two ions by polarography.
3) Determination of the equilibrium constant of triiodide ion formation
4) Magnetic susceptibility measurement by Gouy technique.
5) Determination of dipole moment of liquid at various temperatures.
6) Kinetics of iodination of aniline: pH effect and base catalysis.
7) Dissociation constant of an acid- base indicator by spectrophotometry.
8) Actinometry – photolysis of uranyl oxalate.
9) Absorption coefficient and half thickness of lead for gamma radiation.
10) Radiation dose measurement by Fricke dosimeter/ceric sulphate dosimeter.
11) Flame Photometric determination of Na / K by calibration curve method.
12) Flame Photometric determination of Na and K from mixture.
13) Estimation of Na / K by using internal standard method (Li as internal standard).
14) Estimation of K by standard addition method.
15) A photometric titration of a mixture of Bi and Cu with EDTA (-745nm).
16) Demonstration practical on AAS: setting of fuel to oxidizer ratio, choice of conc. of metal ion for AAS (Linearity range) (Use metal ion of which lamp is available with your laboratory).
17) The reaction between potassium persulphate and potassium iodide by colorimetry.
18) Determination of the chain linkage in poly (vinyl alcohol) from viscosity measurements.
18) Calibration of Gamma ray spectrometer and determination of energy of given Radioisotope.
19) To determine concentration of Boric acid titrating with NaOH by Conductometry.
20) Stability constant of silver thiosulphate by potentiometry.
21) Determination of SO_4^{2-} by turbidimetric titration / calibration curve method.
22) Determination of SO_4^{2-} by turbidimetric titration / calibration curve method.
23) Determination of Riboflavin by Photoflurometry calibration curve method.
24) Determination of quinine sulfate by Photoflurometry by standard addition method.
25) Determination of Fe / Cu/ Zn / Mn / B by AAS from soil sample.

References

1. Findlay's Practical Chemistry, S P Levitt (Editor), Longman Group Ltd
2. Experimental Physical Chemistry, Farrington Daniels and others, McGraw-Hill Book Company.

3. Experiments in Physical Chemistry, J.M. Wilson and others, Pergamon Press
4. Practical Physical Chemistry, A.M. James and P.E. Pritchard, Longman Group Ltd.
5. Experimental Physical Chemistry, V. Dathavale, Parul Mathur, New Age International Publishers.
6. Experimental Physical Chemistry, Das and Behera, Tata McGraw-Hill. Practical Physical Chemistry, D.V. Jahagirdar
7. Advanced physical Chemistry experiments by A. Gurtu, J.N. Gurtu
8. Vogel's textbook of quantitative chemical analysis, 6th Ed.

SEMESTER-IV

CCTP-10 CHP-410: Molecular Structure and Spectroscopy [48 L + 12 T]

I: Molecular Structure and Spectroscopy [24 L +6 T]

1. **Nuclear Magnetic Resonance Spectroscopy:** Nuclear spin, nuclear resonance saturation. Shielding of magnetic nuclei, chemical shift and its measurements. Factors influencing chemical shift, deshielding, spin-spin interactions, factors influencing coupling constant "J" Classification (ABX, AMX, ABC. A2 B2) spin decoupling, basic ideas about Instrument, NMR studies of nuclei other than proton ^{13}C, $^{19}F$and, ^{31}P, FT NMR, advantages of FT NMR, use of NMR in medical diagnostics. **(12L)**
2. **Electron Spin Resonance Spectroscopy:** Basic principles, zero field splitting and Kramer's degeneracy, factors affecting the "g" value. Isotropic and anisotropic hyperfine coupling constants, spin Hamiltonian, spin densities and Mc Connell relationship, measurement techniques, applications. **(8L)**
3. **Nuclear quadrupole resonance spectroscopy:** Quadrupole nuclei, quadrupole moments, electric field gradient, coupling constant, splitting, and applications. **(4L)**

Section II: Molecular Structure and Spectroscopy [24 L +6 T]

1. **X- Ray diffraction:** Index reflections, Identifications of unit cell from systematic absences in diffraction pattern. Structure of simple lattices and X-Ray intensities. Structure factor and its relation to intensity and electron density, phase problems in XRD **(8 L)**
2. **Electron Diffraction: C**attering intensity Vs Scattering angle, Wierl equation, measurement technique, elucidation of structure of simple gas phase molecules, low energy electron diffraction and structure of surfaces. **(4 L)**
3. **Neutron Diffraction analysis:** Scattering of neutron by solids and liquids, Magnetic scattering, Measurement techniques, Elucidation of structure of magnetically ordered unit cell**.(4 L)**
4. **Magnetic susceptibility:** Pascal constant, Diamagnetic susceptibility, paramagnetic susceptibility, Langevin Equation ,Van Vlecks formula, Ferro, Ferri and Antiferromagnetism, Measurement of Magnetic susceptibility by Faraday and Gouy Techniques. **(8 L)**

Reference Books

1. Modern Spectroscopy J.M. Hollas, (John Wiley)
2. Spectroscopy (Atomic and Molecular) Gurdeep Chatwal, Sham Anand (Himalaya Publishing house)
3. Applied Electron Spectroscopy for Chemical Analysis Ed. H. Windawi& F.L. Ho (Wiley interscience)
4. Introduction to Magnetic resonance A. Carrington and A.D Maclachalan , Harper & Row
5. Spectroscopy B.K. Sharma
6. NMR, NQR, & Mossbauer Spectroscopy in Inorganic Chemistry R.V.Parish, Ellis Harr wood
7. Physical methods in Chemistry R.S Drago, Saunders college
8. Introduction to Molecular Spectroscopy G.M. Barro, Mc Graw Hill
9. Basic principles of spectroscopy R. Chang, Mc Graw Hill
10. A text book of Spectroscopy.O.D. Tyagi& M. Yadhav Anmol Publications
11. Introduction to Magento chemistry Alen Earnshaw, Acad Press (1968)
12. Magneto chemistry Sanyl and Dutta

13. Chemist's guide to NM spectroscopy – Mc Comber (Wiley) 2000.

CCTP-11 CHP-411: Surface Chemistry and Electrochemistry

Section I: Surface Chemistry [24 L +6 T]

1. Adsorption at liquid surfaces, Gibbs equation and its verification, Gibbs Monolayers, insoluble films on liquid substrates, states of monomolecular Films, Wetting, flotation, detergency. **(8L)**
2. Adsorption forces, thermodynamics of physical adsorption, heat of adsorption and its determination, measurement of adsorption by different methods, chemisorption and its mechanism. **(8L)**
3. Multilayer adsorption – critical comparison of various multilayer models- BET, Potential and Polanyi models (no derivation). Measurement of surface area of solids by different methods. Harkins and Jura equation. **(6L)**
4. Porous solids – Definition, pore size distribution, methods to determine pore size, hysteresis of adsorption, theories of hysteresis, and Adsorption behaviours of porous materials. **(2L)**

Section II: Electrochemistry [24 L +6 T]

1. Ionics - Ion-ion interaction: Activity and activity coefficients, Debye-Huckel Theory, limited and extended law. Ion transport in solution: Fick's laws of diffusion, Einstein relation between diffusion coefficient and ionic mobilities, The Nernst-Einstein equation, relation between absolute and conventional mobilities. **(12L)**

2. Electrodics – Standard electrode potentials, Liquid junction potential, Zeta potential, electrokinetic phenomena, electrode-electrolyte interface, double layer theories, Butler- Volmer equation, and Tafel equation**. (8L)**

3. Applications -Fuel cells and batteries – primary and secondary power cells, fuel cells, Li ion battery **(4L)**

Reference Books

1. Physical chemistry of surfaces – A. W. Adamson, Interscience publishers Inc New York, 1967.
2. Surface chemistry – Theory and applications, J. J. Bikerman, Academic press, New York 1972.
3. Adsorption, surface area and porosity – S. J. Gregg and K. S. W. Sing, Academic Press Ltd., London 1967.
4. Zeolites and clay minerals as Adsorbents and molecular sieves, R. M. Barrar, Academic Press London.
5. Physical adsorption of gases, D. M. Young and A. D. Crowell, Butterworths, London, 1962.
6. Adsorption, J. Oscik, John Wiley and Sons. New York.
7. Physical chemistry - Peter Atkins, Julio de Paula, 7th Edition Oxford University Press.
8. Modern Electrochemistry - Vol I & II J O'M Bockris and AKN eddy, Plenum Press, N.Y.
9. Fuel cells - heir Electrochemistry, J O'M Bockris and S Srinivasan, McGraw Hill, NY (1969)
10. Fuel cell systems L.I. M Blomen and M.N. Mugerwa, Plenum Press NY (1993)
11. Principles of Physical Chemistry – Samuel

CBOP-4 CHP-412(A): Materials Chemistry and Catalysis [48 L + 12 T]

Section I: Materials Chemistry [24 L +6 T]

1. **Hitech materials**: Defect perovskites, super conductivity in cuprates, preparation & characterization of 1-2-3 & 2- 1-4, Normal state properties, anisotropy, temperature dependents of electrical resistance, optical photon modes, coherent length, elastic constants posion life times, heat capacity, micro wave absorption, pairing & multigap structure in hi tech materials. Application of Hitech materials. **(12L)**
2. **Thin films Langmuir – Blodgett films**: Preparation techniques, sputtering, chemical process, MOCVED, Langmuir – Blodgett films, Photolithography, Applications of LB films. **(5L)**
3. **Superconducting solid materials**: Superconducting state, high critical temperature superconductors, Low critical temperature superconductors **(3L)**
4. **Materials of solid devices**: Rectifiers, transistors, capacitors, IV-V compounds low dimensional quantum structures, optical properties. **(4L)**

Section II: Catalysis [24 L +6 T]

1. **Theories of catalysis-** intermediate compound formation theory and adsorption theory. Catalysis: bio catalysis, autocatalysis, negative catalysis, characteristics of catalytic reactions concept of activity, selectivity, poisoning, promotion and deactivation. Types of catalysis: homogeneous, heterogeneous. Enzyme catalysis, effect of temperature and pH on enzyme catalysis. Heterogeneous catalysis and catalytic kinetics: concept of Langmuir-Hinshelwood **(8L)**
2. **Preparation and Characterization of Catalysts:** General methods for preparation of catalysts: precipitation, sol-gel, hydrothermal, impregnation, hydrolysis, vapour deposition. Activation of catalysts: calcinations, reduction. Catalyst characterization: surface area, pore size distribution, particle size determination, XPS, AES, UV-Vis, FT-IR and thermal methods **(8L)**
3. **Catalysis in green chemistry and environmental applications**: Purification of exhaust gases from different sources: auto-exhaust catalysts (petrol vehicles, diesel vehicles), VOC removal; ozone decomposition. **(3L)**
4. **Photo-catalysis: Photoprocesses at metals, oxides and semiconductors:** concepts and mechanism. Photocatalysis application in organic pollutant degradation present in water and air. Photocatalytic water splitting, photocatalysis in the field of energy and environment. **(5L)**

Reference books

1. Physical Chemistry of Surfaces, W. Adamson, Wiley Intersciences,(5th edition) 1990.
2. Heterogeneous Catalysis: Principles and Applications. Bond, G C, Oxford University Press 1987
3. Heterogeneous Catalysis, D.K. Chakrabarty and B. Viswanathan, New Age Publishers
4. Principles of Physical Chemistry by Puri, Sharma, Pathania , 45th edition
5. Catalytic Chemistry, B.C. Gates, John Wiley and Sons Inc. (1992)
6. Solid state physics – N.W. Aschocruts& N.D. Mermin, Saunders College.
7. Material science & Engineering, An Introduction - W.D. Callister, Willey.
8. Principles of solid state – H.V. Keer, Willey.
9. Materials Science – Anderson, Leaver, Alexander, & Rawlings, ELBS
10. Theromotropic liquid crystals Gray, Willey
11. Text Book of liquid crystals – Kelkar&Halz, ChemieVerlag

CBOP-5 CHP-412(B): Biophysical Chemistry and Special Topics in Nuclear Chemistry [48 L + 12 T]

Section I: Biophysical Chemistry [24 L +6 T]

1. Bioenergetics and Thermodynamics: Molecular interpretation of Energy and Enthalpy, Non-covalent reactions, hydrophobic interactions, Protein and Nucleic Acids. Biochemical Applications of Thermodynamics, Thermodynamics of Metabolism, Role of ATP in biological Systems (hydrolysis of ATP). Biological Reactions, Double Stranded Formation in Nucleic Acids, Ionic Effect on Protein–Nucleic Acid Interactions**. (8L)**
2. Kinetics: Basic Concepts, Enzyme kinetics, catalytic antibodies and RNA enzymes-Ribozymes, Michaelis Menten Kinetics, Competition and Inhibition, Monod- Whyman Changeux Mechanism. **(5L)**
3. Spectroscopy of Biomolecules: Spectra of Proteins and Nucleic Acids, Amino acid, Polypeptides, Secondary structure, Rhodopsin: A Chromophoric Protein, Principles of Circular dichorism and optical rotator dispersion, applications to biomolecules. **(6L)**
4. Macromolecular structure and X-ray diffraction: Chain configuration and conformations of macromolecules, proteins and polypeptides, problems of protein folding, Fundamentals of X-rays, Braggs Law, Determination of molecular structure, calculation of diffracted intensities from atomic co-ordinates. **(5L)**

Section II: Special Topics in Nuclear and Radiation Chemistry [24 L +6 T]

1. Radiation hazards and safety ; Natural and manmade sources of radiations, internal and external radiation hazards, safe handling methods, personal dosimetry, reactor safety, the effects of Three miles and Chernobyl accidents, radiation protecting materials. **(5L)**
2. Biological effects of radiations: The interaction of radiations with biological cells, various stages, somatic and genetic effects, maximum permissible dose-ICRP recommendations. **(3L)**
3. Applications of radioisotopes in nuclear medicine and pharmaceuticals: general applications of radiopharmaceuticals, use of nuclear properties of indicator nuclides. In vivo diagnostic procedures, in vitro diagnostic testing therapeutic use of radiations, Use of radiation for food preservation and sterilization**. (8L)**
4. The origin of chemical elements, cosmology, primordial nucleosynthesis, stellar evolution and stellar nucleosynthesis, solar neutrino problem, synthesis of Be, B, Li in the cosmos. (4L)
5. Radioactive waste management: Introduction, Classification of radioactive waste, Origin of Radioactive waste, Treatment of Radioactive wastes: Radioactive waste disposal. **(4L)**

Reference Books

1. Biophysical Chemistry, Gurtu and Gurtu, Pragati Edition, 2007.
2. Physical Chemistry, Principles and Applications in Biological Sciences I. Tinico, K. Sauer, J. Wang and J. D. Puglisi, 4th Edition, Pearson Edition, 2007.
3. Biophysical Chemistry, A. Upadhyay, K Upadhyay and N. Nath, Himalaya Publishing House, 2005.
4. Biophysical Chemistry, James P. Allen,
5. Biophysical Chemistry, C. R.Cantor and P.R. Schimmel, WH Freeman & Company, New York, 2004.
6. Radiation Chemistry: Principles and Applications, Farhataziz and M. A. J. Rodgers (Eds.), VCH Publishers, New York (1987).
7. Radiation Chemistry: Present Status and Future Trends, C. D. Jonah and B. S. M. Rao (Eds.) Elsevier, Amsterdam (2001).
8. Essentials of Nuclear Chemistry: H. J. Arnikar. New Age Publication Ltd. (1995).
9. Radiation chemistry and Nuclear Methods of Analysis W. D. Ehmann, D. E. Vance. John Wiley (1991).
10. Nuclear and Radiochemistry G. Friedelarder, J. W. Kennedy, E.S. Macias, J. M. Miller John Wiley (1981).
11. Source Book of Atomic Energy, S. Glasstone, D. Van Nostrand (1967)
12. Nuclear analytical chemistry- J. Tolgyessy and S. Verga Vol. 2 , University park press (1972)
13. Fundamental of Radiochemistry, D.D. Sood, A.V.R. Reddy, N. Ramamoorthy, IANCAs , Mumbai, 4th Edition

CBOP-5 CHP-413(A): Physical Chemistry Practical III (Perform any 24 practical)

[96 L + 24 T]

1. Hydrolysis constant of aniline hydrochloride by distribution coefficient method.
2. Determination of the dimerization constant of an organic acid in benzene.
3. Differential potentiometric titration.
4. Aerometric titration with platinum microelectrode.
5. Determination of the stability constant of a complex by spectrophotometry.
6. Studies on a clock reaction: determination of the energy of activation

a. Reactions such as bromate-bromide reaction, iodate –iodide reaction,

b. Formaldehyde - bisulphite reaction etc.

7. Magnetic susceptibility measurements by the Faraday technique.
8. Analysis of fruit juice for vitamin C by HPLC technique.
9. Determination of half-life of two isotopes in a mixture.
10. Study of characteristics of GM counter.
11. Effect of salt on the distribution of acetic acid between water ethyl acetate.
12. To study the effect of addition of a salt on the solubility of an acid in water.
13. Determination of concentration of sulfuric acid, acetic acid and copper sulphate by

conductometric titration with sodium hydroxide.
14. Determine the formula and stability constant of a metal ion complex (Lead Oxalate) by polarography.
15. To determine order of reaction of iodination of aniline.
16. To determine second order velocity constant of ethyl acetate by conductometry.
17. Determination of Molecular weight of a given polymer by turbidimetry
18. Determination of surface tension of water in presence of surfactant and hence surface excess by capillary rise method/Du-Nouy Tensionometer.
19. To investigate reaction between H_2O_2 and KI.
20. Thermodynamic parameters of an electrochemical cell, temperature dependence of EMF.
21. Surface tension and parachor of liquids by stalagmometer and differential capillary method.
22. Determination of activity coefficient of electrolyte/ non electrolyte by cryoscopy.
23. To study the formation of complex ions by cryoscopy.
24. To determine critical composition and critical temperature for given naphthalene bi-phenyl binary phase system.
25. Determination of diffusion coefficient and hydrodynamic radius of $K_3[Fe(CN)_6]$by cyclic voltammetry.

References

1. Findlay's Practical Chemistry, S P Levitt (Editor), Longman Group Ltd.
2. Experimental Physical Chemistry, Farrington Daniels and others, McGraw-Hill Book Company.
3. Experiments in Physical Chemistry, J.M. Wilson and others, Pergamon Press.
4. Practical Physical Chemistry, A.M. James and P.E. Pritchard, Longman Group Ltd.
5. Experimental Physical Chemistry, V. Dathavale, Parul Mathur, New Age International Publishers.
6. Experimental Physical Chemistry, Das and Behera, Tata McGraw-Hill. Practical Physical Chemistry, D.V. Jahagirdar.
7. Advanced physical Chemistry experiments by A. Gurtu, J.N. Gurtu.

CBOP-5 CHP-413(B): Project **[96 L + 24 T]**

Each student will perform project separately. Working hours are same as practical of CHP-413(A) project length should be sufficient and should be equivalent to 24 practical. ***Project report must be written systematically and presented in bound form: The project will consist of name page, certificate, content, summary of project (2-3 page) followed by introduction (4 to 7 pages), literature survey (4-7) pages (recently published about 30 papers must be included), experimental techniques, results, discussion, conclusions, Appendix consisting of i) references, 2) standard spectra / data if any and 3) safety precautions.*** If student is performing project in another institute, for such a student, internal mentor must be allotted and he will be responsible for internal assessment of a student. In this case student has to obtain certificate from both external and internal mentor. ***Systematic record of attendance of project students must be maintained by a mentor.*** Project will be evaluated jointly by three examiners and there will not be any practical performance during the examination. Typically, student has to present his practical work and discuss results and conclusions in details (20-30 min.) which will be followed by question-answer session (10 min). It is open type of examination.

CCPP- 4 CHP-414:Physical Chemistry Practical-II [96 L + 24 T]

(Perform any 24 practical)

1. Solubility of a sparingly soluble salt by conductometry.
2. Coulometric estimation of arsenite by bromine.
3. Dead stop end point titration.
4. Activity coefficient of electrolyte by emf measurements.
5. Titration of polybasic acid with sodium hydroxide by pH- metry.

6. Formation constant of a complex by pH- metry.
7. Kinetics of the reaction between 2,4-dinitrochlorobenzene and piperidine.
8. Determination of solubility diagram for a three component liquid system.
9. Radiolysis of aqueous iodate solution and determination of G values.
10. Molecular weight of a polymer by end group estimation.
11. Determination of the formula of complexes such as silver –ammonia complex by titration, cuprammonium ion complex by distribution coefficient measurement.
12. Determine the transport number of silver and nitrate ions in aqueous solution from the cell potential of the concentration cell with junction potential.
13. Recording of TGA curve of $CuSO_4$ and NaCl and hence to find the percentage composition of the mixture.
14. Determination of the heat of ionization of phenol/weak acid.
15. Analysis of tertiary mixture by Gas chromatography.
16. To determine the relative strength of acetic acid, chloroacetic acid and tri-chloroacetic acid by conductometry.
17. To determine the solubility of given salt at room temperature from its solubility curve.
18. To study the effect of amount of different salts on critical temperature of phenol water system.
19. Use of thiocynate dosimeter for determining the radiation dose.
20. Determination of rate constant (Oxidation/reduction of Substituted benzene) by pulse radiolysis technique
21. Determination of half-life of radioisotopes in a given mixture.
22. Determination of manganese content of steel sample by neutron activation analysis technique.
23. Study of counting errors
24. Determination of gamma energy of a given source using scintillation counter coupled with single channel analyser.
25. Determination of manganese content of steel sample by neutron activation analysis technique.
26. Kinetics of condensation polymerization by dilatometry.

References

1. Findlay's Practical Chemistry, S P Levitt (Editor), Longman Group Ltd
2. Experimental Physical Chemistry, Farrington Daniels and others, McGraw-Hill Book Company.
3. Experiments in Physical Chemistry, J.M. Wilson and others, Pergamon Press
4. Practical Physical Chemistry, A.M. James and P.E. Pritchard, Longman Group Ltd.
5. Experimental Physical Chemistry, V. Dathavale, Parul Mathur, New Age International Publishers.
6. Experimental Physical Chemistry, Das and Behera, Tata McGraw-Hill. Practical Physical Chemistry, D.V. Jahagirdar
7. Advanced physical Chemistry experiments by A. Gurtu, J.N. Gurtu

2. M. Sc. (II): Inorganic Chemistry

Course Structure

Semester - III			
Sr. No.	**Paper No. and Code**	**Course Name**	**Credit**
1	CCTP-7 CHI-330	Organometallic and Homogeneous Catalysis	4
2	CCTP-8 CHI-331	Inorganic Reaction Mechanism	4
3	CCTP-9 CHI-332	Bioinorganic and Medicinal Inorganic Chemistry	4
4	CBOP-3 Theory CHI-333	A) Modern Instrumental methods in Inorganic Chemistry **OR** B) Inorganic Magneto and Polymer Chemistry	4
5	CCPP-3 CHI-334	**Practical I**-Modern Methods of Inorganic Analysis	4
Semester-IV			
6	CCTP-10 CHI-430	Heterogeneous Catalysis and its Applications	4
7	CCTP-11 CHI-431	Inorganic Nanomaterials: Properties, Applications and Toxicity	4
8	CBOP-4 Theory CHI-432	A) Material Science **OR** B) Inorganic Chemistry Applications in Industry	4 4
9	CBOP-5 Practical CHI-433	**Practical III**-A)Extended Practical in Inorganic Chemistry **OR** B)Project Work	4
10	CCPP-4 CHI-434	**Practical II-** **Section-I**: Inorganic Instrumental analysis and Computer applications **Section-II**: Preparation of Inorganic Compounds	4

Equivalence to Previous Syllabus

Semester - III			
New Syllabus 2019 Pattern		**Old Syllabus 2014 Pattern**	
CCTP-7 CHI-330	Organometallic and Homogeneous Catalysis	CHI-326	Organometallic and Homogeneous Catalysis
CCTP-8 CHI-331	Inorganic Reaction Mechanism	CHI-330	Inorganic Reaction Mechanism, Photochemistry and Magnetic Properties of Coordination Compounds
CCTP-9 CHI-332	Bioinorganic and Medicinal Inorganic Chemistry	CHI-331	Physical Methods in Inorganic Chemistry.
CBOP-3 Theory CHI-333	Modern Instrumental Methods in Inorganic Chemistry **OR** Inorganic Magneto and Polymer Chemistry	CHI-332	Bioinorganic Chemistry
CCPP-3 CHI-334	Modern Methods of Inorganic Analysis	CHI-387	Experiments &Computer Applications in Inorganic Chemistry.
Semester-IV			
CCTP-10 CHI-430	Heterogeneous Catalysis and its Applications	CHI-430	Inorganic polymer &Heterogeneous Catalysis.
CCTP-11 CHI-431	Inorganic Nanomaterials: Properties, Applications and Toxicity	CHI-431	Material Science-I Solid State & other inorganic Materials
CBOP-4 Theory CHI-432	Material Science **OR** Inorganic Chemistry Applications in Industry	CHI-432	Material Science-II Nanomaterials.
		CHI-445	Inorganic Chemistry Applications in Industry
CBOP-5 Practical CHI-433	Extended Practical in Inorganic Chemistry **OR** Project Work	CHI-488	Extended Practical in Inorganic Chemistry
CCPP-4 CHI-434	**Section-I**: Inorganic Instrumental analysis and Computer applications **Section-II**: Preparation of Inorganic Compounds	CHI-388	Practical course II.

The Detailed Syllabus of M. Sc-II Inorganic Chemistry is as Follows:

Semester - III

CCTP-7, CHI- 330: Organometallic and Homogeneous Catalysis [48 L + 12 T]

Section-I: Advanced Organometallic Chemistry [24 L +6 T]

1. Introduction & Recapitulation d-block metal carbonyls. [**2L]**
2. Sigma complexes: Synthesis, bonding, properties and applications. Hydrocarbyl compounds,
3. Metal-Carbon multiple bonded compounds Carbene and Carbynes. [**4L]**
4. π-complexes Alkenes di and polynes. [**2L]**
5. $n^nC_nR_n$: Carbocyclic polyenes: Synthesis, bonding, properties and applications of Allyls Pentadienyls, Cyclobutadienes, Cyclo pentadienyls, Cycloheptetrienyls, Arenes**. [4L]**
6. Phosphine complexesSynthesis, bonding,properties andapplications. **[2L]**
7. Metal-metal bonds Transition metal atom clusters Carbonyl polymers. [**4L]**
8. Transition metal organo-metallics in organic synthesis. As Electrophiles, Nucleophiles, Activating agents, Protecting agents. [**4L]**
9. Fluxional Behaviour of organometallic compounds, [**2L]**

Section-II: Homogeneous Catalysis [24 L +6 T]

1. Introduction to catalysis. basic principles, definition of activity& selectivity catalysis, homogenous *vs.* heterogeneous catalysis. Importance of homogenous catalysis in synthesis of high value chemicals. **[4L]**

2. Characteristics of central metal atom &influence of attached ligands on catalytic activity, Important reaction types: oxidative addition, reductive elimination, migratory insertion, beta hydride elimination. **[4L]**

3. Tollman catalytic cycles. Use of spectral techniques for identification of intermediates. (IR, NMR), [**3L]**

4. Reactions of olefins: **a)** Polymerisation: Catalytic cycle for alkene Polymerisation, Metallocene catalysts-structure, special features advantages and mechanism of action. **b)** Oxidation including catalyst separation in homogeneous catalysis, Fenton Reaction-$FeBr_3/H_2O_2$, Metal catalysed liquid phase oxidation, Epoxidation, Biphasic catalysis –oxidation. **c)** C-C coupling (Cativa process, Heck, Suzuki, Negeshi and cycloaddtion reactions). [**8L]**

5. Metathesis [**2L]**

6. Asymmetric catalysis. [**3L]**

References:

1. Organotransition Metal Chemistry Anthony F. Hill, Royal Society of Chemistry, Tutorial
2. Chemistry Text, 2002.Chapters1-7.
3. Organometallics: A concise Introduction, Ch. Elshebroicn and A. Salzer, VCH, chapters, 12-16
4. Organotransition Metal Chemistry: Applications to Organic Synthesis, S.G. Davies, Permagaon 1982.
5. Inorganic Chemistry 3rd edn D.F. Shriver and P.W. Atkins, Oxford University Press, 1999, Chapter 16.
6. Organometallic Chemistry –R.C. Mehrotra and A. Singh, 1992, Wiley
7. Principles of Organometallic Chemistry, P. Powell, Chapman & Hall
8. Organometallic Compounds, Morries, Sijlirn, IVY Publication House
9. Organometallics in Organic Synthesis – Swan & Black
10. Organometallic Chemistry - E.J. Elias and Gupta
11. Homogeneous Catalysis - G.W.Parshall

CCTP-8,CHI- 331: Inorganic Reaction Mechanism [48 L + 12 T]

Section-I: Inorganic Reaction Mechanism [24 L +6 T]

1. Types of Mechanisms: Basic concepts as stability and liability, stability constants; HSAB principle, chelate effect, Classification of inorganic reactions, Intimate and stoichiometric mechanism of ligand substitution. **[4 L]**
2. Substitution in square planar complexes: Trans effect, Trans series, applications of trans effect.**[4 L]**
3. Substitution in octahedral complexes: SN_1, SN_2, SN_1CB mechanisms, steric effects on substitution Isomerization and racemization in coordination compounds. **[4 L]**
4. Electron Transfer reactions: Potential energy diagrams as a conceptual tool, Marcus equation Types of and factors affecting electron transfer reactions. **[6 L]**
5. Inner & Outer sphere reactions, exited state outer sphere reactions & their applications**[6 L]**

Section -II: Photochemistry and Reaction of Co-ordinated Ligands [24 L +6 T]

1. Photochemistry of metal complexes [10 L]

Photochemical reactions, Prompt and delayed reactions, quantum yield, recapitulation of fluorescence & phosphorescence, phtotochemical reactions irradiating at d-d and CT band Transitions in metal-metal bonded systems, photochemical reactions involving chlorophyll Kinetics of excited state processes

2. Reactions of coordinated ligand [10 L]

i) Non-chelate forming reactions: Reaction of donor atoms (Halogenation of coordinated N atoms, Alkylation of coordinated S and N atoms, Solvolysis of coordinated phosphorus atoms). Reactions of nondonor atoms (nucleophilic behaviour of the ligand, electrophilic bahaviour of the ligand). ii) Chelate ring forming reactions: (reactions predominantly involving thermodynamic template effects, reactions predominantly involving kinetic affects). iii) Chelate modifying reactions

3. Other reaction types [4 L]

Oxidative addition, reductive elimination, methyl migration and CO insertion

References:

1. Mechanism of Inorganic Reactions- C.F. Basselo, R.G. Pearson, Wiley, NY
2. Mechanism of Inorganic Reactions in Solution – An Introduction, D. Benson, McGraw – Hill Chapt.15, p.465, (1968)
3. Inorganic Chemistry – D.F. Shriver, P.W. Atkins, C.H. Langford – Oxoford, 2nd Edition, 1994.
4. Inorganic Chemistry – Principles of Structure and Reactivity, J. E. Huheey, E. A. Keiter and R. L. Keiter, 4thedn. Harper Collins College Publ. New York, Chapt.13, p.537-76, (1993).
5. Inorganic Chemistry - Messler and Tarr - Pearson Publishers

CCTP-9,CHI-332:Bioinorganic and Medicinal Inorganic Chemistry [48L + 12T]

Section - I: Bioinorganic Chemistry [24 L +6 T]

1. Recapitulation of Biological roles of Metals and ligands [1 L]

Structure, function and biochemistry of enzymes containing following metals:

2. Zinc [6 L]

Zinc Fingers, Carboxy peptidase, Carbonic anhydrase

3. Copper [6 L]

Type I, Type II, Type III, Blue Proteins Azurins, Plastocynins& Blue Oxidases, Model compounds of Blue copper proteins, Non Blue Proteins eg. Tyrosinase, Galactose oxidase, SOD

4. Cobalt [4 L]

Vitamin B_{12} co-enzymes & model compounds, Actions of Cobalamines, Adenosylcobalamine as a coenzyme, Ribonucleotide reductase, Methylcobalamine as cofactor

5. Molybdenum [3 L]

Mo-cofactors, Antagonism between Cu & Mo, Hydroxylase

6. Manganese [2 L]

7. Non-heme Iron [2 L]

References:

1. Bioinorganic Chemistry: A ShortCourse-RosetteM.Malone3 Wiley Interscience, 2002.
2. Biological Inorganic Chemistry-An Introduction, Robert Crichton, Elsevier Science, 2007.
3. The biological Chemistry of the Elements: The Inorganic Chemistry of Life–J. J. R.
4. Fraustoda Silva and R. J. P. Williams. Clarendron Press, Oxford, 1991.
5. Bioinorganic Chemistry: Inorganic elements in the Chemistry of life., An Introduction and Guide—Wolfgang Kaim, Brigille Schwedrski John Wiley and sons, 1994.
6. Principles of Bioinorganic Chemistry –S.J. Lippard and J.M.Berg, University Science Books, 1994.
7. The Biological Chemistry of the Elements: The Inorganic Chemistry of Life– Silva, J. J.
8. R. Fraustoda and R. J. P. Williams; 2nd Ed. Oxford University Press, 2012.

Section- II: Inorganic Pharmaceuticals and Medicinal Chemistry [24 L +6 T]

1. Overview [2 L]

Introduction, Metal Ions in Disease, Use of chelating agents, Metalloproteins as Drug Targets, Matrix Metallopreteinases, Modulation of Cellular responses by Metal-Containing, Drugs Metal-Based Chemotherapeutic, Drugs Metal Complexes as Diagnostic Agents

2. Cisplatin-based Anticancer Agents [3 L]

Introduction, Clinical Properties, Cisplatins carboplatin, Iproplatin, Determination of Platinum Drug Levels and Pharmakokinetics, Platinum Chemistry Mechanism of Action, Structure-Specific Damage-Recognition Proteins, Mechanisms of Resistance to Cisplatin/Carboplatin, Circumvention of Tumor Resistance to Cisplatin, Development of New Platinum Drugs, Dose Intensification of Cisplatin/Carboplatin, Modulation of Platinum Resistance Mechanisms, Dinuclear and Trinuclear Platinum Complexes as Anticancer Agents.

3. Transition Metal Complexes as Chemical Nucleases [4 L]

Interaction of Metal Complexes with DNA, Reactions of Metal Complexes with DNA, Nuclease activity of $[Cu(phen)2]^{+}$

4. Biomedical Uses of Lithium [3L]

Chemistry of Lithium, Distribution of Lithium in the body and in Cells, Studies using Lithium isotopes, Biochemistry of Lithium

5. Bismuth in Medicine [3L]

The Chemistry of Bismuth, Properties of the element, Bi(III) Compounds, Bi(V) Compounds Bismuth in Medicine, Helicobacter Pylori bacterium, Methods for the study of Bi, Bismuth Citrate Complexes, Bismuth Complexes with Biomolecules, Bismuth binding to oxygen-containing molecules, Bismuth Complexes with thiolate ligands, Bismuth(III) complexes with Metallothionine and Transferrin, Enzyme Inhibition

6. Gold Complexes with Anti-arthritic, anti-tumor and Anti-HIV activity [4L]

Introduction, Chrysotherapy, History of Medicinal Uses, Gold Chemistry, Oxidation states, Gold(I) complexes, Gold(III) Complexes, Oxidation-Reduction Potentials, Gold Biochemistry and Pharmacology In-vivo metabolism and ligand displacement, Anti-tumor Activity, Anti-HIV activity

7. Vanadium Compounds as Possible Insulin Modifiers [3L]

Introduction, Characterization of Vanadium's Insulin-mimetic Effects, Sites of Action of Vanadium, Animal Studies and Human Trials, Toxicological Considerations, Improved Tissue Uptake with Metal Chelation

8. Therapeutic Radiopharmaceuticals: [2L]

Introduction, Therapeutic radio nuclides, β- Particle emitting radionuclides, α- Particle emitting radionuclides, Low energy electron emitters, Therapeutic radiopharmaceuticals for routine medical use, ^{131}I – sodium iodide, Intra-cavity and Intra-arterial radiopharmaceuticals, Radio-therapeutic agents for bone cancer treatment ^{89}Sr-chloride, ^{153}Sm- EDTMP,

References

1. Uses of Inorganic Chemistry in Medicine Ed. Nicholas P. Farrell
2. Metal Complexes as drugs and chemotherapeutic agents
3. Metal Complexes as Enzyme inhibitors A.Y. Louie and Thomas Meade Chem. Rev., 1999, 99, 2711.

CBOP-3,CHI-333: Theory

A) Modern Instrumental Methods in Inorganic Chemistry [48L + 12T]

OR

B) Inorganic Magneto and Polymer Chemistry [48L + 12T]

CBOP-3,CHI-333: Theory

A) Modern Instrumental Methods in Inorganic Chemistry [48L + 12T]

Section-I: Inorganic Thermal and Spectroscopic Methods of Characterization [24 L +6 T]

Chapter 1: Thermal techniques. [12L]

Principle, instrumentation, working and applications of following spectroscopic techniques

1. TGA
2. DTA
3. DSC
4. TPD study

Chapter 2: Spectroscopic techniques. [12L]

Principle, instrumentation, working and applications of following spectroscopic techniques:

1. X-Ray diffraction
2. NMR
3. ESR
4. Auger
5. FT-IR
6. Fluorescence

Section-II: Imaging and Analytical Techniques [24 L +6 T]

Chapter 1: Imaging techniques. [12L]

Principle, instrumentation, working and applications of following spectroscopic techniques:

1. TEM
2. SEM
3. XPS
4. STEM
5. UV

Chapter 2: Analytical techniques. [12L]

Principle, instrumentation, working and applications of following spectroscopic techniques:

1. Cyclic voltammetry
2. Flame Photometer
3. Magnetic susceptibility
4. Photodegradation

Reference Books:

1- Instrumental methods of analysis by B.K Shrama
2- Instrumental methods of chemical analysis- Chatwal and Anand
2- Introduction to Instrumental Analysis- R. D. Braun, Pharma ed Press, Indian
3- Principles of Instrumental Analysis, 5th edition- D. A. Skoog, F.J. Holler, T. A. Nieman, Philadelphia Saunders College Publishing (1988)
5- Materials characterization, Introduction to microscopic and spectroscopic methods, Yang Leng, John Wiley and Sons Pvt.ltd.

OR

CBOP-3,CHI-333: Theory
B) Inorganic Magneto and Polymer Chemistry [48L + 12T]

Section-I: Magneto-chemistry [24 L +6 T]

1. Introduction [4 L]

Definition of magnetic properties and types of magnetic substances, magnetic susceptibility, anisotropy in magnetic susceptibility, experimental arrangements for determination of magnetic susceptibility: Gouy method, Faraday method, Evans method, SQUID.

2. Paramagnetic Susceptibility [2 L]

Simplification and application of Van-Vleck susceptibility equation, temperature independent paramagnetism.

3. Magnetic properties [6 L]

Magnetic properties of transition metal complexes in cubic and axially symmetric crystal fields, low spin, high-spin crossover, magnetic behaviour of lanthanides and actinides, magnetic exchange interactions.

4. Anti-ferromagnetism [2 L]

Transition metal monoxides and halide salts of transition metals, ferrimagnetism (ferrites), magnetic anisotropy.

5. Anomalous magnetic moments [4 L]

Anomalous magnetic moments in magnetically dilute and concentrated system in various symmetrical environments of coordination complexes. Study of mixed valence compounds, their magnetic behaviour

6. Magnetic materials [6 L]

Soft and hard ferrites, i.e. structure and magnetic interactions in spinels, garnets, hexagonal ferrites. Application of magnetic materials, Molecular magnets, Single chain magnet, Photoinduced magnetism, Spin canting, Magnetic ordering.

Reference Books:

1. Elements of Magnetochemistry, 2nd Edn., R. L. Datta and A. Syamal (1993) Affiliation, East-Wiley Press (p) Ltd.
2. Introduction to Magnetochemistry, A. Earnshaw, Academic Press, (1968).
3. Magnetism and Transition Metal Complexes, F. E. Mabbs and D. J. Machin (1973) Chapman and Hall, London.

Section - II: Inorganic Polymer [24 L +6 T]

1. **Inorganic polymers: [8 L]**

Overview and classification of polymers. Coordination Polymers: Homopolar and heteropolar inorganic polymers.Polyphosphazenes, Polysilanes, Polysiloxanes, Boron Polymers, Borazines, Phosphorous based polymer, polymeric compounds of sulphur, polythiazoles, silicates with reference to preparation, properties, structures, bonding and applications.

2. **Natural polymers [4 L]**

Natural polymers and reactions yielding coordination polymers. Synthesis of coordination polymers.

3. **Pre-ceramic Inorganic polymers**: [**6 L]**

Silicon carbide, Boron nitride, Aluminium nitride, Phosphorous nitride.

4. **Applications of Inorganic Polymers**: [**6 L]**

Metal containing polymer for medical purposes, Inorganic polymers as catalysts, Luminescent Inorganic polymers.

Reference Books:

1. I. S. Butler and J. F. Harrod, Inorganic Chemistry – Principles and Applications, The Benjamin/Cummings Publishing Co., Inc., Redwood City, California (USA) (1989) Chapter 15 to 17, pp 441-503.

2. Ranald D. Archer, Inorganic and organometallic polymers, A John Wiley and Sons, Inc. publication (USA) 2001
3. N. H. Ray, Inorganic Polymers, Academic Press (1978).

CCPP-3, CHI-334: Modern Methods of Inorganic Analysis [96L + 24T]

A. Analysis (12 experiments)

1-2. Stainless steel Alloy. [iron, chromium and nickel from sample]
2-3. Ilmenite Ore [acid-insoluble matter (combined oxides), iron and titanium from ore]
4-5. Analysis of Cement (Al(III), Mg(II), Fe(III), Ca(II)]
6. Analysis of zinc-chrome Pigment [e.g. Chromium from Zinc chrome]
7-8. Pharmaceutical products **any two** i) magnesium from tablet of "Milk of magnesia", calcium from calcium supplementary tablet, ii) iron from iron supplementary capsule iii) zinc from iron-zinc supplementary capsule or insulin.
9. Consumer products [e.g. aluminium from alum]
10. Ion exchange chromatography [separation and estimation of mixture of anions
11-12. Purity & Percentage of Metal in Coordination Complexes.
13-14. Organometallic Compounds: Synthesis and characterization of Acetyl ferrocene.
15. Preconcentration of Co(II) using ion exchange resin and colorimetric estimation. (Ref-7)

B. Inorganic Practical (12 experiments)

1. Photometric Titrations Cu Vs. EDTA, Fe Vs. EDTA using salicylic acid.
2. Photochemistry of ferrioxalate a) Preparation b) Photochemistry
3. Preparation of complex and Kinetics by conductometry.
4. Preparation of complex and Kinetics by spectrophotometry.
5. To study metal-DNA interaction spectrophotometrically.

6-7. A) Synthesis of Tetrakis(triphenylphosphine)nickel(0) and its application for cross coupling reactions.
8-9. Synthesis of Ferrocene and its derivative such as Acetyl Ferrocene.
10-11. Flame photometry: determination of the ppm of i) sodium by calibration curve method and ii) calcium by standard addition method in the water sample.
12. Determination of phosphate in detergent by spectrophotometry.
13. Atomic absorption spectrophotometer (AAS): Demonstration and determination of amount of iron from tap water sample.
14. Chemical mineralization of pollutants by Fenton's Process (Ref-5)
15. Estimation of Vitamin-C by reaction with Fe(III) and estimation of Fe(II) colorimetrically. (Ref-6)

Each experiment includes standardization of reagents, calibration of instrument with known reagents and analysis of an unknown.

Reference Books:

1) Text book of Quantitative Analysis, A.I. Vogel 4th edn (1992).
2) Experimental Inorganic Chemistry, Mounir A. Malati, Horwood Series in Chemical Science (Horwood publishing, Chichester) 1999.
3) Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House
4) General Chemistry Experiments, Anil. J Elias, University press (2002)
5) Environmental Chemistry, Microscale Laboratory Experiments, Jorge G. Ibanez, Margarita Hernandez-Esparza, Carmen Doria-Serrano, Arturo Fregoso-Infante, Mono Mohan Singh, published by Springer.
6) Vitamin C as a Model for a Novel and Approachable Experimental Framework for Investigating Spectrophotometry, Journal of Chemical Education, DOI:10.1021/acs.jchemed.9b00197.
7) Separation, Preconcentration and Spectrophotometry in Inorganic Analysis, by Z. Marczenko and M. Balcerzak, Analytical Spectroscopy Library – 10, Elsevier

Semester-IV

CCTP-10,CHI-430: Heterogeneous Catalysis and its Applications [48L + 12T]

Section - I: Heterogeneous Catalysis [24 L +6 T]

1. Principles of Heterogeneous Catalysis [**1L]**
2. Development of industrial heterogeneous catalysis, Important milestones [**2L]**
3. Quantitative aspects of adsorption on solid surfaces [**2L]**
4. Basic Adsorption Isotherms and their applications [**1L]**
5. Classification of heterogeneous catalysts [**1L]**
6. Metals, Bimetals, metal oxides, supported metal catalysts [**2L]**
7. Preparation of Solid Catalysts: Precipitation and co-precipitation, impregnation, High temperature fusion and alloy leaching, Hydrothermal synthesis, vacuum pore impregnation, impregnation of porous support [**3L]**
8. Post synthetic treatment: Drying, calcinations, activation and forming [**2L]**
9. Characterization of Solid Catalysts: BET surface area, temperature programmed techniques (TPD, TPR, TPS, TPO), spectroscopic techniques (XRD, SEM TEM, XPS, FTIR, solid state NMR) [**3L]**
10. Metal–Support Interactions, Support selection and role of support [**1L]**
11. Chemistry of zeolites: [**2L]**
    a. General Introduction, Nomenclature and classification of zeolites
    b. Hydrothermal synthesis Zeolite (eg. ZSM-5) and factors influencing on zeolite synthsis.
    c. Zeolite framework structure and selected zeolite framework type such as Sodalite,LTA, FAU, MFI (ZSM-5),MEL(ZSM-11), BEA (zeolite beta).
    d. Zeolite characterization by powder XRD method.
12. Factors Influencing Catalytic Action: Promoters and Poisons, Deactivation and Regeneration of catalyst [**1L]**
13. Heterogenization of Transition Metal Complexes to Inorganic Oxides: supported aqueous phase catalyst (SAPC), Supported ionic liquid phase catalyst (SILPC), and Phase transfer catalysis [**2L]**
14. Types of Chemical reactors [**1L]**

Section - II: Applications of Heterogeneous catalysis in organic synthesis [24 L +6 T]

1. Catalysis by acidic solids: Application of zeolites in catalysis: Hydrocracking, Shape selective catalysis, Hydrogen transfer, Catalytic reforming, oxidation catalyst. **[2L]**
2. The Fischer–Tropsch (FT) Synthesis Process [**2L]**
3. Water Gas Shift Reaction [**1L]**
4. Methanol Synthesis [**1L]**
5. Alkylation of Aromatics [**1L]**
6. Selective Hydrogenation of Hydrocarbons [**2L]**
7. Heterogeneous Catalysis for Oxidation of Alcohols [**2L]**
8. Photocatalysis: semiconducting oxides w.r.t. Titanium Oxide as Photocatalysts [**2L]**
9. Use of $BiMoO_4$ as Oxidation and Ammoxidation catalysts [**2L]**
10. Conversion of biomass on solid catalysts [**1L]**
11. MCM-41 as a catalyst [**2L]**
12. Clays and Intercalated clays as catalyst [**1L]**
13. Industrial Electrocatalysis [**2L]**
14. Catalysis in Environmental Protection: Automotive Exhaust catalysts:The catalytic converter, Perovskite and related oxides as catalysts [**3L]**

References:

1. Handbook of Heterogeneous Catalysis: Wiley International Wiley-VCH Verlag GmbH & Co. KGaA, 2008
2. Catalysis: Concepts and Green Applications: Gadi Rothenberg, Wiley-VCH; First edition, 2015

3. Heterogeneous catalysis by B.Viswanathanand D. K.Chakrabarty , New Age International Private Limited, 2007.
4. Heterogeneous Catalysis for the Synthetic Chemist By Robert L. Augustine, Marcel Dekker Inc.New York,1996
5. Gerard, V. S.; Ferenc, N. Heterogeneous Catalysis in Organic Chemistry; Academic Press; New York. First edition, 2006.

CCTP-11,CHI-431: Inorganic Nanomaterials: Properties, Applications and Toxicity [48L + 12T]

Section - I: Nano-structural Materials and its Applications [24 L +6 T]

Chapter1: Nanoscience and Nanotechnology: [6L]

a) What is nanoscience and nanotechnology?
b) Natural and artificial nanoparticles
c) Ancient Nanotechnology
d) Stalwarts of nanotechnology- Feynman, Drexler and Taniguchi
e) Moore's law
f) Basics of nanophotonics.

Chapter 2: Effects of making into small [6L]

a) Size dependence of material properties
b) Special properties
   i. Structural properties
   ii. Thermal properties
   iii. Chemical properties
   iv. Mechanical properties
   v. Magnetic properties
   vi. Optical properties
   vii. Electronic properties
   viii. Biological properties

Chapter 3: Classification of nanotechnology [6L

a) Classification of nanomaterials
b) Classification of Nanotechnology
   i. Wet nanotechnology
   ii. Dry nanotechnology
   iii. Computational nanotechnology
c) Concept of 0D,1D, 2D and 3D nanostructures.

Chapter 4: Applications of nanomaterials [6L]

a) Carbon nanomaterials
b) Nanocomposites include metal nanomaterials such as single particle as well as coreshell nanomaterials.
c) Polymer Nanotechnology
d) Organic Electronics
e) Nanotribology
f) Nanobiotechnology

Section - II: Nanotoxicology and Biosafety [24 L +6 T]

Nanotoxicology

1. Introduction to Nanotoxicology [**3L]**
2. Nano etymology [**3L]**
3. Nanotoxicology challenges [**2L]**
4. Physico-chemical characteristic dependent toxicology [**4L]**
5. Epidemiological evidences **[4L]**

6. Mechanism of nanotoxicity [**4L]**
7. Assessment of nanomaterial toxicity: In vitro toxicity assessment-cell viability and in vivo toxicity assessment [**4L]**

Reference Books:

1. The Chemistry of Nanomaterials edited by C.N.R.Rao, A.Muller, A.K.Cheetham Wiley-VCH Verlag GmbH & co. Volumes 1&2.
2. Nanomaterials by Dr. Sulbha Kulkarni.
3. T. Pradeep, "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill Education Pvt. Ltd., 2012
4. Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology", Academic Press, 2008
5. Handbook of Nanotoxicology, Nanomedicine and Stem Cell Use in Toxicology. Saura C Sahu, Daniel A Casciano

CBOP-4, CHI-432: A) Material Science (4 Credits) [48L + 12T]

OR

B) Inorganic Chemistry Applications in Industry[48L + 12T]

CBOP-4,CHI-432, Theory: A) Material Science [48L + 12T]

Section – I: Crystal Defects, Magnetic and Superconducting Materials [24 L +6 T]

1. Crystal defects and Non stoichiometry, Diffusion in solids, phase transformation in solids, solid state reactions and crystal growth. Preparation methods of solids. [**4L]**

2. Magnetic Materials [**12L]**

Atomic magnetism and solids, type of magnetic materials, exchange interactions, hysteresis loop and their classification, calculation of magnetic moment from saturation magnetisation, magnetic domains, examples of magnetic materials, soft & hard ferrites, structure & magnetic interactions in spinel, garnet hexagonal ferrites, application of magnetic materials

3. Superconducting materials [8L]

Definition, superconductivity, critical temperature, critical field, BCS theory, properties & classification of superconductors, high Tc superconductors, examples with structure and applications, fullerenes, intermetallic superconductors, synthesis, applications

Section-II: Ceramic, composite, Cementitious and Bio Materials [24 L +6 T]

1. CeramicMaterials [6L]

Classification of ceramics, dielectric properties and polarization properties of ceramics, piezo-, pyro- and ferro-electric effect of ceramics, sol-gel processing of ceramics. Examples and application of ceramics: oxides, carbides, borides, nitrides.

2. CompositeMaterials [6L]

Definition, glass transition temperature,fibersfor reinforced plastic composite materials (i.e. glass fibers, carbon fibres, and aramid fibers); concrets and asphalt materials. Application ofcomposite material

3. Cementitious Materials [8L]

Difference between Blended and Non-Portland cements; Non-portland cements; high alumina cements, calcium sulfoaluminate cements, phosphate cements.Chemicals in cement hydration; hydration process, set retardersandaccelerators, plasticizers, slip-casting processing. Application of cementitousmaterials.

4. Bio-materials [4L]

Definition of biomaterials and biocompatibility;, Type of bio-materials: Metallic materials, Biopolymeric materials, Bioceramic materials (dense hydroxyapatite ceramics, bioactive glasses,and bioactive composites); Basic requirement of bone implants; Coating of hydroxyapatite on porous ceramics; Biomaterials in tissue attachments; Application of Biomaterials

References

1. Solid state Chemistry: An Introduction – L.E. Smart & E.A. Moore, CRC, Taylor & Francis, 3rd Edn.
2. Materials Science & Engineering – V. Raghvan, 2nd Edn.
3. Introduction to Solids – L.V. Azarroff, 2nd Edn. 1980
4. Elements of materials science and engineering – Van Vleck, 5th Edn.
5. Insight to Speciality Inorganic Chemicals – D. Thompson, Royal Society of Chemistry, 1995.

CBOP-4, CHI-432, Theory: B) Inorganic Chemistry Applications in Industry [48L + 12T]

Section - I: Inorganic Chemistry Applications in Industry [24 L +6 T]

1.Inorganic Chemicals as metallicCorrosionInhibitors [2L]

Introduction, Principles of corrosion inhibitors, corrosion as an electrochemical process, Practical aspects of corrosion inhibition, Anion inhibitor properties in neutral electrolytes, some application of corrosion inhibitors (cooling water circulation-once through and open systems, engine radiation & cooling systems, central heating system, refrigeration plants and high chloride systems, water for steam raising, corrosion inhibitors for paintcoating).

2. Industrialgases: [4L]

Introduction, Separation of gases from air,Hydrogen, Carbon dioxide, Carbon monoxide, Oxygen, Acetylene, Sulphur dioxide, Nitrous oxides.

3. Chemical explosivesandpropellants: [6L]

Introduction, Potential energy of explosives , Properties of explosives, Manufacture of explosives , Explosives made by nitration, Dynamite , Commercial high explosives containing no nitroglycerine , Initiating devices, Sporting and military explosives , Disruptive explosives for military use, Handling and storage of explosives.

4. Metalfinishingtechnology: [4L]

Fundamental considerations, Electrodepositions of Copper , Nickel, Gold, Silver, Tin and Tin alloys for Lead free solder, Electrodeposition of Chromium , Electrodeposition of semiconductors , Elctoroless deposition of Copper and Nickel, Environmental aspects of electrodeposition , Ionic Liquid treatments for enhanced corrosion resistance of Magnesium basedsubstrates.

5. Safety consideration in chemicalprocessindustries: [5L]

Introduction , Concern for chemical safety , Hazards and their control in petrochemical industries , Hazards and their control in petroleum refineries and LPG boiling plants , Hazards in storage , Handling and use of chemicals, Chemical storage- safety issues, Observations related to safety aspects , Specific recommendation for hazard control and improved plant safety, Chemical plant safety- from concept to decommissioning.

6. Green Chemistry: [3L]

Introduction, Designing a Green synthesis, Basic Principles of Green Chemistry, Green Chemistry in Day-to- Day life, Green Chemistry in sustainable development.

References:

1. Handbook of Industrial Chemistry,Vol.1, by K.H.Davis,F.S.Berner,Edited by S.C. Bhatia (CBS Publishers, Bangalore,2004)
2. Industrial inorganic chemistry, Karl Heinz Buchel, Hans-Heinrich Moretto, Peterwoditsch
3. Modern Electroplating, By M. Schlesinger and M. Paunovic (John Wiley and sons, Hoboken , New Jersey, 5th Edition2010)
4. Insight into Specialty Inorganic Chemicals-David Thompson (The Royal Society of Chemistry,1995)- Chapter15.
5. New Trends in Green Chemistry (2nd Edition)-V.K.Ahluwalia and M.Kidwai (AnamayaPublishers, 2007)

Section-II: Inorganic Chemistry Applications in Environments [24 L +6 T]

1. **Introduction to waste water Analysis: [10L]**
   Specification of treated waste water for disposal into surface water, Screening chamber, Grit Chamber, Oil & Grease removal, designing of biological unit- stabilisation pond, Aerated lagoon, Trickling filters, Anaerobic treatment.
2. **Water Pollutants: [4L]**
   Types, Disease causing agents, oxygen consuming waste, suspended solids and sediments, Dissolved solids, Regulation of water quality, Analysis of solids by different techniques.
3. **Applications of Biotechnology for the treatment of waste water [4L]**
   Introduction, Role of microorganism for the treatment of waste water, Application of biotechnology for a. high strength waste. b. Primary and secondary sludge c. Phenol & cyanide removal d. Solid phase extraction
4. **Energy sources for future: [6L]**
   a. Solar Energy-Solar heating for homes and other buildings, electricity from solar thermal power collectors, electricity from photovoltaic cells.
   b. Energy from biomass- Production of biomass, biofuels, biodiesel.
   c. Geothermal energy,
   d. water power
   e. Tidal power.
   f. Fuel Cells-Polymer electrolyte membrane fuel cells, Phosphoric acid fuel cell, Direct methanol fuel cell, Alkaline fuel cell, Regenerative(reversible) fuel cell, Clean cars for the future, Energy sources for the twenty first century.

References:

1. Environmental Chemistry by A. K. Bagio.
2. Principles of Environmental Chemistry by James Girard Bartlett Publishers.
3. Waste Water Engineering by Calf& Eddy.
4. Waste Water treatment for pollution control by Arceivala.
5. Principles of water quality Control by T. H. Y Tebbut.
6. Manual on Sewage &Sewage treatment, Ministry of Works, New Delhi.

CBOP-5, CHI-433: A) Extended Practical in Inorganic Chemistry [96 L + 24T]

A. Preparation and Purity of following complexes of

1. DMG
2. 8-hydroxy quinoline
3. Salicylaldoxime
4. Thiourea
5. Thiocarbamate ligand

With Copper, Nickel, Iron, Chromium & Manganese (any three metals)

B: Structural determination of above complexes using following techniques

1. UV-Visible spectroscopy
2. Magnetic susceptibility
3. Thermogravimetric analysis
4. IR
5. Solution conductivity

C. Introduction to literature survey

Each experiment includes standardization of reagents, calibration of instrument with known reagents and analysis of an unknown.

Reference Books:

1) Text book of Quantitative Analysis, A.I. Vogel 4th edn (1992).
2) Experimental Inorganic Chemistry, Mounir A. Malati, Horwood Series in Chemical Science

(Horwood publishing, Chichester) 1999.
3) Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House
4) General Chemistry Experiments, Anil. J Elias, University press (2002)

CBOP-5,CHI-433; B) Project Work [96L + 24T]

Each student will perform project separately. Working hours are same as practical of CHI-433(A). Project length should be sufficient and should be equivalent to minimum 24 practical session of 4 h. ***Project report must be written systematically and presented in bound form: The project will consist of name page, certificate, content, summary of project (2-3 page) followed by introduction (4 to 7 pages), literature survey (4-7) pages (recently published about 30 papers must be included), experimental techniques, results, discussion, conclusions, Appendix consisting of i) references, 2) standard spectra / data if any and 3) safety precautions.*** If student is performing project in another institute, for such a student, internal mentor must be allotted and he will be responsible for internal assessment of a student. In this case student has to obtain certificate from both external and internal mentor. ***Systematic record of attendance of project students must be maintained by a mentor.*** Project will be evaluated jointly by three examiners and there will not be any practical performance during the examination. Typically, student has to present his practical work and discuss results and conclusions in details (20-30 min.) which will be followed by question-answer session (10 min). It is open type of examination.

CCPP-4:CHI-434; Practical -Inorganic Instrumental Analysis and Inorganic Preparations [96L + 24T]

Section-I: Inorganic Instrumental analysis (Equivalent to 12 practical)

1. Magnetic Susceptibility – 2 samples
2. Thermogravimetric studies – 2 samples
3. Catalytic hydrogenation Kinetics of Aquation/Isomerisation - 2experiments
4. Photochemical reactions using Nanoparticles
5. Table work – Four techniques IR, ESR, XRD, CV, NMR
6. Metal DNA interactions (Viscosity & spectrophotometry)
7. Synthetic Copper Oxidase (Copper catalysed oxidation of 2,6,disubstituted Phenols)
8. Cyclic Voltametric study of i)Potassium ferricyanide ii) Ferrocene

Section-II: Preparation of Inorganic Compounds (Equivalent to 12 practical)

Part B Preparation of Inorganic compounds:

Metal complexes

1. Trans-dichloro-bis(ethylene diamine) cobalt (III) chloride
2. [Mn(Salen)]
3. $[Mn(acac)_3]$
4. Hg $[Co(SCN)_4]$
5. $[Cu(o\text{-}phen)_2]$
6. Hexa thiocyanato chromate
7. Tris(triphenylphosphine)nickel(II) sulphate.
8. Chloroaquotetraaminocobalt(III) sulphate.
9. $[Fe\ (DTC)_3]$

Synthesis of Solid State Materials

1. Zinc Ferrite
2. NiO
3. Nickel Ferrite
4. Nano particles of MnO_2

Each experiment includes standardization of reagents, calibration of instrument with known reagents and analysis of an unknown.

Reference Books:

1) Text book of Quantitative Analysis, A.I. Vogel 4th edn (1992).
2) Experimental Inorganic Chemistry, Mounir A. Malati, Horwood Series in Chemical Science (Horwood publishing, Chichester) 1999.
3) Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House
4) General Chemistry Experiments, Anil. J Elias, University press (2002)

3. M.Sc. (II) Organic Chemistry

Course Structure

Sr. No.	Paper No. & Course Code	Course Nam e	Credits
		Semester - III	
1	**CCTP-7** CHO-350	Organic Reaction Mechanism and Biogenesis	4
2	**CCTP-8** CHO-351	Structure Determination of Organic Compounds by Spectroscopic Methods	4
3	**CCTP-9** CHO-352	Stereochemistry and Asymmetric Synthesis of Organic Compounds.	4
4	**CBOP-3** CHO-353 Theory	CHO-353-A) Protection - De-protection, Chiron approach and Carbohydrate Chemistry	4
		Or	
		CHO-353B**)** Designing Organic Syntheses and Heterocyclic Chemistry	4
5	**CCPP-3** CHO-354	**Practical I**: Solvent Free Organic Synthesis	4
		Semester – IV	
6	**CCTP-10** CHO-450	Chemistry of Natural Products	4
7	**CCTP-11** CHO-451	Organometallic Reagents in Organic Synthesis	4
8	**CBOP-4** CHO-452 **Theory**	CHO-452 A) Medicinal Chemistry CHO-452 B) Applied Organic Chemistry	4 4
9	**CBOP-5** CHO-453 Practical	**Practical III: Select any two Sections**	4
		Section-I: Ternary Mixture Separation	2
		Section-I: Carbohydrates Synthesis and Isolation of Natural Products	2
		Section-I: Project / Industrial Training/ Internships/ Summer Project	2
10	**CCPP-4** CHO-454	**Practical II**: Convergent and Divergent Organic Syntheses.	4

Equivalence of Previous Syllabus

New Course (2019 Pattern)	Old Course – 2014 Pattern
CHO-350: Organic Reaction Mechanism and Biogenesis	CHO-350 Organic ReactionMechanism
CHO-351: Structure Determination of Organic Compounds by Spectroscopic Methods	CHO-351 Spectroscopic Methods in Structure Determination
CHO-352: Stereochemistry and Asymmetric Synthesis of Organic Compounds.	CHO-352 Organic Stereochemistry
CHO-353A: Protection - De-protection, Chiron approach and Carbohydrate Chemistry.	CHO-452 Carbohydrate and Chiron Approach/ Chiral Drugs and Medicinal Chemistry
CHO-353B: Designing Organic Syntheses and Heterocyclic Chemistry	CHO-453 Designing Organic Synthesis and Asymmetric Synthesis
CHO-354: **Practical I**: Solvent Free Organic Synthesisis	CHO-347 Single Stage Preparations
CHO-450: Chemistry of Natural Products	CHO-450 Chemistry of Natural Products
CHO-451: Organometallic Reagents in Organic Synthesis	CHO-451 Advanced Synthetic Organic Chemistry
CHO-452B: Medicinal Chemistry	
CHO-452B: Applied Organic Chemistry	CHO-353 Pericyclic Reactions, Photo-chemistry and Heterocyclic Chemistry
CHO-453: **Practical III**: **Select any two Sections from I, II,III** Section-I: Ternary Mixture Separation Section-II: Carbohydrates Synthesis and Isolation of Natural Products Section-III: Project / Industrial Training/ Internships (including Summer Project)	CHO-448 Project/Industrial Training/ Green Chemistry and Chemical Biology Experiments
CHO-454: **Practical II**: Convergent and Divergent Organic Syntheses.	CHO-447: Double Stage Preparation Preparation

The detailed course wise syllabus of M. Sc-II Organic Chemistry is as follows:

Semester-III

CCTP-7, CHO-350: Organic Reaction Mechanism and Biogenesis [48L+12T]

Section I: Organic Reaction Mechanism, [24 L + 6 T]

1. Methods for determining Reaction Mechanisms
(Kinetic and nonkinetic methods), Ref -1, **[4 L]**

2. Free Radicals: Generation, stability, reactivity, Free radical substitution, addition to multiple bonds, radicals in synthesis, Inter- and intra-molecular bond formation via mercury hydride, tin hydride, thiol donors, cleavage of C-X , C-Sn, C-S, O-O bonds, Oxidative coupling, C-C bond formation in aromatics, SNAr reactions, Free Radicals in Organic Synthesis. ***(Ref**-2, 3, 6, 7).* **[8 L]**

3. Linear Free Energy Relationships, *Ref. 3, 4*. **[6 L]**

4. Hammet plots, Hammet equation, substituent constants, reaction constants, use of Hammet plots, calculation of k and K, Deviations from straight line plots, Taft equation, solvent effects. *Ref. 3, 4, 5* **[6 L]**

Section II: Biogenesis: The Bbuilding Blocks and Cconstruction Mmechanism, [24 L + 6 T]

1. Terpenoids: Mono-, Sesqui-, Di-, tri-terpenoids and cholesterol, *Ref.- 8, 9, 10* **[6 L]**

2. Alkaloids: Derived from ornithine, lysine, nicotinic acid, tyrosine and tryptophan. *Ref.- 8, 9, 10* **[6 L]**

3. The Shikimate pathway: Cinnamic acids, lignans and lignin, coumarins, flavonoids and stilbens, isoflavanoids and terpenoid quinones. *Ref.- 8, 9, 10* **[6 L]**

3. A case study: Alkaloids isolated from the Roots of ***Piper nigrum,*** *Ref. -11, 12* **[6 L]**

References:

1. Mechanism and structure in Organic Chemistry E. S. Gould (Holt, Rinehart and Winston)
2. Advanced Organic Chemistry –J. March, 4th edition
3. Advanced Organic Chemistry- Part A: Structure and Mechanism- F. A. Carey and R. J. Sundberg, 5th Edition, Springer 2007)
4. A guidebook to mechanism in Organic Chemistry- Peter Sykes
5. The Hammett Equation by C. D. Johnson
6. Organic Chemistry-J. Clayden, N. Greeves, S. Warren, P. Wothers, Oxford University Press
7. Radical in Organic Synthesis- B. Giese, Pergamon Press (1986)
8. Natural Product Biosynthesis: Chemical Logic and Enzymatic Machinery by Christopher T Walsh, Yi Tang
9. From Biosynthesis to Total Synthesis: Strategies and Tactics for Natural Products- Editor Alexandros L. Zografo
10. Medicinal Natural Products: A Biosynthetic Approach, 3rd Edition By Paul M. Dewick
11. J. Nat. Prod. 2004, 67, 1005-1009.
12. J. Org. Chem. 2005, 70, 4, 1164–1176

Additional Study Material: Organic Reaction Mechanism

https://nptel.ac.in/courses/104/101/104101005/
https://nptel.ac.in/courses/104/101/104101115/

CCTP-8, CHO-351: Structure Determination of Organic Compounds by Spectroscopic Methods [48L +12L]

Section-I: NMR Spectroscopy [24 L + 6 T]

1. NMR in Stereochemistry Determination: Homotopic, enatiotopic and distereotopic protons, Chemical and Magnetic equivalence; First and second order splitting, Complex multiplicity patterns and coupling constants in asymmetric compounds; Simplification of complex spectra, NOE, Diastereomerism, Atrop or axial chirality, % Enantiomeric excess, chiral NMR solvents etc in structure elucidation. **[10 L]**

2. ^{13}C NMR spectroscopy - APT, DEPT and INEPT **[6 L]**

3. ^{15}N, ^{19}F and ^{31}P NMR spectroscopy

Fundamentals and applications in structure elucidation of organic compounds, catalysts and biomolecules. *(**Self learning and for internal assessment only). [*0 L]**

4. 2D NMR spectroscopy in structure elucidation: (a)Homonuclear: COSY, TOCSY, 2D-INADEQUATE, 2D- ADEQUATE, NOESY, ROESY (b) Heteronuclear: HSQC, HMQC, HMBC **[8 L]**

Section-II: Mass Spectrometry [24 L + 6 T]

1. Mass Spectrometry: Principle, ionization methods like EI, CI, ES, MALDI and FAB-Fragmentation of typical organic compounds, stability of fragments, Rearrangements, factors affecting fragmentation, ion analysis, ion abundance, High-Resolution mass spectrometry in determination of molecular formula. **[6 L]**

2. Applications of Mass Spectrometry: Determination of the elemental composition, Isotopic Abundance in structure establishment; Analysis of Biomolecules: Proteins and Peptides, Oligonucleotides and Oligosaccharides **[6 L]**

3. Problems solving: Structure elucidation using UV, IR, 1D (1H and13C) NMR and 2D NMR (1H-1H, 13C- 1H COSY /HETCOR only), APT, DEPT and MS data as well as spectra. **[12 L]**

References:

1. Spectrometric Identification of Organic Compounds by R. M. Silverstein, G. C. Bassler and T. C. Morrill, John Wiley.
2. One and Two dimensional NMR Spectroscopy by Atta-Ur-Rehman, Elsevier (1989).
3. Organic Structure Analysis-Phillip Crews, Rodriguez, Jaspars by Oxford University Press (1998).
4. Organic Structural Spectroscopy by Joseph B. Lambert, Shurvell, Lightner, Cooks, Prentice-Hall (1998).
5. Organic Structures from Spectra by Field L.D. Kalman J.R. and Sternhell S. 4th Ed. John Wiley and Sons Ltd.
6. Mass Spectrometry Basics by Christopher G. Herbert Robert A.W. Johnstone
7. Mass Spectrometry Principles and Applications by Edmond de Hoffmann and Vincent Stroobant.

CCTP-9, CHO-352: Stereochemistry and Asymmetric Synthesis of Organic Compounds [48L + 12T]

Section I- Stereochemistry [24L + 6T]

1. Conformations of polysubstituted cyclohexane, six membered rings with SP^2 carbon, heterocycles with N and O, anomeric effect, stereochemical principles involved in reactions of six membered rings and other than six membered rings, concept of I- Strain. ***(Ref.** 1, 2, 3, 4, 5, 6)* **[8 L]**

2. A) Stereochemistry of fused and bridged ring systems: Nomenclature, synthesis; stereochemical aspects of Perhydrophenanthrene, Perhydroanthracene, hydrindane, Steroids; Bridged system (bi, tri and polycyclo system) including heteroatoms, Bredt's Rule. **(*Ref.-1, 2, 3, 4, 5, 6)*. 2. B) Conformations of following compounds with**

justification of each: cis and trans -1,3- and l,4-di-t-butyl-cyclohexanes; Cis-4-di-t-butyl-cis-2,5-dihydroxycyclohexane; Twistane; bicyclo- [2.2.2]octane; Trans-anti-trans-Perhydro-anthracene and the lactone; cyclohexane-l,4-dione; 1,2,2,6,6-penta-methyl-4-hydroxy-4-phenylpiperidine; ψ-tropine; 2-hydroxy-2-phenyl quinolizidine; 4-t-butyl-4-methyl-l,3-dioxane; cis- and trans-2,5-di-t-butyl-l,3-dithianes;cis-2,5-di-t-butyl-l,3,2-dioxaphosphorinan-2-one ***(Ref.** 1, 7, 8)* **[8 L]**

3. Determination of configuration, Cram's rule, Cram's cycle model, Cram's dipolar model, Felkin-Anh Model; Resolution and analysis of stereomers - formation of racemization and methods of resolution. (***Ref.*** 1, 2, 4), Stereochemistry of a polymer chain – Types and examples of Tacticity **(Ref. 7)**, **[8 L]**
4. Decalols, Decalones, Octahydronaphthalenes, decahydroquinolines

***(Self learning and for internal assessment only)** **[*0 L]**

1.

References:

1. Stereochemistry of Carbon compounds - E. L. Eliel
2. Stereochemistry of carbon compounds - E. L. Eliel and S. H. Wilen
3. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers 1st. Ed.
4. Stereochemistry of organic compounds –Nasipuri
5. Stereochemistry of organic compounds-P. S. Kalsi
6. Organic stereochemistry – Jagdamba Singh
7. Topics in Stereochemistry (Volume 2) By Norman L. Allinger and Ernest L. Eliel.
8. Topics in Stereochemistry (Volume 8) By Ernest L. Eliel and Norman L. Allinger.

Additional Study Material: Stereochemistry

https://nptel.ac.in/content/syllabus_pdf/104105086.pdf
https://nptel.ac.in/courses/104/105/104105086/

Section II- Asymmetric Synthesis [24L + 6T]

1. Introduction of Asymmetric Synthesis, Chirol pool and Chiral auxillaries.
2. Asymmetric Organocatalysis
3. Asymmetric Aldol Reaction, Enantioselective, diastereoselective and double diastereoselective Aldol reactions.
4. Transition Metal-Catalyzed Homogeneous Asymmetric Hydrogenation
5. Transition Metal-Catalyzed Homogeneous Asymmetric Hydroxylation and Epoxidation
6. Asymmetric Phase-Transfer and Ion Pair Catalysis **(*Self learning)**

References:

1. Catalytic Asymmetric Synthesis, 3rd ed,Ed: I. Ojima, John Wiley & Sons, New Jersey, 2010
2. Catalysis in Asymmetric Synthesis by Vittorio Caprio and Jonathan M. J. Williams
3. Angew. Chem. Int. Edn. 2008, 47, 4638–4660.
4. Principles and Applications of Asymmetric Synthesis by Guo-Qiang Lin, Yue-Ming Li, Albert S. C. Chan, A John Wiley & Sons, Inc., Publication.

15. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers 2nd. Ed.

Additional Study material: Catalytic Asymmetric Synthesis

https://nptel.ac.in/content/syllabus_pdf/104103067.pdf
https://nptel.ac.in/courses/104/103/104103067/

CBOP-3, CHO-353(A): Protection - De-protection, Chiron approach and Carbohydrate Chemistry OR CHO-353(B): Designing Organic Syntheses and Heterocyclic Chemistr [48L + 12T]

CBOP-3, CHO-353(A): Protection - De-protection, Chiron approach and Carbohydrate

Section I: Protection - De-protection, Chiron approach [24L + 6T]

1. Protection and de-protection of functional group in organic synthesis: Hydroxyl group- alkyl ether, benzyl ether,acyl, PMB, Trityl, TMS, TBDMS, THP, MOM, MEM, MIP ether; **Diol** - Acetone,Cyclohexanone; **Amines**- Benzyl, Acyl, CBZ, BOC, FMOC, **Carboxyl group**-Ester, DCCI, DIPCDI; **Ketone and aldehydes**- Glycol, Thioglycol, Ketal, Acetal; Othroesters as protecting groups, Protection de-protection approach - In Solid phase synthesis of polypeptide; polynucleotide, cyclitols, and amino-sugars**.** ***(Ref. 1, 2, 3, 4)*****[12 L]**

2. Chiron approach: a) Introduction, b) The concept of chiral templates and chirons wherein the carbon skeleton is the chiral precursor, c) Utilization of the basic concepts in synthesis of (S) Propanediol, (R) and (S) – Epichlorohydrin, L (+)-Alanine, (-) Multistratin, (-) Pentenomycin and (-) Shikimic acid (***Ref.*** 2, 5, 6, 7). **[12 L]**

Section - II: Carbohydrate Chemistry [24 L + 6T]

a) Basics of Carbohydrates: Introduction of sugars, structures of monosaccharides, triose, tetrose, pentose, hexose, D/L forms of aldoses and ketoses in Fisher projections, cyclic hemiacetal forms of monosaccharides, representation of monosaccharide structure (Fisher, Zig-zag, Mills, Haworth projection and Chair conformation), The structure of Glucose, the anomeric configuration, mutarotation (D-Glucose), Conformations of monosaccharides, the anomeric effect. Modified monosaccharides, Alditols, Cyclitols, Nomenclature of monosaccharides, Cyclic forms of the α and β-D-aldoses.

b) Synthesis of Glycosides: glycosyldonar acceptor concept, general methods for glycosyl bond formation: Glycosyl halides, Trichloroacetimides, Glycals and Glycal derivatives, Thioglycosides, Phosphites, n-Pentyl glycosides, SulfoxidesDiazarines, Alkylation of reducing sugars

c) Synthesis of disachharides, trisachharides, polysaccharies: Stereoselective synthesis of □-Mannosides, Synthesis of 2-Deoxy Sugars, Orthogonal strategy in Oligosaccharide synthesis, Effect of protecting groups on glycosylation stereoselectivity and coupling efficiency, Intramolecular glycosylation, Total synthesis of natural products: Oligosaccharides and Glycoconjugates. (**Ref. 5, 8, 9, 10, 11, 12)**

[24 L]

References:

1. Greene's protective groups in organic synthesis – Peter G. M. Wuts and Theodor R. A. Green 4th Edn. Wiley-India
2. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press)
3. Modern organic synthesis-An introduction- George S. Zweifel, Michael H. Nantz.
4. Advanced Organic chemistry, Part B – F. A Carey and R. J. Sundberg, 5th edition (2007)
5. Chiron Approach in organic synthesis – S. Hanessianh
6. Organic Chemistry – R. P. Morrison and R. N. Boyd
7. Organic Chemistry – I. L. Finar, volume II.
8. Essentials of Carbohydrate Chemistry and Biology: Thisbe K. Lindhorst, WILEY-VCH, 2000, Chapter 3.
9. Monosaccharide's: Their Chemistry and their Roles in Natural Products: Peter M. Collins, Robert J. Ferrier: John Wiley & Sons, 1995.
10. Carbohydrate in Chemistry and Biology: Part 1 Chemistry of Saccharides Vol.1. WILEY-VCH, 2000.
11. The Organic Chemistry of Sugars; By: Daniel E. Levy Peter Fugedi Publication: Taylor & Francis, Published on 2006
12. Handbook of Chemical Glycosylation by Alexei V. Demchenko, Wiley VCH, 2008

CBOP-3, CHO-353(B): Designing Organic Syntheses and Heterocyclic Chemistry

[48 L + 12 T]

Section I: Designing Organic Syntheses [24 L + 6 T]

1. Concepts of Retrosynthesis: Retrosynthetic analysis, disconnection approach, Synthons, multiple step synthesis, functional group intercoversion, Illogical two group intercoversion, C-C disconnection, Donor and acceptor Synthons, two group disconnection, 1,5 related functional group disconnection, Umpolung, convergent synthesis, special methods for small rings, Heteroatom and Heterocyclic compounds, problems, (***Ref***.-1, 2, 4). **[12 L]**

2. Application of Retrosynthetic Approach: Retrosynthesis and synthesis of following Molecules: Strychnine, Reserpine, Thienamycin, Asteltoxin, Indolizomycin, Erythronolide B**. Ref**-3 **[12 L]**

References:

1. Designing Organic Syntheses by Stuart Warren
2. Organic Chemistry from Retrosynthesis to Asymmetric Synthesis, by Vitomir Sunjic, Springer; 1st ed. 2016 edition
3. Classics in Total Synthesis by K.C. Nicolaou and E.J.Sorensen

Additional Study material: NPTEL Lecture:

A Study Guide in Organic Retrosynthesis: Problem Solving Approach (https://nptel.ac.in/content/syllabus_pdf/104105087.pdf)

Section II: Advanced Heterocyclic Chemistry [24 L + 6 T]

1. Systematic nomenclature (Hantzsch-Widman System) for monocyclic, fused and bridged heterocycles. Tautomerism in aromatic heterocycles. Strain-bond angle, torsional strains and their consequences in small ring heterocycles. **[4 L]**

2. General chemical behaviour of heterocyclic compounds and their applications in: Biological systems (Anthocyanins, Flavones, Neurotransmitters), Natural Products (Alkaloids: Nicotin, Quinine), Drugs and Medicines (Omeprazole, Amlodipine, Cilostazol) **[4 L]**

3. Synthesis, reactions and structural effects of heterocyclic rings [16 L]

a) Common Methods in Ring Synthesis of Aromatic Heterocyclic Systems**:** Typical ring synthesis involving C – Heteroatom, C – C bond formations, Electrocyclic processes in heterocyclic Synthesis: 1,3 -dipolar cycloadditions producing five - membered heterocycles, Nitrenes in heterocyclic synthesis, Palladium catalysis in the synthesis of Benzo - Fused heterocycles, Fischer synthesis, Epoxidation, Use of Sulphur Ylides, Azides for small rings

b) Three and four membered heterocylces: Aziridines, Oxiranes, Thirienes, Azetidines, Oxitanes and Thietanes

c) Five-membered and benzo-fused five memberedheterocycles:Oxazole, Isoxazole, Thiazole, Pyrazole, Imidazole, Benzothiazole and Benzimidazole

d) Six membered and benzo-fused six membered heterocycles:Pyrazine, Pyridazine, Pyrimidine, Quinazoline, Quinoxaline, Aziridines, Quinoline

Self Learning: Isoquinoline, Indoles

References

1. Heterocyclic Chemistry by T. Gilchrist.
2. An Introduction to the Chemistry of Heterocyclic Compounds by RM Acheson.
3. Heterocyclic Chemistry by J A Joule and K. Mills.
4. Principles of Modern Heterocyclic Chemistry by A Paquette.

5. Heterocyclic Chemistry by J A Joule and Smith.
6. Handbook of Heterocyclic Chemistry by A R Katritzky

Additional Study Material: Heterocyclic Chemistry

https://nptel.ac.in/content/syllabus_pdf/104105034.pdf

https://nptel.ac.in/courses/104/105/104105034/

CCPP-3, CHO-354: Practical-I Solvent Free Organic Synthesis

[96L +24T]

Note:

The students should perform any 24 Syntheses from the following list. Students should acquire **pre-experiment** (Reading MSDS, purification of reactants and reagents, mechanism, stoichiometry etc) and **post-experiment** skills (work-up, isolation and purification of products, physical constants characterization using any spectroscopic methods etc.)

A) Solvent Free Carbon–Carbon Bond Formation

1. Pinacol coupling reaction (Page 36)
2. Reformatsky reaction/Luche reaction (Page 36)
3. Knoevenagel condensation (Page 40)
4. Dieckmann condensation (Page 42)
5. Corrole Synthesis (Page 42)
6. Knoevenagel condensation, 3-carboxycoumarin (Page 45)
7. 3-(ethoxycarbonyl)-4-hydroxy-5-(1-hydroxyalkyl)-2-isoxazoline-2-oxide (Page 46)
8. Biginelli reaction (Page 46)
9. Claisen reaction(Page 47)
10. Pechmann reaction (Page 50)
11. calix[4]resorcinarene (Page 50)

B) **Solvent-Free C–N Bond Formation**

1. terephthalic acid dihydrazide (Page 205)
2. azomethine synthesis (Page 213)
3. diazepinone synthesis (Page 218)
4. dibenzyl sulfone Synthesis (Page 297)

C) **Solvent-Free C–S Bond Formation**

1. 1,3-dithiolane synthesis (Page 299/300)

D) **Solvent-Free C–X Bond Formation**

1. Cinnamic acid/ stilbene halogenations (Page 319)
2. Phenol bromination using , *N*-bromosuccinimide (Page 320)

E) **Solvent-Free N–N Bond Formation**

1. Triazenes Synthesis (Page 335)
2. Beckmann rearrangement (Page 346)

F) **Other Solvent-Free Reactions**

1. D-mannitol protection using phenylboronic acid (Page 388)
2. Baeyer-Villiger reaction
3. 2-Hydroxybenzaldehyde oxidation using urea-hydrogen peroxideComplex (Page 13)
4. Alumina-supported permanganate oxidation (Page 15)
5. Sulfide oxidation using MnO_2 (Page 21)
6. Oxidative coupling of thiol using MnO_2 (Page 22)
7. Iodine catalysed S-S bond formation of Cystine (Page 28)

G) Solvent free supramolecular assembly formation

1. Caffeine and oxalic acid (Page 420)
2. *rac-Bis*-beta-naphthol and benzoquinone
3. Isovaleraldehyde and pyrogallol

Reference:

Solvent-free Organic Synthesis by Koichi Tanaka (Copyright © 2009 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, ISBN: 978-3-527-32264-)

Additional Study Material: https://nptel.ac.in/courses/104/106/104106108/

Semester IV

CCTP- 10, CHO-450: Chemistry of Natural Products [48L +12T]

Section I: [24 L + 6 T]

1. Understanding and planning of total synthesis while maintaining the stereochemistry. A case study: **Longifolene** – (All Nine syntheses from Advanced Organic Chemistry Carey, Sundberg; Part B). **[12 L]**

2. Total Synthesis of

i. Hirsutellone B (Angew. Chem. Int. Ed. 2009, 48, 6870 –6874.)

ii. Ribisins A and B : (J. Org. Chem. 2019, 84, 15165−15172)

iii. Subincanadine E : **(*For Self-Learning)** (J. Org. Chem. 2017, 82, 11126-11133) **[12 L]**

Section II : [24 L + 6 T]

A) Vannusals

References:

1.J. Am. Chem. Soc. 2010, 132, 20, 7138-7152.
2.J. Am. Chem. Soc. 2010, 132, 20, 7153-7176.
3.Angew. Chem. Int. Ed. 2009, 48, 5642 –5647.
4.Angew. Chem. Int. Ed. 2009, 48, 5648–5652

B) **Pinnaic acid**

References:

1. Angew. Chem. Int. Ed. 2001, 40 (23), 4450-4452.
2. Angew. Chem. Int. Ed. 2001, 40, (23), 4453-4456.
3. Angew. Chem. Int. Ed. 2007, 46, 5746–5749

CCTP- 11, CHO-451: Organometallic Reagents in Organic Synthesis [48 L + 12T]

1. Transition metal complexes in organic synthesis; Pd, Ni, Ru, Fe, Ir and Cu only (C-C, C-N, C-O bond formation reactions with catalytic cycle, ligand and % mole concepts)**[18 L]**
2. C=C formation reactions: Wittig, Horner-Wordworth-Emmons, Shapiro, Bamford-Stevens, McMurry, Julia-Lythgoe and Peterson olefination reactions. **[6 L]**
3. Multi-component reactions: Ugi, Passerini, Biginelli and Mannich reaction **[3 L]**
4. Ring formation reactions: Pausan-Khand, Bergman and Nazerov cyclization **[3 L]**
5. Click chemistry: criterion for click reaction, Sharpless azides cycloadditions. Click reactions in synthesis of bioconjugates **(sugars and proteins)** **[4 L]**
6. Metathesis: Schrock and Grubbs catalyst, Olefin cross coupling (OCM), ring closing (RCM) and ring opening (ROM) metathesis, application in polymerization and synthesis of small organic molecules**.** **[6 L]**
7. Use of Boron and Silicon reagents in organic synthesis. **[8 L]**
8. Other important reactions: Baylis Hilman, Eschenmoser-Tanabe fragmentation, Mitsunobu reaction**. [*Self Learning]**

References:

1. C–N bond forming cross-coupling reactions: an overview: by Jitender Bariwalab and Erik Van der Eycken *Chem. Soc. Rev.*, 2013, **42**, 9283
2. Iron Catalysis in Organic Synthesis Chem. Rev. 2015, 115, 3170–3387.

3. Recent advances in homogeneous nickel catalysis Nature 2014, Vol 509, Page 299-309.
4. Ruthenium-Catalyzed Reactions for Organic Synthesis *Chem. Rev.* **1998**, *98*, 2599-2660.
5. Organic Synthesis Involving Iridium-Catalyzed Oxidation Chem. Rev. 2011, 111, 1825–1845.
6. Aerobic Copper-Catalyzed Organic Reactions Chem. Rev. 2013, 113, 6234−6458.
7. Transition Metals for Organic Synthesis Volume 1 *Edited by M. Beller and C. Bolm* WILEY-VCH Verlag GmbH & Co. KGaA ISBN: 3-527-30613-7
8. Multicomponent Reactions Edited by Jieping Zhu, Hugues Bienayme WILEY-VCH Verlag GmbH & Co. KGaA
9. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press),
10. Some modern methods of organic synthesis – W. Carruthers (Cambridge)
11. Organic synthesis – Michael B. Smith
12. Advanced organic chemistry, Part B – F. A Carey and R. J. Sundberg, 5th edition (2007).
13. Strategic Applications of named reactions in organic synthesis-Laszlo Kurti and Barbara Czako
14. Name Reactions Jie Jack Li (Fourth Expanded Edition), Page No: 1-582.
15. Organic Synthesis Using Transition Metals, by Roderick Bates, Second Edition, A John Wiley & Sons, Ltd., Publication.

CBOP-4, CHO-452(A): Concepts and Applications of Medicinal Chemistry
OR
CHO-452(B): Applied Organic Chemistry [48L + 12T]

CBOP-4, CHO-452(A): Concepts and Applications of Medicinal Chemistry [48L + 12T]

Section-I: [24 L + 6 T]

1. Introduction to Peptides and proteins, Proteins as biological catalyst Nucleic acids, Metabolism, Chemistry of cofactors/coenzymes, Chemistry of TPP, PLP, Folic Acid and other vitamins, Principle of drug design, Chemistry of diseases and Drug development, Proton pump inhibitors and Problem solving. **[8 L]**
Additional study material: NPTEL lecture: Organic Chemistry in Biology and Drug Development (full course) https://nptel.ac.in/content/syllabus_pdf/104105120.pdf) https://nptel.ac.in/courses/104/105/104105120/

2. Peptides, sequencing and applications in therapeutics, Solution phase and solid phase peptide synthesis and Modern techniques for biomolecules and disease diagnosis. **[6 L]**
Additional study material: NPTEL lecture (only 3 topics): Essentials of Biomolecules: Nucleic Acids and Peptides https://nptel.ac.in/content/syllabus_pdf/104103121.pdf https://nptel.ac.in/courses/104/103/104103121/

3. Introduction to medicinal Chemistry. History, drug targets, Drug discovery, design and development, Case Study: Design of Oxamniquine. **[4 L]**

4. Pharmacokinetics and Pharmacodynamics of drug: Drug absorption, distribution, metabolism, elimination and toxicity, drug metabolism, biotransformation, Drug receptor interactions, Hansch Equation and significance of terms involved in it. **[6 L]**

Section II: [24 L + 6 T]

1. Structure and activity Relationship: QSAR, Applications of SAR and QSAR in drug design, physio-chemical parameters lipophilicity, partition coefficient, electronic ionization constant, Case Study: Statins **[10 L]**
2. Introduction, Developments, SAR, Mode of action, limitations and adverse effect of Anti-infective Agents, Beta lactam antibacterial agents (Penicillins, Cephalosporins), Tetracyclins, Macrolides, Chloramphenicol, Polyenes, Amphotrecin-B, Azoles, Amantadine,Acyclovir, Quinine, Quinolines, Quinolones, Refamycine, Sulphonamides [**14 L]**

References:

1. Medicinal Chemistry and Drug Discovery by Burger
2. Introduction to Medicinal Chemistry by Grham and Patrick
3. Introduction to Drug Design by J. R. Dimmock and S.S. Pandeya
4. The Organic Chemistry of Drug Design and Drug Action, 3rd Edition, R. B. Silverman, Academic Press, 2014
5. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry, Ed Robert F Dorge, 12th Edition, 2010
6. Chemistry of Heterocycles by T. Eicher and S. Hauptmann, Thieme

CBOP-4, CHO-452(B): Applied Organic Chemistry [48 L + 12T]

Section-I: [24 L + 6 T]

1. Covalent Organic Frameworks: Structures, Synthesis, and Applications. [12 L]
(Ref: Review article by Maria S. Lohse and Thomas Bein ***Adv. Funct. Mater***. 2018, 28(33), 1705553.)

2. Organic Electroluminescent Materials, [12 L]
(Ref: Review article by L.S. Hunga and C. H. Chen ***Materials Science and Engineering*** 2002, R 39, 143–222)

Section –II : [24 L + 6 T]

1. Supramolecular Organic Compounds [8 L]

(Ref: Review by Matthew C. T. Fyfe and J. Fraser Stoddart ***Accounts of Chemical*** *Research* 1997, 30 (10), 393-401.)

(Ref: Review article by Wei Chen and et al. ***Chem. Soc. Rev.***, **2015**, *44*, 2998-3022)

2. Single Molecule Switches [8 L]

(Refs: Review article by Wei Chen and et al. ***Chem. Soc. Rev.***, **2015**, *44*, 2998-3022.)

2. Molecular Machines [8 L]
(**References:**

1. Review article by David A. Leigh and et al. *Chem. Rev.* 2015, *115*, 10081−10206.
2. Redox-Gated Tristable Molecular Brakes of Geared Rotation. *J. Org. Chem.*, 2017, 82(10), 5354-5366.
3. Massimo Baroncini, Serena Silvi, Alberto Credi. *Chem. Rev.* 2020, *120* (1), 200-268).

References:

1. The Chemistry of Metal–Organic Frameworks- Wiley Online. Print ISBN: 9783527338740, Online ISBN:9783527693078, DOI:10.1002/9783527693078
2. Covalent Organic Frameworks - 1st Edition - Atsushi Nagai, ISBN 9789814800877, Published January 24, 2020 by Jenny Stanford Publishing.

CBOP-5, CHO-453: Practical-III: Select ANY TWO Section I, II and III [96 L + 24 T]

Section-I: Ternary Mixture Separation [48 L + 12 T]

Separation of minimum 12 mixtures containing three components. The mixtures should also involve separation of nitrophenols, amino acids, low boiling and water soluble and insoluble compounds solids and liquids with **multifunctional groups**. The mixture separation should be carried out on micro-scale using ether or water.

The students should be able to

1. Understand and employ concept of type determination and separation
2. Meticulously record physical constants
3. Perform micro scale chemical elemental analysis
4. Perform qualitative estimation of functional groups
5. Recrystallize /distill the separated compounds
6. Extend these skills to organic synthesis

Section-II: Carbohydrates Synthesis and Isolation Natural Products [48 L + 12 T]

Unit I: Carbohydrate Synthesis (Any 3)

1) Synthesis and structural determination of α- and β-D-glucose penta- acetate.
2) Selective deacylation of α- and β-D-glucose penta-acetate.
3) Benzoylation of D-glucose.to D-glucose penta-benzoate.
4) Selective debenzoylation of D-glucose penta-benzoate
5) Synthesis 1,2:5,6-di-O-isopropylene-D-glucofuranose.
6) Synthesis of 1,2: 5,6 – di-O-isopropylene-3-O-benzyl –D-glucofuranose.

Note:

Carbohydrate (sugar molecules) are highly soluble in water, to derivatives the sugar molecules require special practical skill in order to get product in hand.

i) To understand the meaning of dry condition in reaction.
ii) How to prepare dry solvents.
iii) Workup of reaction in minimum quantity of water.
iv) To acquire skill in handling of carbohydrates reaction.

Unit II: Isolation of pigments from the natural products (Any 3)

1. Orange Marigold
2. Rose
3. Sunflower
4. Hibiscus
5. Any colored flowers/fruits available in the local area **(only one is allowed).**

Note: Students should be able to collect reasonable quantities of color pigments to do the characterization (Physical Constant, Elemental analysis functional group test etc) and should also form the appropriate derivative. They are encouraged to use these pigments for developing food grade natural colors from lesser known plant sources.

Unit III: Isolation of essential oils from the natural products (Any 3)

1. Ginger
2. Lemongrass
3. Garlic
4. Ajwain/ajowan/Trachyspermum ammi
5. Vekhand (achourus calamus) root

6. Any natural products available in the local area **(only one is allowed)**

Note: Students should be able to collect a reasonable quantities of essential oils to do the characterization(Physical Constant, Density, Elemental analysis functional group test) Should form the appropriate derivative. They are encouraged to use these essential oils for the development of the products like soap, perfumes etc.

Unit IV: Isolation of medicinally important component from the natural products (Any 3)

1. Nimbin from Neem leave
2. Amyrin from Apati/Apta bark
3. Eujenol from Tulsi leaves
4. D-Galacturonic Acid from Jeshtamadh
5. Piper from Betel leaf
6. Any medicinally important plants available in the local area **(only one is allowed)**

At least one natural product should be isolated by using column chromatographic techniques (Use micro columns to avoid excess use of solvents)

Note: Students should be able to collect a reasonable quantities natural products to do the characterization (Physical Constant, solubility, Elemental analysis functional group test etc) and should also form the appropriate derivative. They are encouraged to study novel medicinal plants from their local area.

References for Carbohydrates:

1. Essentials of Carbohydrate and Chemistry and Biology: Thisbe K. Lindhorst, WILEY-VCH, 2000.
2. Kawanata , K. P. R. Tretrahedron Lett. 1986, 27, 3415.
3. Bessodes, M., Shamszar, J. Antonakies, K., Synthesis, 1988, 560.

Section-III: Project [48 L + 12 T]

Project/ Industrial Training/Summer Training/ Internships

1. Students should carry out a small research project.
2. This should make them familiar with
   i. Literature survey, research methodologies
   ii. Data Analysis
   iii. Column and TLC chromatographic techniques
   iv. Characterization of the products by analytical and spectral methods.
3. **Project report must be written and submitted in a proper format as follows;**
   i) Certificate (Signed by Project guide and Head of the Department)
   ii) Certificates for Poster/Paper presented in conferences (if any)
   iii) Self declaration certificate for plagiarism
   iv) Introduction (not more than 6 pages)
   v) Results and Discussions
   vi) Experimental Section
   vii) Conclusion
   viii) References (Use ACS format)
   ix) Spectroscopic or other relevant supporting data
   x) Acknowledgement
4. Interdisciplinary projects shall be encouraged; however there **must be some organic chemistry component**.
5. Students should spend enough time for the project works (**at least** 4 hours per week for **15 weeks**)
6. At least 30% students should undertake projects/summer training/Internships etc.
7. If student is performing project in another institute, for such a student, internal mentor must be allotted and he will be responsible for internal assessment of a student. In this

case student has to obtain certificate from both external and internal mentor. ***Systematic record of attendance of project students must be maintained by a mentor.*** Project will be evaluated jointly by three examiners and there will not be any practical performance during the examination. Typically, student has to present his practical work, discuss results and conclusions in details (20-30 min.) which will be followed by question-answer session (10 min). It is open type of examination.

CCPP-04, CHO-454: Practical-II: Convergent and Divergent Organic Syntheses [96 L + 24T]

Note: Any **3 sets** should be conducted from the following convergent and divergent synthesis sets.

Students should acquire **pre-experiment** (Reading MSDS, purification of reactants and reagents, mechanism, stoichiometry etc) and **post-experiment skills** (work-up, isolation and purification of products, physical constants characterization using any spectroscopic methods etc.)

SET-I

A) Convergent Synthesis 1 (Three Stage Synthesis)

1. Stage I: Anisole to 4-nitro anisole to 4-amino anisole (2 steps)
2. Stage II: Toluene to 4-nitro toluene to 3-acyl nitro toluene (2 steps)
3. Stage III: Synthesis of N-(1-(2-methyl-5-nitrophenyl) ethyl) aniline from 4-amino anisole, 3-acyl nitro toluene and SBH (One pot synthesis: MCR)

B) Divergent Synthesis 1 (5 Single Stage Synthesis from Acetyl acetone):

1. Acetyl acetone to Pyrimidine
2. Acetyl acetone to 2,4-dimethyl-1H-benzo[b][1,4]diazepine
3. Acetyl acetone to Pyrazole
4. Acetyl acetone with 1mmol benzaldehyde to 3-benzylidenepentane-2,4-dione
5. Acetyl acetone with 3 mmol benzaldehyde into 3-benzylidene-6-phenylhex-5-ene-2,4-dione

SET-II

A). Convergent Synthesis 2(Three Stage Synthesis)

1. Stage I: 4-Nitro toluene to 4-amino toluene (Reduction by using Sn/HCl)
2. Stage II: Phenol into 2-hydroxy benzaldehyde (Reimer-Tiemann reaction)
3. Stage III: Synthesis of amidoalkyl-2-naphthols from β-Naphthol,4-amino toluene and of 2-hydroxy benzaldehyde (One pot synthesis: MCR)

B). Divergent Synthesis (5 Single Stage Synthesis from β-Naphthol)

1. β-Naphthol to Synthetic dye (By diazonium coupling)
2. β-Naphthol to 6-Bromo-2-naphthol (Bromination reaction)
3. β-Naphthol to β-Naphthyl methyl ether (Methylation reaction)
4. β-Naphthol to temperature dependent sulfonation (Sulfonation reaction)
5. β-Naphthol to (±) Binol then Resolution of Binol (Resolution technique)

SET-III

A). Convergent Synthesis-3 (Three Stage Synthesis)

1. Stage I: Salicylic acid to 5-Chloro-2-hydroxybenzoic acid
2. Stage II: o- Anisidine to 2-methoxy-4-nitroaniline
3. Stage III: Synthesis of 5-chloro-2-hydroxy-N-(2-methoxy-4-nitrophenyl) benzamide from 5-Chloro-2-hydroxybenzoic acid, -methoxy-4-nitroaniline (One pot synthesis: MCR)

B). Divergent Synthesis-3 (5 Single Stage Synthesis from Salysaldehyde)

1. Salicylaldehyde to Salicylaldehyde phenylhydrazone
2. Salicylaldehyde with melanonitrile to 2-iminochromene by intramolecular cyclization.
3. Salicylaldehyde to 2-hydroxy-3,5-dinitrobenzaldehyde

4. Salicylaldehyde to o-Formylphenoxy acetic acid
5. Salicylaldehyde to catechol

SET-IV

A) Convergent Synthesis- 4 (Three Stage Synthesis)

1. Stage I: Benzene to actophenone (F.C acylation)
2. Stage II: 4-Nitrochlorobenzene into 4-amino chlorobenzene (Reduction by using hydrazine)
3. Stage III: Quinoline synthesis by using acetophenone, 4-amino chloro benzene and styrene (One pot synthesis: [3 + 2 + 1] cycloaddition reaction)

B). Divergent Synthesis-4 (5 Single Stage Synthesis from Acetophenone)

1. Acetophenone to Ethyl benzene by Wolf Kishner reduction
2. Acetophenone to m-Nitro acetophenone by nitration
3. Acetophenone to Chalcone using aromatic aldehyde
4. Acetophenone into Schiff base using aromatic amine
5. Acetophenone to Benzoic acid and Iodoform

References

1. Practical organic chemistry by Mann and Saunders
2. Text book of practical organic chemistry –by Vogel
3. The synthesis, identification of organic compounds –Ralph L. Shriner, Christine K.F.
4. Hermann, Terence C. Morrill and David Y. Curtin

Important Notes for Practical Courses

- All experiments should be carried out on micro-scale and by considering stoichiometric quantities of reactants and reagents with the proper understanding of the mechanism.
- Post graduate departments should arrange at least **one study visit to relevant industry/national research laboratory/premier academic institute**.
- Students must read MSDS and should handle chemicals and reactions accordingly.
- The necessary reactions should be carried out in fume hood and appropriate safety measures should be taken during the laboratory experiments and projects.
- All reactions should be **monitored using alumina coated TLC plates**.
- Certified journals should be presented at the time of final examination.
- Students opting for the projects are encouraged to participate in AVISHKAR, national and international conferences and other project competitions.
- Teachers are encouraged to give the project ideas based on the societal needs.

4. M. Sc. (II) Drug Chemistry
Course Structure

Sr. No.	Paper No.	Course Name	Credit
		Semester – III	
1	CCTP-7 CHD-360	Advanced Analytical Methods	4
2	CCTP-8 CHD-361	Drug Discovery and Development	4
3	CCTP-9 CHD-362	Stereochemical Principles and Applications	4
4	CBOP-3 Theory CHD-363	CHD-363(A) Chemistry of Heterocycles and Biologically active Molecules	4
		CHD-363(B): Any two sections	4
		Sec-I: Microbilogy,Immunogy Sec-II: Bioinformatics, Biostatistics in Drug Discovery Sec-III: Enterpreneurship Development	2 2 2
5	CCPP-3 CHD- 364	**Practical-I**: Two Stage Preparation	4
		Semester-IV	
6	CCTP-10 CHD-460	Advanced Medicinal Chemistry	4
7	CCTP-11 CHD-461	Drug Design	4
8	CBOP-4 Theory CHD-462	CHD-462(A) Advanced Synthetic Methods in Chemistry **OR** CHD-462(B) Supramolecular, Green Chemistry and Forensic chemistry	4 4
9	CBOP-5 Practical CHD-463	**Practical-III: Select any two sections from I, II, III, IV** Section-I: Microbiology, Drug Chemistry Section-II: Practical For Forensic Chemistry Section-III: Ternary Mixture Separation Section-IV: Project / Industrial Training	4
10	CCPP-4 CHD- 464	**Practical-II**: Synthesis of Heterocycles and Drug Molecules	4

Equivalence to Previous Syllabus

New Syllabus 2019 pattern		Old Syllabus 2014 syllabus	
CCTP-7 CHD-360	Advanced Analytical Methods	**CHD-362**	Advanced Analytical Methods
CCTP-8 CHD - 361	Drug Discovery and Development	**CHD-363**	Microbiology, Immunology & Drug Discovery and Development
CCTP-9 CHD -362	Stereochemical Principles and Applications	**CHD-364**	Stereochemistry, Assymetric synthesis and Pericyclic Reactions
CBOP-3 Theory CHD-363	A)Chemistry of Heterocycles and Biologically active Molecules	**CHD-361**	Chemistry of Heterocycles and Drug Synthesis
	B-I) Microbiology, Immunology		No Equivalence
	B-II) Bioinformatics, Biostatistics in Drug Discovery		No Equivalence
	B-III) Entrepreneurship Development,		No Equivalence
CCPP –3 CHD - 364	**Practical-I**: Two Stage Preparation	**CHD- 367**	Practical Course I Organic Synthesis
CCTP –10 CHD - 460	Advanced Medicinal Chemistry	**CHD- 462**	Advanced Medicinal Chemistry
CCTP –11 CHD - 461	Drug Design	**CHD- 463**	Principles and applications in Drug Design
CBOP-4 Theory CHD-462	A) Advanced Synthetic Methods in Chemistry	**CHD- 461**	Advanced Organic Synthesis- Principles and Strategies
	B) Supramolecular, Green Chemistry and Forensic Chemistry		No Equivalence
CBOP-5 Practical CHD-463	**Practical-III:** I) Microbiology, Biochemistry	**CHD- 468**	Practical Course II Microbiology and Biochemistry
	II) Practical on Forensic Chemistry		No Equivalence
	III) Ternary Mixture Separation		No Equivalence
	IV) Project / Industrial Training	**CHD- 469**	Practical Course III Project /Industrial training
CCPP – 4 CHD - 464	**Practical-II:** Synthesis of Heterocycles and Drug Molecules	**CHD- 469**	Practical Course III Project /Industrial training / Advanced practical

The detailed course wise syllabus of M. Sc-II Drug Chemistry is as follows:

Semester-III

CCTP-7, CHD-360: Advanced Analytical Methods [48L + 12T]

SECTION I: Spectroscopy-I [24 L +6 T]

1. ^{1}H NMR Spectroscopy [14 L]

Recapitulation: shielding and deshielding, Chemical shift, factors influencing chemical shift, Chemical and magnetic shift equivalence. **Chemical shift(δ):** correlation for protons bonded to carbons (aliphatic, olefinic, aldehydic, aromatic) and other nuclei (oxygen and nitrogen);

Spin-spin splitting: (n+1) rule, origin of spin-spin splitting, pascal triangle. **Coupling Constant (J):** Mechanism of coupling, Type (Geminal, vicinal coupling, long range and W coupling), factors effecting geminal and vicinal coupling constant; **Spin System:** classification of spin system, spin notations (A_2, AB, AX, AB_2, AX_2, ABC, ABX, AMX, A_2B_2, A_2X_2), complex spin-spin interaction between two, three and four nuclei (First Order Spectra and Second order spectra); **Simplification of complex spectra:** nuclear magnetic double resonance, spin decoupling, contact shift reagents, solvent effects, chiral resolving agent, nuclear overhauser effect (NOE), resonance of other nuclei like ^{31}P, ^{19}F.Problems and Assignment of PMR signal

2. ^{13}C NMR spectroscopy [10 L]

Recapitulation: ^{13}C Nucleus, Chemical Shift and factor affecting ^{13}C NMR, **Types of ^{13}C NMR Spectra:** proton coupled (spin-spin splitting), Proton decoupled, Off resonance, **Pulse sequence:** spin and magnetization vector, DEPT, APT and NOE, **Coupling constants:** Homo nuclear (^{13}C-^{13}C) and Hetero nuclear (^{13}C-^{1}H, ^{13}C-^{19}F, ^{13}C-^{31}P).Problems and Assignment of ^{13}C NMR signal

SECTION II: Spectroscopy-II [24 L +6 T]

3. Correlation Spectrometry; 2D NMR [04 L]

Pulse sequence in 1 D and 2 D spectra, type of 2D (Homo and Hetero nuclear); **2D in structure determination:** ^{1}H- ^{1}H Correlation spectroscopy (COSY), Double Quantum Filtered COSY (^{1}H-^{1}H), Heteronuclear Correlation (HETCOR, HMQC and HMBC); **Applications:** INADEQUATE, Totally correlated spectroscopy (TOCSY), NOESY and ROESY experiments.

4. Mass Spectrometry [10 L]

Instrumentation, various methods of ionization: Gas phase ionization (electron impact and Chemical) Desorption ionization (field desorption, FAB, Plasma, Laser), Evaporative ionization (Thermospray and Electrospray mass spectrometry); Detectors: Quadrupole mass filter, time of flight (TOF). **EI mass spectra interpretation:** intensity of molecular ion peak, base peak, fragment ion peak and isotope peak (M+1, M+2); Nitrogen Rule, Molecular formula determination (Rule of 13). Fragmentation Pattern and McLafferty rearrangement.**Fragmentation of functional groups:** Hydrocarbons, Ether, Aldehyde, Ketone, Carboxylic Acid, Ester, Amide, Sulfur and halogen compound.

5. Problems based on joint application of UV, IR, PMR, CMR, Mass and 2-D NMR. [**10 L]**

References

1. Introduction to Spectroscopy – D. L. Pavia, G.M. Lampman, G. S. Kriz, 3rd Ed. (Harcourtcollege publishers).
2. Spectrometric identification of organic compounds R. M. Silverstein, F. X. Webster, 7th Ed. John Wiley and Sons.
3. Spectroscopic methods in organic chemistry – D. H. Williams and I. Flemming Mc Graw Hill

4. Absorption spectroscopy of organic molecules – V. M. Parikh
5. Nuclear Magnetic Resonance – Basic Principles- Atta-Ur-Rehman, Springer-Verlag (1986).
6. One- and two-dimensional NMR Spectroscopy – Atta-Ur-Rehman, Elsevier (1989).
7. Organic structure Analysis- Phillip Crews, Rodriguez, Jaspars, Oxford University Press (1998)
8. Organic structural Spectroscopy- Joseph B.Lambert, Shurvell, Lightner, Cooks, Prentice-Hall (1998).
9. Organic structures from spectra –Field L.D., Kalman J.R. and Sternhell S. 4th Ed. John Wiley and sons Ltd.
10. Spectroscopic identification of organic compound- R M Silverstein, G C Bassler and T CMorril, John Wiley
11. Introduction to NMR spectroscopy-R J Abrahm, J Fisher and P loftus Wiley
12. Organic spectroscopy-William kemp, E L B with McMillan
13. Spectroscopy of organic molecule-PS Kalsi,Wiley, Esterna, New Delhi
14. Organic spectroscopy-RT Morrison and RN Boyd
15. Practical NMR spectroscopy-ML Martin, J J Delpench, and D J Martyin
16. Spectroscopic methods in organic chemistry-D H Willson, I Fleming
17. Spectroscopy in organic chemistry- C N R Rao and J R Ferraro
18. NMR –Basic principle and application-H Guntur
19. Interpretation of NMR spectra-Roy H Bible
20. Mass spectrometry organic chemical applications, J H Banyon

Learning Outcome

1. Understand the principle, working and application of Nuclear magnetic resonance spectroscopy.
2. Understand the use of coupling constant values in structure determination.
3. Understand the principle, working and application of Mass spectrometry.
4. Understand the structure elucidation using combined spectroscopic data.

CCTP-8, CHD-361: Drug Discovery and Development [48L + 12T]

SECTION-I: Drug Discovery [24 L +6 T]

1. Introduction to drugs, History and classification, their action and discovery **[2L]**
2. Drug targets- lipids, carbohydrates, proteins, and nucleic acids [**4L]**
3. Sources of drugs, Microbial, Plant, Marine, synthetic, A historical perspective. **[4L]**
4. Introduction to the different systems of medicines-Ayurveda, Allopathy, Unani and Homeopathy **[6L]**
5. Routes of drug administration, formulation of Dosage forms, Types of dosage forms [**8L]**

SECTION-II: Drug Development [24 L +6 T]

1. **Discovery and Development of Drugs [8L]**
   History of drug discovery, Strategies in drug discovery, lead discovery, pharmacophore identification, lead development, Bioassays, screening of compounds.
2. **Toxicological evaluation of new drugs [8L]**
   Pre-Clinical testing, Clinical trials, Bioavailabability of drugs, Bioequivalence
3. **Patents and intellectual property rights [4L]**
4. **Pharmacokinetics and Pharmacodynamics of drug action [4L]**
   From R & D to plant, QA, QC scale up process. GMP, FDA Documentation, Pharmacopeia, Industrial hygiene and safety

References

1. Medicinal Chemistry an Introduction-Gareth Thomas 2nd Ed. Wiley
2. An introduction to medicinal chemistry-Graham L. Patrick 5th Ed. Oxford

3. Introduction to Medicinal Chemistry-Alex Gringauz (Wiley)
4. Comprehensive Medicinal Chemistry Vol-I (Hansch (1990) Pergamon press
5. Principle of Drug action-Goldstein.
6. Bioavailabinty and Bio equivalence-H.P.Tinis.
7. Pharmacoepia of India, British pharmecoepia, US Pharmacoepia
8. Pharmaceutical Dosage forms and Drug Delivery system VIthEdn. .Arnel (Wessl
9. Organic Chemistry of Drug Design and Drug Action. R.B.Silverman (1993) Academic Press

Learning Outcomes:-

1. Student should understand the various systems of medicines.
2. To understand concept of drug and different sources of drugs.
3. Student should able to learn lead discovery and pharmacophore identification.
4. To know about bioassays and toxicological evaluation of new drugs.
5. Student should understand the pre-clinical testing and clinical trials.
6. Student should able to understand the concept of Patents and intellectual property rights.
7. To know about Pharmacokinetics and Pharmacodynamics of drug action.
8. Student should able to understand the different dosage forms of drugs.

CCTP-9, CHD-362: Stereochemical Principles and Applications [48L + 12T]

SECTION - I Stereochemistry [24 L +6 T]

1. Stereochemistry of six membered rings-
Relation to physical properties, conformation and chemical reactivity, conformational effects in six membered rings containing unsaturation. **[8L]**

2. The shapes of rings other than six membered rings: five membered, medium rings, transannular effects, concept of I strain – **[6L]**

3. Fused rings and bridged rings **[6L]**

4. Stereochemistry of Drug molecules
Saquinavir (HIV protease inhibitor), Abiraterone (drug for prostate cancer), ephedrine and pseudoephedrine, *R- and S-enantiomers of* Ibuprofen (non-steroidal anti-inflammatory), *R- and S-enantiomers of thalidomide.* **[4L]**

SECTION II: Principles and Applications of Asymmetric Synthesis [24 L +6 T]

1. Principles and applications of asymmetric synthesis:
Stereoselectivity in cyclic compounds, enantio-selectivity, diastereo-selectivity, enatiomeric and diastereomeric excess, stereoselective aldol reactions. Cram's rule,Felkin Anh rule, Cram's chelate model, Asymmetric synthesis, use of chiral auxiliaries,chiral reagents and catalysts, asymmetric hydrogenation, asymmetric epoxidation andasymmetric dihydroxylation. Synthetic and Industrial applications. **[18L]**

2 Racemization and Resolution methods **[04L]**

3. Stereochemistry of a polymer chain – Types and examples of Tacticity **[02 L]**

References:

1. Stereochemistry of carbon compound-by E.L. Eliel
2. Stereochemistry of organic compound-by Nasipuri
3. Stereochemistry of carbon compounds – E. L. Eliel and S. H. Wilen
4. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers,
5.Topics in Stereochemistry (Volume 2) By Norman L. Allinger and Ernest L. Eliel
6. Stereochemistry of organic compounds-P. S. Kalsi
7. Organic stereochemistry – Jagdamba Singh

Learning Outcome:
On the successful completion of the course, students will be able to:
1. Understand the stereochemistry, reactivity and conformational effects of six membered rings.
2. Understand the stereochemistry, shapes of rings other than six membered rings.
3. Understand the role various resolution methods, stereoselective synthesis and asymmetric synthesis.
4. Understand the stereochemistry of polymer chain.

CBOP-3, CHD-363(A) : Chemistry of Heterocycles and Biologically active Molecules

OR

CBOP-3, CHD-363(B) : Any two section from I, II, III

Section-I : Immunology and Microbiology.
Section-II : Bioinformatics, Biostatistics in Drug Discovery
Section-III: Entrepreneurship Development

CBOP-3, CHD-363(A) - Chemistry of Heterocycles and Biologically active Molecules [48L + 12T]

Section-I: Chemistry of Heterocycles [24 L + 6 T]

1. **Condensed five membered heterocycles**: Indole, Benzofuran and Benzothiophene- Nomenclature, reactivity, synthesis and reactions. **[6L]**
2. **Condensed six membered heterocycles:** Quinoline, Isoquinoline, Coumarines and Chromones- Nomenclature, reactivity, synthesis and reactions. **[6L]**
3. **Five membered, condensed five member**, **six membered and condensed six membered heterocycles with more than one heteroatom-** Oxazole, imidazole, Thiazole, 50ydrazine, pyrazole, isothiazole, triazole (1,2,3-triazole, 1,2,4-triazole), pyrimidine, pyrazine, oxazine, thiazine, benzimidazole, benzoxazole, benzthiazole Nomenclature, reactivity, synthesis and reactions. **[12L]**

Section-II: Chemistry of Biologically Active Natural And Synthetic Molecules [24 L +6 T]

1. Synthesis of biologically active natural products: Prostoglandin PGF_2, Cephalosporin–C, Reserpine, Taxol, Periplanone B, Aspidophytine Penicillin, Griseofulvin. **[12L]**
2. Synthetic Drugs and their derivatives: Nalidixic acid, metronidazole, Ciprofloxacin, Ibuprofen, Atenolol, Captopril, Diazepam, Chloroquine, Barbiturates, pyrazinamide, Miconazole, Omeprazole, Astemizole, Orcanozole,lomustine, carmustine, procarbazine, Ranitidine. **[12L]**

Learning Outcomes
1. Knowledge of name reactions in synthesis
2. Different application of name reactions
3. Drug molecule and their uses in treatment
4. Synthetic strategy involved in preparation
5. Recent drug developments

References
1. John A. Joule, Keith Mills.; Heterocyclic Chemistry, 5thEdition, April 2010, ©2010, WileyBlackwell, ISBN: 978-1-4051-3300-5.
2. Gilchrist, T. L. Heterocyclic chemistry; 3rd ed.; Addison Wesley Longman: Edinburgh Gate
3. Joule, J. A.; Mills, K.; Heterocyclic chemistry; 4th ed.; Blackwell Science: Oxford, 2000.
4. An Introduction to Medicinal chemistry: Graham, Patric third edition
5. Classics in total synthesis- More target, Strategies, methods-Nicolaou- Snyder, (Wiley-VCH)
6. The organic Chemistry of drug synthesis-Daniel Lednicer, Lester A. Mitscher (Wiley and

Sons) vol-3

7. Classics in Total Synthesis- Target, Strategy, methods-Nicolaou- Sorensen, (Wiley-VCH)

CBOP-3, CHD – 363(B): Any two section from I, II, III

Section-I: Immunology and Microbiology.
Section-II: Bioinformatics, Biostatistics in Drug Discovery
Section-III: Entrepreneurship Development

Section-I: Immunology and Microbiology. [24 L +6 T]

1. Microbial Drug Development [12L]

Introduction to Microbiology and classification of Microbes. Screening of Microbes fermentation process, concept of primary and secondary screening, characterization of ideal industrial strains, Microbia1growth, kinetics, Isolation and Improvement of Individual micro- organism, fermenter designing, Media designing, antimicrobial assays; Down Stream process and effluent treatment (Microbial and Chemical)

2. Immunology and Immunopharmacology [12L]

Overview of the immune system and its role, three lines of defence, Types of immunity – active, passive, cell mediated and humoral immunity. Antigen and antibody, organs of immune system (Primary and secondary). Adaptive and innate Immunity. Immune response and the underlying mechanisms, Hypersensitivity, immunodeficiency, Autoimmunnity, Immunzation, Immunosuppresants, Immunomodulators, Immunological techniques – Agglutination reaction (Haemogluttination, bacterial agglutination), Precipitation reaction (single and double Immunodiffusion), Diagnostic techniques – ELISA, RIA, FACS

References:

1. Principles of Medicinal Chemistry including Proteomics S. Rangnathan& Jerad Suresh 2011 CBS press
2. Statistical Methods in Biology-Norman Bailey (1995) Cambridge
3. Molecular Modeling, Principles and applications -Andrew Leach (Longman) 1998.
4. Comprehensive Medicinal Chemistry vol.4 Corwin Hansch (1990) pergaman press.
5. Organic Chemistry of drug design and drug action-RB. Silverman 2nd Ed. (2004) Elsevier
6. Basic and Chemical Immunology-Stites (1987) Prentice Hall.

Learning Outcomes: Students will

1. Understand recent trends in drug development
2. Learn various biological databases and their applications
3. Learn applications of bioinformatics and chemoinformatics
4. Learn applications of biostatistics

SECTION-II: Bioinformatics, Biostatistics [24 L +6 T]

1. Bioinformatics: Introduction to biological databases, types of databases, Information retrevial from biological databases. Gene prediction programs, promoter and regulatory elements prediction programs. Structural bioinformatics, Phylogenetics and structural bioinformatics. Elements of genomics, transcriptomics proteomoics and metabolomics and applications Elements of Cheminformatics: Representation of molecular structure, graphs connection tables, linear notations, canonical representations. Structure and substructure searching algorithms. Reaction databases, representation of patents and patent databases. Relational databases for molecules. Use of Chembioinformatics in drug designing with case studies. **[12 L]**

2. Biostatistics: Fundamentals of statistics, various statistical parameters, statistical tests, use of statistics in drug discovery and development and in clinical trials **[12 L]**

References

1. Principles of Medicinal Chemistry including Proteomics S. Rangnathan& Jerad Suresh 2011 CBS press
2. Statistical Methods in Biology-Norman Bailey(1995) Cambridge
3. Molecular Modeling, Principles and applications -Andrew Leach (Longman) 1998.
4. Comprehensive Medicinal Chemistry vol.4 Corwin Hansch(1990) pergaman press.
5. Organic Chemistry of drug design and drug action-RB. Silverman 2nd Ed. (2004) Elsevier

Learning Outcomes:

Students will learn

1. Understand recent trends in drug development
2. Learn various biological databases and their applications
3. Learn applications of bioinformatics and chemoinformatics
4. Learn applications of biostatistics

SECTION III: Entrepreneurship Development [24 L +6 T]

1. Fundaments of Entrepreneurship Development:

Concept and need of Entrepreneurship, Development and Definition of Entrepreneurship, Entrepreneurship, Innovation, Invention, Creativity, Business, Idea, Opportunities, through change, Concept of Entrepreneurship, Manager, Entrepreneur/ cooperate, Entrepreneur-comparative study-Roles, Responsibilities, Career opportunity, Entrepreneurship as a carrier, Entrepreneurship as style of management, The changing role of Entrepreneur: mid career dilemmas, -Closing the window; Sustaining competitive-Maintaining competitive advantages. **[6L]**

2. Theory of Entrepreneurship:

a. Innovation Theory by Schumpeter & Imitating
b. Theory of High Achievement by McClelland
c. X-Efficiency Theory by Leibenstein
d. Theory of profit by Knight
e. Theory of Social change by Everett Hagen [**6L]**

3. Influence of Entrepreneurship devlopment:

a. Entrepreneur Triaits, b. External influence on Entrepreneurship Development: Socio-cultural , political, Economical, Personel, Entrepreneurial culture with special reference to Entrepreneurship, Corporate Entrepreneurship c. Entrepreneurial Success and failure: Reasons and Remedies **[6L]**

4. Business planning process:

The business plan as Entrepreneurial tool, Element of Business plan, Objectives, market Analysis, Development of product /idea, Marketing Finance, Organization & Management, Ownership, Critical risk, contingencies of the proposal, Scheduling and Milestones. [**6L]**

References

1. Entrepreneurship –Robert D Hisrich, Michael P, Peters, Dean A Shepherd
2. Entrepreneurship as strategy –G, Dale Meyer,kurt A. Heppard
3. Project Manegment: K. Nagarajan
4. The Culture of Entrepreneurship-Brigitte Berger
5. Entrepreneurship: New venture Creation –David H Holt

Learning Outcomes: Students will learn

1. Understand aspects of entrepreneurship development
2. Innovation and creativity
3. Development of an idea in marketing and finance
4. Entrepreneurship success and failure

CCPP-3, CHD – 364: Practical-I: Two Stage Preparation [96L + 24T]

At least eight two stage heterocyclic preparations from the following should be carried out. The preparations should be carried out on micro scale

1. Benzaldehyde → Benzalacetophenone → Epoxide
2. 4-Nitro toluene → 4-nitro benzoic acid → 4-Amino benzoic acid
3. Resorcinol → 4-methyl-7-hydroxy coumarin → 4-Methyl-7-acetoxy coumarin
4. Cyclohexanone → Phenyl 53ydrazine→ 1,2,3,4-tetrahydrocarbazole
5. Hydroquinone → Hydroquinone diacetate → 1,2,4-Triacetoxy benzene
6. Acetanilide → p-Acetamidobenzene sulphonyl chloride → P. acetamidobenzene sulphonamide
7. p-Amino phenol → p-acetyl amino phenol → p-Ethoxy acetanilide
8. Cyclohexanol from cyclohexanone (LAH reduction)
9. p-Cresol → p-Cresyl benzoate → 2-Hydroxy-5-methyl benzophenone
10. Phthalimide → N-benzylphthalimide → benzylamine
11. Grignard Reaction
12. Phthalic acid → phthalimide → Anthranilic acid
13. Benzyl cyanide→ p-Nitrobenzyl cyanide→p-Nitro phenyl acetic acid
14. Hydroquinone → Hydroquinone diacetate → 2,5-dihydroxy acetopheneone
15. Cyclohexanone→ Enamine→2-acetyl cyclohexanone
16. α-Pinene→ Disiamyl borane→Pinanol
17. Benzoin ⟶Desylbenzoate ⟶2,4,5-triphenyl Oxazole
18. Phenylacetate ⟶O-Hydroxyacetophenone⟶Chromone -2-carboxylic acid

References

1. Practical organic chemistry by Mann and Saunders
2. Text book of practical organic chemistry –by Vogel
3. The synthesis, identification of organic compounds –Ralph L. Shriner, Christine K.F. Hermann, Terence C. Morrill and David Y. Curtin

Learning Outcomes: Students will

1. Understand different name reactions
2. Learn monitoring of reactions
3. Be able to purify and characterize the reaction products

Semester-IV

CCTP-10, CHD-460: Advanced Medicinal Chemistry [48L + 12T]

SECTION I : [24 L +6 T]

1. Antimicrobial therapy -Development and mechanism of action for Penicillins, Cephalosporins.and Quinolones. An Overview of Aminoglycosides, Macrolides, Tetracyclines, Sulfa drugs. Peptides and polyene antibiotics. [**10L]**
2. Antifungals, Antiviral, Antimalarial, Antimycobacterials [**8L]**
3. Cancer and its Chemotherapy, including developments in Immunotherapy [**6L]**

SECTION II: [24 L +6 T]

1. Cardiovascular system and its disorders: Hypertension, Heart Failure, AnginaPectoris, Arrythmia, Myocardial Infarction, Ischaemic heart diseases, Stroke. Management ofthese disorders with drugs. [**6L]**
2. Central Nervous System, CNS disorders, A study of antidepresants, Anticonvulsants. [**6L]**
3. Pain, Inflammation, Analgesics, anti- inflammatory agents. **[3L]**
4. Endocrine system and Hormonal therapy. [**4L]**
5. Gastrointestinal tract disorders and Drugs. [**3L]**
6. Diabetis and Management of Diabetis. [**2L]**

References

1. Medicinal Chemistry -Burger vols. I to IV (John Wiley)
2. Principles of Medicinal Chemistry- W.Foye.
3. Comprehensive Medicinal Chemistry -C. Hansch (Pregaman Press).
4. Selective Toxicity –A. Albert (Chapman Hall)
5. Principles of Drug action - A. Goldstein.
6. Organic Chemistry of Drug action and Drug design -LB. Silverman (Elsevier)
7. Physiology and Anatomy- Carolla.
8. Medicinal Chemistry-Biochemical approach, Thomas Nogardy.
9. Essential of pharmacology -K. D. Tripathi.
10. Pharmacology-Hanney
11. Pharmacology-Goodman and Gilman.
12.An introduction to medicinal Chemistry Graham Patrick (Oxford)
13. Introduction to the Principles of Drug design and action. IVth Ed. H.John Smith(Taylor and Francis)2010
14. Introduction to Medicinal chemistry Alex Gringauz (Wiley India)
15.Medicinal Chemistry An introduction II nd Edition. Gareth Thomas (Wiley India)2011
16. Wilson and Gisvolds Textbook of Organic, Medicinal and Pharmaceutical Chemistry 12th Ed. John M beale and John H Block 2011 Lippincott Williams and Wilkins

Learning Outcomes: Students will

1. Understand development of various antibiotics.
2. Understand mode of actions of different antibiotics.
3. Study pharmacokinetics and pharmacodynamics of antibiotics
4. Understand the selective toxicity and side effects of various antibiotics.
5. Will understand diseases caused by various pathogens and their treatment.
6. Will biochemical basis of cancer and different approaches to treat cancer.
7. Will study functioning of systems like CNS, CVS, Gastrointestinal system and endocrine system, coordination among these, systemic diseases and their treatment.

CCTP-11, CHD-461: Drug Design [48 L +12 T]

SECTION I: [24 L +6 T]

1. Membrane and Receptors- Structure, functions and the mechanism of drug action (Receptor Response), Clasifications, types of receptors. GPCR & Ion channels Design of agonist and antagonists as drugs. Receptor theories, Models and their types. Receptors and metabolic disorders imp in drug design. **[10L]**
2. Case studies on drug design from Patricks 5th Ed.2013 [**4L]**
3. Physicochemical principles of Drug action- Drug Receptor interactions, Quantitative 4. Description of physicochemical parameters and their calculation. QSAR, Hanschanalysis, COMFA, COMSIA, Free Wilson Method, Topliss manual and batchwise approach. Craig's models. Current trends. [**5L]**
4. Design of Drugs based on pharmacokinetics, Bio activation and metabolism Pro-drug Design. Design of enzyme inhibitors. [**5L]**

SECTION II: [24 L +6 T]

1. Molecular Biology, Genetic engineering and Biotechnology in production of biological as drugs. Antisense therapeutic agents: design and use of siRNA with examples. An overview of Genomics, Metabolomics, pharmacogenomics and Toxicogenomics etc. [**10L]**
2. Combinatorial Chemistry and high throughput Screening. [**5L]**
3. Computers Aided Drug design: Basic concept of Computational chemistry like Quantum Mechanics, Molecular Mechanics, Force fields, Energy minimization, Conformational

search, Molecular dynamics. Ligand based drug design; Receptor based drug design. Analog approach, pharmacophore mapping. Molecular-modeling, Dock, Autodock and Flexidock etc. Virtual Screening. **[8L]**

4. Current trends in the field of drug discovery and design. **[1L]**

References

1. An Introduction to Medicinal Chemistry- 5th Edn. Patrick(Qxford 2013)
2. Medicinal Chemistry Vol. I Burger.
3. Molecular Modeling, Principles and applications -Andrew Leach (Longman) 1998.
4. Comprehensive Medicinal Chemistry vol.4 Corwin Hansch (1990) Pergaman press.
5. Organic Chemistry of drug design and drug action-RB. Silverman 2nd Ed. (2004) Elsevier
6. A Text book of Drug design and development IInd Edn. Povl.Krogsgaard-Larsen Tommy L. and U Madsen (1996) Harwood Acad. Publishers.
7. Medicinal Chemistry An introduction Gareth Thomas 2nd Edition (Wiley India)
8. Introduction to the Principles of Drug design and action. IVth Ed. H.John Smith (Taylor and Francis)2010

Learning Outcomes:

1. Student should understand the various types of receptors and its superfamilies.
2. To understand concept of Receptor theories.
3. Student should able to understand the Receptors and metabolic disorders important in drug design.
4. To know about signal transduction mechanism of various receptors.
5. Student should understand the physicochemical principles of Drug action.
6. Student should able to understand the concept of Quantitative description of physicochemical parameters and their calculation.
7. To know about Pharmacokinetics and Pharmacodynamics of drug action.
8. Student should able to understand the different dosage forms of drugs.
9. To understand concept of Design of Drugs based on pharmacokinetics.
10. Student should understand the concept of Pro-drug design strategy.
11. Student should know the concept of molecular biology.
12. To know about Computers Aided Drug design.
13. To know about Ligand based drug design and Receptor based drug design.

CBOP-4, CHD-462(A): Advanced Synthetic Methods in Chemistry

OR

CHD-462 (B): Supramolecular, Green Chemistry and Forensic Chemistry

CBOP-4, CHD-462(A): Advanced Synthetic Methods in Chemistry [48L + 12T]

Section-I: Designing of Organic Synthesis [24 L +6 T]

1. Protection and de-protection of hydroxyl, amino, carboxyl, ketone and aldehyde functions as illustrated in the synthesis of polypeptide and polynucleotide **[4L]**
2. Enamines in synthesis **[2L]**
3. Umpolung synthons and reagents in organic synthesis **[4L]**
4. Retrosynthesis **[14L]**

Section-II: Transition metal complexes in synthesis [24 L, 6T]

1. Multi-component reactions: Ugi, Passerini, Biginelli and Mannich reactions **[3L]**
2. Ring formation reactions: Pausan-Khand, Bergman and Nazerov cyclization **[2L]**
3. Transition metal complexes in Organic synthesis. Suzuki, Heck, Sonogashira, Stille, **[3L]**
4. Fukuyama, Kumada, Hiyama, Negishi, Buchwald-Hartwig, Noyori, Reppe, Oxo process **[4L]**
5. Organolithium, Aluminium, Phosphorous and Boranes, Synthetic applications **[6L]**

6. Click chemistry: criterion for click reaction, Sharpless azides cycloadditions [**2L]**
7. Biomimetic synthesis [**2L]**
8. Domino Reactions [**2L]**

References

1. Designing Organic synthesis - S Warren (Wiley Interscience)
2. Organic synthesis through disconnection approach- P. S. Kalsi – 2nd edition
3. Some modern methods of Organic synthesis. W Carruthers (Cambridge)
4. Organic Chemistry -Clayden, Greeves, Warren of wothers (Oxford press)
5. Organic synthesis M. B. Smith.
6. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5 Paper 14: Organic chemistry IV- Advance organic synthesis, supramolecular chemistry and carbocyclic ring
7. Principles of Organometallic Chemistry- G. E. Coates, Green and K Wade
8. Transition Metal Intermediates in Organic synthesis C W Bird, Logos (1967)
9. Organometallics in Organic synthesis- J. M. Swan and DC Black (Chapman Hall)
10. Modem synthetic Reactions- HO House, Benjamin
11. Domino reactions in organic synthesis- L.F. Tietze, G. Brasche, K. m. Gericke

Learning outcome :

1. Use and applications of protecting and deprotecting reagent
2. Applications of enamine and umpolung in synthesis
3. Retro analysis of one and more functional group
4. Synthons, Convergent and divergent synthesis
5. Applications of multicomponent and Cyclic ring formation reactions in synthesis
6. Different name reactions involving transition metal viz. Pd, Ni, Ru, Co, Fe, Cu etc.
7. Organometal applications and uses of Al, Li, P, B
8. Sharpless azide cycloaddition, Domino and biomimetic synthesis

CBOP-4, CHD-462(B): Supramolecular, Green Chemistry and Forensic Chemistry [48L + 12T]

Section-I: Supramolecular, Green Chemistry [24 L +6 T]

1. Supra-molecular Chemistry [12L]

Properties of covalent bond, bond length, inter-bond angles, force constant, bond and molecular dipole moments, molecular and bond polarizability, bond dissociation enthalpy, entropy, Intermolecular forces, hydrophobic effects, Electrostatics, induction, dispersion and resonance energy, magnetic interactions, magnitude of interaction energy, force between microscopic bodies, medium effects, hydrogen bond, Principles of molecular association and organization as exemplified by in biological macromolecules like enzymes, nucleic acids, membrane and model systems like micelles and vesicles, molecular receptors and design principles. Cryptands, cyclophanes, calixeranes, cyclodextrins. Supramolecular reactivity and catalysis. Molecular channels and transport processes. Molecular devices and nontechnology.

2. Green chemistry [12L]

1. Atom Economy and Principles of chemistry Green
2. Solvent free reactions
3. Organic synthesis in solid state: Michael addition, Beckmann rearrangement, solid support organic synthesis, synthesis of aziridine, pyridine, chromans and flavones.
4. Aqueous phase Reactions: Diels –Alder reaction, Heck reaction, epoxidation, dihydroxylation [syn & Anti].
5. Microwave Technology: Microwave solvent free reactions- Deacetylation, deprotection, saponification of ester, alkylation of reactive methylene compounds, synthesis of nitrile from aldehyde, reductions.

6. Microwave assisted reaction in water: Hoffmann elimination, hydrolysis, oxidation, saponification reactions
7. Ultrasound assisted reactions: introduction, substitution reactions, addition, oxidation, reduction reactions.
8. Ionic liquids: Introduction and application in organic synthesis.
9. Use of bio-catalyst in organic synthesis.

References

1. Supramolecular Chemistry- Concepts and perspectives by J.M. Lehn
2. Green Chemistry-Theory and practical, By Paul and Anastas and John C. warner.
3. New trends in greenchemistry-by V.K. Ahuwalia and Kidwai
4. Organic synthesis special techniques. by V.K. Ahuwalia and Renu Agrawal
5. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5 Paper 14: Organic chemistry IV- Advance organic synthesis, supramolecular chemistry and carbocyclic ring

Learning outcome:

1) Concept of supramolecular chemistry
2) Application of supramolecular chemistry in drug synthesis
3) Concept of green chemistry, various green synthetic strategies
4) Use of microwave and ultrasound techniques in synthetic chemistry

Section-II: Forensic Chemistry [24 L +6 T]

1. General Drugs, Other Chemicals [8L]

Introduction, Pharma drugs [barbiturates, benzodiazepine &other pharma drugs],

Drug abuse in sports & Date rape drugs: Introduction, common prohibited substances, analytical approach, Forensic Pharmacological studies, Ingestion of drugs, absorption, distribution, metabolism, pathways of drug metabolism, drug metabolism and drug toxicity, excretion of drugs, detection of drugs on the basis of their Metabolic studies.

Solvent Abuse [chlorinated hydrocarbons, Aromatic hydrocarbons, alcohols, glycols, fuel and fuel additives]: absorption, distribution, and metabolism, psychological & clinical effects.

Analysis: collection of samples, distillation & extraction, Analysis by GC, HPLC.

2. **Narcotic Drugs and Psychotropic Substances [6L]**

Introduction to narcotic drugs, Analysis of Narcotic Drugs and Psychotropic Substances, Classification of Narcotics and other drugs, Analytical techniques for identification of drugs. Characterization and synthesis of 1) Narcotics- heroin and cocaine. 2) Stimulants- caffeine, amphetamines. 3) Depressants- Barbiturates, Benzodiazepinesanalysis of NDPS evidence by various procedures prescribed by U.N. Manual, DFS manual, spot tests, microcrystal tests, extraction methods, TLC, UV-Vis spectrophotometry, IR spectrophotometry, GC-HPLC, MS, GC-MS, NMR and XRD as exemplified by cocaine, cannabis, amphetamines, opiates and hallucinogens (LSD, psilocybine and mescaline), evidence handling & sampling techniques, clandestine laboratory investigation and designer drugs.

3. Fingerprinting & Other Impressions [10L]

Fingerprint: Nature, Location, Classification, Types, Patterns of Fingerprints, Poroscopy & Edgeoscopy, Classification of Fingerprints: Henry's Classification, Single Digit Classification, Extended Henry's System, Types of Fingerprints [Latent, Patent and Plastic], Invisible Fingermarks development methods [Powder methods, Fuming methods, Chemical Methods, etc.] Recent techniques [Digital Imaging & Enhancement, Laser & other radiation-based techniques, Preservation and photography of fingerprints on various surfaces. Ridge counting, Ridge tracing, Minutiae Identification & Matching [Manual and Automated: AFIS].

Palm Prints: Nature, Location, Types, Classification, Development, Lifting, Evaluation, Analysis, Forensic Significance. Footprints: Importance, Gait pattern analysis, Evaluation and analysis of various casts.Electrostatic lifting of latent footprints and comparison with reference sample. Tyre marks / prints and skid marks and comparison with control samples.

Cheiloscopy: Nature, location, collection and evaluation of lip print. Ear prints: Introduction, growth & development, evaluation and analysis of ear print.

Refrences:

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=16 Paper 03: Fingerprint and other impression
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=16 Paper 09: Drug of Abuse
3. Krishnamurthy, R., Introduction to Forensic Science in Crime Investigation, 2011, Selective & Scientific Books, New Delhi.
4. Clark, E.G.C.; Isolation and Identification of Drugs, Vol. I and Vol. II, Academic Press, (1986).
5. Moenssens: Finger Prints Techniques, 1975, Chitton Book Co., Philadelphia, New York.
6. Mehta, M. K. : Identification of Thumb Impression & Cross Examination of Finger Prints, 1980 N. M. Tripathi (P) Ltd. Bombay.
7. Cummins & Midlo : Finger Prints, Palms and Soles, 1943, The Blakiston office London
8. Sharma B. R. : Footprints, Tracks and Trials. 1980. Central Law Agency. Allahabad
9. Iannarelli, A V; Ear Identification, Forensic Identification series, Paramount (1989)
10. Saxena's : Saxena's Law & Techniques Relating to Finger Prints, Foot Prints & Detection of Forgery, Central Law Agency, Allahabd (Ed. A.K. Singla).
11. Menzel, E Roland; Fingerprint detection with lasers, Marcel Dekker, NY (1999)

Learning Outcomes:

1. Identification of Type of Drug
2. Expertise in handling UV, IR, GC and HPLC
3. Interpretation of data and comparative study with literature
4. Crime investigation of drug abuse
5. Methods of development of fingerprint
6. Role of Fingerprinting in investigation

CBOP-5, CHD-463: Practical III

Select any two Sections from sections I to IV [96L + 24T]

Section-I: Microbiology, Biochemistry
Section-II: Practical on Forensic Chemistry
Section-III: Ternary Mixture Separation
Section-IV: Project/ Industrial Training

CHD- 463 Section-I: Microbiology and Biochemistry [48 L + 12T]

1. Microbiology - Differentiation, Gram staining Morphology, Protoplast fusion, Screening of bacterial substances, sterility testing. Microbial assays, Production of penicillin by fermentation, Immunology practicals
2. Biochemistry- Isolation, purification and characterisation of Enzymes, stability studies,Kinetics determination of Km, Vmax, 1-50, Inhibition studies, reversible, irreversible and KCat. Electrophoresis, Isolation and estimation of DNA, DNA-drug interaction studies, Determination of drug in blood and urine.

References

1. Practical Organic Chemistry, Al. Vogel (ELBS).
2. Pharmacological Basis of Therapeutics (Pergman press, New York) Goodman and Gilman.

3. Evaluation of Drug Activities- Pharmacometrics, Lawrence D. R. Bacharach AL. (Academic press London)
4. Screening Methods in Pharmacology, Turner R..A (Academic press London).
5. Physiological Chemistry, Hawk.
6. Clinical Biochemistry, Vol I and II Varley.
7. Fundamentals of Experimental Pharmacology, Ghosh M.N.(Scientific Book Agency, Calcutta)
8. Practical Biochemistry Plummer
9. Practical Microbiology. :
10. Practical Biochemistry, Jayaraman.

Learning Outcomes: Students will

1. Understand the various microbial and biochemical techniques
2. Study drug – DNA interactions
3. Learn Synthesis, characterization and purification of drug molecules
4. Learn analysis of biological matrices

CHD- 463 Section-II: Practicals on Forensic Chemistry [48 L + 12T]

(Six practical's to be perform based on instrumentation.)

1. Systematic identification of Narcotic Drugs and Psychotropic substances (opiates, cannabis, barbiturates, benzodiazepines and amphetamines) by spot colour tests. TLC, UV, IR, GC and HPLC. (min. 2 Nos.)
2. Systematic extraction and identification of acidic and basic drugs from viscera (simulated sample) by wet test & GC. (min. 2 Nos)
3. Detection of pesticides and insecticides from blood
4. Systematic analysis of cosmetic products as per IPC specification by using HPLC
5. Systematic analysis of cosmetic products as per IPC specification by using GC

References for Forensic Practicals

1.Practical Organic Chemistry; J.B. COHEN
2. Spot test in Organic Chemistry; Feigl
3. Practical Organic chemistry; Vogel
4. Quantitative Inorganic Analysis; Vogel
5. The Merck index; Stetchar & others
6. Inorganic Semi micro qualitative analysis; Griffin & Plunky
7. Peerson's Chem. Analysis of food; H.Egan, Kirk
8. Clerk's Analysis of Drugs & Poisons VOL.-I & II; Clerke
9. Development & Validation of Analytical Methods; Christopher, M.Riley, Thomas W
10.Steroid analysis by HPLC; Marie P. Kautsky
11. TLC VOL.-II; Jork, Funk & Others

Learning Outcomes: Students will

1. Expertise in handling UV, IR, GC and HPLC
2. Blood sample pesticide and insecticide detection.
3. Interpretation of data and comparative study with literature

CHD- 463 Section-III: Ternary Mixture Separations [48 L + 12T]

Separation of at least Eight mixtures containing three components. The mixtures should also involve separation of nitro phenols, amino acids, low boiling substances, water soluble substances. Amines, Phenols and acids used should also contain other elements and functional groups. The mixture separation should be carried out on micro-scale using ether.

Learning Outcomes: Student will

1. Determine the type
2. Separation of mixture using ether
3. Microscale workup

CHD – 463 Section-IV: Project / Industrial Training [48L + 12T]

Students should carry out a small research project. This should make them familiar with literature survey, research methodologies, Identification of products by analytical and spectral methods and familiarity with chromatographic techniques. Project report must be written and submitted in format.

1. Students should carry out a small research project separately.
2. This should make them familiar with
   i. Literature survey, research methodologies
   ii. Data Analysis
   iii. Column and TLC chromatographic techniques
   iv. Characterization of the products by analytical and spectral methods.
3. **Project report must be written and submitted in a proper format as follows;**
   i. Certificate (Signed by Project guide and Head of the Department)
   ii. Certificates for Poster/Paper presented in conferences (if any)
   iii. Self declaration certificate for plagiarism
   iv. Introduction (not more than 6 pages)
   v. Results and Discussions
   vi. Experimental Section
   vii. Conclusion
   viii. References (Use ACS format)
   ix. Spectroscopic or other relevant supporting data
   x. Acknowledgement
4. Interdisciplinary projects shall be encouraged; however there **must be some chemistry component**.
5. Students should spend enough time for the project works (**more than** 4 hours per week for **15 weeks**)
6. At least 30% students should undertake projects/summer training/Internships etc.
7. If student is performing project in another institute, for such a student, internal mentor must be allotted and he will be responsible for internal assessment of a student. In this case student has to obtain certificate from both external and internal mentor. ***Systematic record of attendance of project students must be maintained by a mentor.*** Project will be evaluated jointly by three examiners and there will not be any practical performance during the examination. Typically, student has to present his practical work and discuss results and conclusions in details (20-30 min.) which will be followed by question-answer session (10 min). It is open type of examination.

Learning Outcomes; Students will

1. Learn Referencing
2. know about various scientific databases
3. understand applications of various characterization techniques
4. learn how to write project report
5. learn presentation skills

CCPP-4 CHD – 464, Practical II: Synthesis of Heterocycles and Drug Molecules [96L + 24T]

At least fourteen preparations should be carried out on micro scale.

1. 2-Phenyl indole (Fischer indole synthesis),
2. 7-Hydroxy -3-methyl flavone (Baker-Venkatraman reaction),
3. 7-Hydroxy-4-methyl coumarin (Pechmann Reaction)
4. Acridone
5. Triphenyl or diphenyl methyl carbinol (Grignard reaction)

6. Benzotriazole
7. 1-Phenyl-3-methyl pyrazol-5-one
8. O-nitroaniline ⟶O-phenylene diamine ⟶Benzimidazole
9. 2,4-diethoxycarbonyl-3,4-dimethyl pyrrole from ethyl acetoacetate
10. Quinoline from aniline Skraup synthesis)
11. Benzimidazole from benzyl
12. Glycine⟶2,5-dioxopiperazine
13. 3,5-diacetyl-1,4-dihydro2,6-trimethylpyridine
14. Hippuric acid ⟶Azalactone⟶4-benzylidene 2-phenyl oxazol-5-one
15. Benzocaine
16. Antipyrine
17. Paracetamol
18. Aspirin
19. Ibuprofen
20. Barbiturate

References:

1. Practical Organic Chemistry, Al. Vogel (ELBS).
2. Microscale and Macro scale Preparations Williamson and Williamson.
3. Practical Heterocylic Chemistry, Fitton and Smalley (AP)
4. Organic Synthesis Collective Volumes, Vol I to VIII
5. Comprehensive Practical Organic Chemistry by V.K. Ahluwalia and Renu Aggarwal
6. Practical Chemistry, Fitton and Smalley

Learning Outcomes: Students will

1. Learn different syntheses of heterocycles
2. Use of various synthetic strategies in drug synthesis

5. M. Sc. (II) Analytical Chemistry

To be Implemented form Academic Year 2020-21

Sr. No.	Paper No. & Code	Course Name	Credit
		Semester - III	
1	**CCTP-7 CHA-390**	Electrochemical and Thermogravimetric Methods of chemical analysis	4
2	**CCTP-8 CHA-391**	Analytical Method Development and Extraction Techniques	4
3	**CCTP-9 CHA-392**	Advanced Chromatographic Methods of Chemical Analysis	4
4	**CBOP-3 Theory CHA-393**	CBOP-3, CHA-393-A: Bioanalytical Chemistry **Or** CBOP-3, CHA-393-B: Analysis of Food and Controlled Substances	4
5	**CCPP-3 CHA-394**	**Practical I:** Basics of Instrumental Methods of Chemical Analysis	4
		Semester-IV	
6	**CCTP-10 CHA-490**	Advanced Analytical Spectroscopic Techniques	4
7	**CCTP-11 CHA-491**	Chemical Methods of Pharmaceuticals Analysis	4
8	**CBOP-4 Theory CHA-492**	CBOP-4, CHA-492-A: Laboratory Automation and Environmental Analytical Chemistry **Or** CBOP-4, CHA-492-B: Analytical Chemistry of agriculture, polymer and Detergents	4
9	**CBOP-5 Practical CHA-493**	**Practical III:** CBOP-5, CHA-493-A: Optional Analytical Chemistry Practical **OR** CBOP-5, CHA-494-B: Project	4
10	**CCPP-4 CHA-494**	**Practical II**: Applied Analytical Chemistry Practical	4

Equivalence to Previous Syllabus

Old Paper (2014 pattern)	New syllabus (2020)
Semester - III	
CHA-390	CCTP-7, CHA-390
CHA-380	CCTP-8, CHA-391
CHA-391	CCTP-11, CHA-491
CHA-392	CBOP-4, CHA-492 (A)
CHA-387-Practical	CCPP-4, Practical, CHA-394
Semester - IV	
CHA-490	CCTP-10, CHA-490
CHA-491	CBOP-4(B), CHA-492 (B)
CHA-492	CBOP-4, CHA-492(A)
CHA-481	CBOP-3(A), CHA-393(A)
CHA-487, Practical	CCPP-4, Practical, CHA-494
CHA-488, Practical / Project	CBOP-5, CHA-493: A) Practical / B) Project

Detailed of Syllabus: Semester and Paper Wise

Semester-III

CCTP-7, CHA-390: Electrochemical and Thermogravimetric Methods of Chemical Analysis [48L + 12T]

Section-I: Electroanalytical Techniques **[24 L +6 T]**

1. Coulometry [6 L]

Current voltage relationship during an electrolysis, Operating cell an at fixed applied potential, constant current electrolysis, Electrolysis at constant working electrode potential, Coulometric methods of analysis, Faradays laws of electrolysis, Instrumentations-Constant current and constant voltage instruments, potentiation coulometry-Instrumentation and applications, coulometric titrations - apparatus and applications, problems.***(Ref.-1****:696-712, Ref-2: relevant pages)*

2.Voltammetry and Polarographic Methods of Analysis. [18 L]

a) Polarography (linear scanpolarography): Polarographic principles, Instrumentation (different types of microelectrode such as dropping mercury electrode, the static drop mercury electrode, rotating disc and ring disc electrode, cell for polarography, reference and counter electrode and circuit diagram), polarogram and polarographic currents, charging or capacitive current, role of supporting electrolyte, factors affecting on polarographic wave, Ilkovic Equation, advantages and disadvantages of DME, polarographic maxima and maxima suppresors, interference due to dissolved oxygen, Applications (qualitative analysis, quantitative analysis by calibration curve and standard addition methods), specific examples of analysis – analysis of Cu, Cd, Zn, Pb, etc. from tap water and alloys., problems.***(Ref-1:*** *716-723, Ref-2, Supplementary Ref. 3 and 4)*

b) Hydrodynamic Voltametry: Hydrodynamic voltametry and applications of hydrodynamic voltametry (volatameric detectors in chromatography and flow injection analysis, Voltametric oxygen sensors, amperometric titration. ***(Ref-1:*** *723-735)*

c) Cyclic Voltametry: Principle of cyclic Voltammetry, cyclic voltamogram of $K_3[Fe(CN)_6]$ and parathion (*Fundamental studies*), determination of analytes using CV, criteria of reversibility of electrochemical reactions, quasi-reversible and irreversible processes(***Ref-1****:735-742 Ref-2: Relevant pages, Supplementary* ***Ref.-5****: 27-68)*

d) Pulse Polarography: different types of excitation signals in pulse polarography, Differential pulse polarography, square wave polarography, and Stripping method. Voltammetry with ultra-microelectrode, Applications of these techniques Cu and Zn from tap water by differential pulse polarography and by square wave polarography, Vitamin-C by differential pulse polarography, Determination of Pb in tap water by stripping method. (***Ref-1: 742-753*** *2, Supplementary Ref. 3 and 4)*

References

1. Principles of Instrumental Analysis, Skoog, West, Holler, 6th Ed. Cengage Publication.
2. Vogel's Text Book of quantitative analysis 6th Ed.
3. Introduction to Instrumental Analysis by R. D. Braun, Pharmamed Press.
4. Analytical Chemistry, A Modern Approach to Analytical Science, Ed. by R. Kellner, J. M. Mermet, O. Otto, M. Valcarcel, H. M. Widmer, Second Ed. Wiley –VCH

5. Cyclic Voltammetery, Simultaneous Analysis and Reaction Mechanism, David K Gosser, VCH, 1994.

Section-II: Thermal Methods of Analysis [24 L +6 T]

1. Introduction to Thermal Methods [2 L]

Introduction, Historical development, Definitions: *Thermal analysis, Equilibrium -A Kinetic Diversion, General apparatus,* Factors affecting thermal analysis results, *The sample, The crucible, The rate of heating, The atmosphere, The mass of the sample,* Simultaneous and complementary techniques ***(Ref-1:** 1-21)*

2. Thermogravimetry [5 L]

Introduction, Historical, Definition ofthermogravimetry, Apparatus, *The balance, Furnace, Programmer, Samples, Temperature calibration, Atmosphere, Kinetics of reactions,* Kinetics of Reactions, *Measurement of α and dα/dt, Constant rate methods,* Thermogravimetric curves: *Decomposition Of Magnesium Hydroxide,Calcium oxalate monohydrate, Copper sulphate pentahydrate, Degradation of polymers,* Analysis of mixtures: *mixtures of alkaline earth oxalates, polymer blends, soils,* Oxidation studies, Reduction studies, Controlled rate thermogravimetry and Hi-Res ™ TGA, *Polymer blends, Drugs. **(Ref-1:**22 to 62)*

3. Differential Thermal Analysis and Differential Scanning Calorimetry [7 L]

Introduction, Historical, Definitions: *Differential thermal analysis (DTA), Differential scanning calorimetry (DSC),* Apparatus: *The sensors, The furnace and controller, The computer and display, The reference material,* Theory of DT A and DSC, Heat flux DSC, Power-compensated DSC, *The effect of higher temperatures, Sample size,* Calibration, Applications: *Physical changes and measurements (crystalline phase transitions, potassium nitrate, liquid crystalline transitions, thermoplastic polymer phase changes, heat capacity measurements, glass transition temperatures), Chemical reactions, Inorganic compounds and complexes (calcium oxalate monohydrate, metal complexes, high alumina cements, clays and other minerals), Organic compounds (oxidative degradation, protein denaturation, polymer degradation). **(Ref-1:** 63-113)*

4. Thermomechanical and Dynamic Mechanical Analysis [4 L]

Introduction, Definitions: *Thermomechanical analysis, Dynamic mechanical analysis, Mechanical moduli,* Thermomechanical analysis: *Apparatus (probes, calibration),*Applications:*coefficients of expansion, solvent swelling of polymers, phase transitions, sintering), Chemical reactions (inorganic hydrates, polymer cure),* Dynamic Mechanical Analysis: *Apparatus* (DMA configurations, calibration) Applications: *glass transition temperatures,beta and other transitions, relaxation kinetics, polymer miscibility, characterising cross-linking, studying 'problem samples, characterising film formation **(Ref-1:** 123-151)*

5. Simultaneous Techniques and Product Analysis [4 L]

Introduction, Simultaneous Thermal Analysis: *Simultaneous TG-DTA and TG-DSC applications, (sodium tungstate dihydrate, fire-retarded wood, poly(vinyl chloride), pharmaceuticals, reactive atmosphere effects,* Evolved gas analysis, Instrumentation: Apparatus, Detection and identification of evolved gases: *Physical methods,* Chemical

methods, Spectroscopic methods (mass spectrometry (MS) and simultaneous TG-MS, calcium oxalate monohydrate, poly (ethylene oxide), brick clays), Infrared and simultaneous TA-infrared, *Apparatus, Applications, Gas chromatography and pyrolysis GC-FTIR.**(Ref-1:** 163-184)*

6. Problem Solving and Applications of Thermal Methods [2 L]

Introduction, List of examples, Problems: *Inorganic materials, Polymeric materials, Fine chemicals andpharmaceuticals, Other materials,* Solutions to problems.

(Ref-1: *206-270)*

(This topic is for student's self-preparation)

References

1. Thermal Methods of analysis, principles, applications and problems, P. J. Haines, Springer-Science Business Media B.V. 1st Ed.
2. Principles of Thermal Analysis and Calorimetry, P. J. Haines, Royal Society of Chemistry
3. Principles and Applications of Thermal Analysis, Paul Gabbott, Blackwell Publishing Ltd. (2008).
4. Thermal Analysis in Practice, Fundamental Aspects, Matthias Wagner, Hanser Publications, 2018.

Learning Objective: At the end of course, students should able to-

1. Define various terms in electrochemistry and thermogravimetry.
2. Explain instrumentation in electrochemistry and thermogravimetry.
3. describe basic principles of electrochemistry and thermogravimetry.
4. Explain /Describe applications of electrochemistry and thermogravimetry in industry and in analytical laboratory.
5. Apply / select particular method of analysis for sample to be analysed.
6. Solve numerical problems on electrochemistry and thermogravimetry.
7. Interpret polarogram, cyclic voltammogram, pulse polarogram, thermogram, differential thermogram and DSC thermogram.
8. Differentiate among the various methods of electrochemistry and thermogravimetry.

CCTP-8, CHA-391: Analytical Method Development and Extraction Techniques [48L + 12T]

Sec-I: Analytical Extraction Techniques [24 L +6 T]

1. Assay Validation and Inter Laboratory Transfer [2 L]

Introduction, fundamental definitions, Essential principles of method transfer, method validation report, the interlaboratory qualification (ILQ) process. *(**Ref-1:**pp 3 to 14)*

2. Statistical Analysis and analytical Figure of Merit [14 L]

Introduction, Errors (gross errors, systematic errors, random errors), accuracy, validation parameters: Accuracy, precision, mean and standard deviation, calibration, (linear response functions (linear regression-errors in slope and the intercept, error in the estimate of concentration, standard additions), non-linear response functions and weighted

regression analysis, internal standards), selectivity and specificity (chromatographic methods), limits of detections (spectrophotometric methods, chromatographic methods and related techniques, receptor binding assay), limit of quantification, sensitivity, ruggedness and robustness, analyte stability in the sample matrix, how to reduce systematic errors, mean and standard deviation, reliability of results, confidence interval, comparison of results, comparison of two means of two samples, experimental design.***(Ref-1:****15 to 68, Ref-2, p145-197)*

3. Overview of World Wide Regulations (2 L), ***Ref-1:*** *75 to 98)*

4. Specific methods and Applications: Dissolution Studies [4 L]

Introduction, Dissolution test, Apparatus – USP type –I and II, Sampling and analytical instrumentation, Single point test Vs. Dissolution profile, Calibration, regulatory guidelines, analytical validation, linearity, accuracy, precision, specificity.***(Ref-1:*** *169 to 182)*

5. Specific Examples [2 L]

Explain these method w.r.t. method development and validation of specified analyte from the research papers.(***Ref****-4 to 7****)***

References

1. Development and validiation of Analytical Methods, Progress Pharmaceutical and Biomedical Analysis, Vol-3, Edited by Chitofer M. Riley and Tomas W. Rosanske (Elvier).
2. Vogel's Textbook of quantitative Chemical Analysis, Sixth Ed., Mendham, Denney, Barnes, Thomas, Pub: Pearson Education.
3. Development and validation of a colorimetric method for the quantitative analysis of thioamide derivatives, R.B. Ali et al., Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, 220 (2019) 117154.
4. HPLC Method Development and Validation for Formaldehyde in Enteric Coating of ard Gelatine Capsules, Journal of Liquid Chromatography, 18(13), 2683-2693 (1995).
5. Development and Validation of Stability Indicating Rp-HPLC Method for Analysis Of Lercanidipine In Bulk Drug And Microemulsion Formulation, Journal of Liquid Chromatography & Related Technologies, 36:143–154, 2013.
6. Development and validation of an LC-MS/MS method for simultaneous quantification of voriconazole and its main metabolite voriconazole N-oxide in human plasma and its clinical application, Journal of Liquid Chromatography & Related Technologies, 40:20, 1047-1053.
7. Development and validation of the spectrophotometric method of butaphosphan determination in veterinary preparations, Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, 233 (2020) 118171.

Section-II: Analytical Extraction Techniques [24 L +6 T]

1. Pre and Post Extraction Consideration [1 L]

Organic compounds of interest, pre-sampling issues, sampling strategies-solid, aqueous and air samples, chromatographic method of analysis, sample preconcentration methods. ***(Ref-1:*** *1-29)*

2. Classical Approach for Aqueous Extraction [6 L]

Introduction, Liquid-Liquid extraction (LLE), Theory of LLE: distribution ratio and coefficient, solute remaining unextracted, percent extraction, separation factor, factors favouring solvent extraction, quantitative treatment to solvent extraction equilibria, synergic extraction, extraction reagents for metals, selection of solvents, solvent extraction,

problems with LLE process), purge and trap for volatile organics in aqueous samples, Examples of Solvent Extraction- estimation individual metal ions Be, B, Cu, Fe and Pb by solvent extraction. Problems. ***(Ref-2:** relevant pages and **Ref.-1:** 39-45)*

3. Solid Phase extraction (SPE) [6 L]

Introduction, Types of SPE media, SPE formats and apparatus, method for SPE operation, solvent selection, factors affecting SPE, selected methods of analysis for SPE: *application of normal phase SPE, application of reversed phase SPE, application of ion exchange SPE, applications of molecularly impaired polymers,* Automation and On-Line SPE and its applications. ***(Ref-1**: 49-78)*

4. Solid phase micro-extraction [6 L]

Introduction, theoretical considerations, experimental, Methods of analysis: SPME-GC: *direct immersion SPME, headspace SPME, analysis of compounds from solid matrix, other SPME-GC application.* Methods of analysis: SPME-HPLC-MS: *analysis of abitic dehydroabietic acid in food samples, analysis of fungicide in water.* Automation of SPME and its application, New development in micro extraction (Introduction, stirbas sorptive extraction, liquid phase micro-extraction, , membrane micro extraction, micro extraction in packed syringe).***(Ref-1:** 85-110, Ref-3)*

5. Solid -Liquid Extraction, Microwave extraction [6 L]

Classical Approach: Introduction, Soxhlet extraction, Automated Soxhlet extraction, other approaches, **Pressurized Fluid Extraction:** Introduction, theoretical consideration, Instrumentation for PFE, method development and applications. **Microwave assisted extraction:** Introduction, instrumentation, Applications***(Ref-1:** 125-174)*

References

1. Extraction Techniques in Analytical Science, John R. Dean, Wiley
2. Vogel's Textbook of quantitative Chemical Analysis, sixth Ed., Mendham, Denney, Barnes, Thomas, Pub: Pearson Education.
3. Solid Phase Microextraction, A Practical Guide, Edited by Sue Ann Scheppers Wercinski, CRC press, Taylor and Francis.

Learning Objective - At the end of course students should able to-

1. Define / understand various terms in analytical extraction and method development and validation.
2. Explain instrumentations and methodology in analytical extraction.
3. Explain / describe basic principles of analytical extraction method development and validation.
4. Explain /Describe applications analytical extraction and method development and validation in industry and in analytical laboratory.
5. Apply / select particular method of analysis for sample to be analysed.
6. Solve numerical problems on analytical extraction and method development and validation.
7. Develop analytical method for analysis of given sample. Apply statistical treatment to the analytical data. Select appropriate parameters for the development of analytical method
8. Differentiate among the methods of analytical extraction.

CCTP-9, CHA-392: Advanced Chromatographic Methods of Analysis

[48L + 12T]

Section-I: Mass spectrometry and Gas Chromatography [24 L +6 T]

1. Mass Spectrometry [6 L]

Fundamentals, Electron ionization, Chemical ionization, Instrumentation:*Quadrupole mass spectrometers, Magnetic sector mass spectrometers, TOF mass analyser, detector;*Interpretation of mass spectra, Types of ions Isotopic abundances and characteristic ion clusters, Nitrogen rule and rings-plus-double-bonds, steps in interpretation, Examples***(Ref-1:** *39-72, Supplementary Ref.- 4)*

2. Fundamentals of Chromatographic Methods of Analysis [4 L]

Fundamentals of Chromatographic Separation (overview, the development of chromatogram), Characteristics value in chromatogram, Chromatographic theories (plate theory, kinetic theory), R_s as measure of peak separation, qualitative and quantitative analysis. Problems.***(Ref-2,*** *Supplementary Ref-1, 6)*

3. Gas Chromatography [4 L]

Retention data and partition coefficient, separation in the gas phase, Components of gas chromatography:*Carrier gas, sample injection, split injection, spitless injection, cold on column injection, programmable temperature vaporization, head space injection, solvent effects, column, detectors- TCD, FID, ECD,* Stationary phases for GC: *stationary phases for packed column, capillary column, deactivation of surface, different stationary phases*, Applications of GC**,** Problem on quantitative analysis.***(Ref.-2,*** *Supplementary Ref-1, 6)*

4. Gas Chromatography-Mass Spectrometry [8 L]

Vacuum and gas flow, Basic principles, Analysis of vacuum and gas flow, Interfaces, Computerization, Computerized operation, Characteristics, Data analysis, Reconstructed gas chromatogram, Mass chromatogram, Selected ion monitoring, Background subtraction, Biller-Biemann stripping technique, Compound identification using reference spectra matching, Mass spectral compilations, Methods of computerized mass spectral search, Commercial mass spectral computer search systems, Quantitative analysis by selected ion monitoring, Choice of ions: basic considerations, Magnetic sector versus quadrupole analysers, Identification and quantitation procedures, Use of isotopically labelled standards, Precision, accuracy and limit of detection, Automated GC-MS operation, Automated data acquisition, Automated data analysis.***(Ref-1:*** *79-134)*

5. Applications of GC and GC-MS [2 L]

1. Quantitative analysis by GLC-different methods, Elemental Analysis using Gas Chromatography, analysis of Al, analysis of a mixture using the interna1 normalisation method, determination of sucrose as its trimethylsilyl derivative using gas-liquid chromatography, ***Ref-4***
2. Phenols in waste water by LLE-GC method *(sec-6420 phenols),* Organochlorine pesticides in water: LLEGC method-1, LLEGC method-2 *(sec-6630 organochlorine pesticides),* volatile organic compounds – Purge and trap capillary column GC-MS method *(Sec-6200-A,B,C),* Tributyl tin by GC-MS and FID method *(Sec-6710-A,B,C)* ***Ref- 5***

References

1. Basic Gas Chromatography Mass Spectrometry, Principles and Techniques, F.W. Karasekand R.E. Clement, Elsevier, (Elsevier Science B.V.) 1988
2. Analytical Chemistry, Ed. by Kellner, Mermet, Otto, Valcarcel, Widmer, Second Ed. Wiley –VCH
4. Vogels's, Textbook of Quantitative Chemical Analysis 6th Ed.
5. Standard methods for the examination of water and waste wter, 23rd Ed. Rodger Baird, Andrew Eatson, Eugene Rice, jointly published by: Americal Public Health Association, Americal Water Works Association, Water Environment Fedearation,
6. Forensic applications of Gas Chromatography by Michelle Carlin and John Dean, CRC press, 2013)

Section-II: Liquid Chromatography [24 L +6 T]

1. Instrumentation of HPLC [4 L]

Introduction: *HPLC-A powerful separation method, A first HPLC experiment, Liquid chromatographic separation modes, The HPLC instrument*,Pumps: General requirements, The short-stroke piston pump, Preparation of Equipment up to Sample Injection:*Selection of the mobile phase, Preparation of the mobile phase, Gradient systems, Sample injectors, Sample solution and sample volume;* Solvent Properties: *Table of organic solvents, Solvent selectivity, Miscibility, Buffers, Shelf life of mobile phases, The mixing cross;Detectors: General, UV detectors, Refractive index detectors, Fluorescence detectors, Electrochemical (amperometric) detectors, Light-scattering detectors, Multiple detection*; Columns and Stationary Phases: *Columns for HPLC, Precolumn, General properties of stationary phases, Silica, Chemically modified silica, Styrene-divinylbenzene, Column care and regeneration(**Ref-2:** 1-9, 59-136, Ref-1)*

2. HPLC Methods [6 L]

a) Adsorption Chromatography: Normal-Phase Chromatography: What is adsorption?, The eluotropic series, Selectivity properties of the mobile phase,Choice and optimization of the mobile phase, Applications*(**Ref.-2:** 159-168, Ref-1)*

b) Reversed-Phase Chromatography: Principle, Mobile phases in reversed-phase chromatography, Solvent selectivity and strength, Stationary phases, Method development in reversed-phase chromatography, Applications, Hydrophobic interaction chromatography. ***(Ref.-2:** 173-191, Ref-1)*

c) Chromatography with Chemically Bonded Phases: Introduction, Properties of some stationary phases, Hydrophilic interaction chromatography, ***(Ref.-2:** 195-200, Ref-1)*

d) Ion-Exchange Chromatography: Introduction, Principle, Properties of ion exchangers, Influence of the mobile phase, Special possibilities of ion exchange, Practical hints, Applications ***(Ref.-2:** 203-213, Ref-1)*

e) Ion-Pair Chromatography: Introduction, Ion-pair chromatography in practice, Applications ***(Ref.-2:** 217-221, Ref-1)*

f) Ion Chromatography: Principle, Suppression techniques, Phase systems, Applications ***(Ref.-2:** 225-230, Ref-1)*

g) Size-Exclusion Chromatography: Principle, The calibration chromatogram, Molecular mass determination by means of size-exclusion chromatography, Coupled size-exclusion columns, Phase systems, Applications. ***(Ref.-2:** 231-244, Ref-1)*

h) Affinity Chromatography: Principle, Affinity chromatography as a special case of HPLC, Applications. ***(Ref.-2:** 249-252)*

3. Analytical HPLC [2 L]

Qualitative analysis, Trace analysis, Quantitative analysis, Recovery, Peak-height and peak-area determination for quantitative analysis, Integration errors, The detection wavelength, Derivatization, Unexpected peaks: Ghost and system peaks. ***(Ref.-2:** 285-308)*

4. Separation of Enantiomers [2 L]

Introduction, Chiral mobile phases, Chiral liquid stationary phases, Chiral solid stationary phases, Indirect separation of enantiomers. ***(Ref.-2:** 333-345)*

5. Mass Spectrometry, LCMS Interface and applications [8 L]

Interface Technology: Introduction, Thermo-spray interface, The electron spray interface (mechanism of electron-spray ionization, sample types, the electro-spray spectrum, structural information from electrospray ionization), atmospheric pressure chemical ionization interface and the mechanism of atmospheric pressure chemical ionization. Data acquisition (identification, quantitation-selected ion monitoring), Processing of mass spectra (total ion current trace, qualitative analysis, quantitative analysis). **Applications:** Molecular weight determination of small molecules (Method Development for Structural Studies, The Use of Target-Compound Analysis and LC–MS–MS for the Identification of Drug Metabolites, The Use of High-Accuracy Mass Measurements in Combination with LC–MS for the Structure Determination of Drug Metabolites, The Use of Cone-Voltage Fragmentation in Conjunction with High-Accuracy Mass Measurements and LC–MS for Metabolite Identification, The Use of LC–MS^n for the Identification of Drug Metabolites),Quantitation (requirements, quantitative standardization, matrix effect in LC-MS, the method of standard addition to overcome matrix effect).***(Ref-3:** 75, 94-123, 189-218**)***

Chapter-6: Super Critical Fluid Chromatography and Extraction [2 L]

Properties of supercritical fluid, Supercritical fluid chromatography: *Instrumentation and operating variables, effect of pressure, stationary phases, mobile phases, detectors, comparison with other types of chromatography, Applications,* supercritical fluid extraction: *Advantages of SFE, instrumentation, of line and on line extraction, applications.****(Ref-4:** 856-865,supplementary Ref-1)*

1. Analytical Chemistry, Ed. by Kellner, Mermet, Otto, Valcarcel, Widmer, Second Ed. Wiley –VCH
2. Practical High-Performance Liquid Chromatography, Veronika R. Meyer, Fifth Ed. John Wiley and Sons, Ltd.
3. Liquid Chromatography Mass Spectrometry: An Introduction by Bob Ardery, Publisher: Wiley India Pvt. Ltd. (2003). A book from series- Analytical techniques in the Science.
4. Principles of Instrumental Analysis, Skoog, West, Holler, 6th Ed. Cengage Publication.

Learning Objective - At the end of course students should able to-

1. Define / understand various terms in chromatography (GC and HPLC) and mass spectroscopy.
2. Explain instrumentations in chromatography (GC and HPLC) and mass spectroscopy.
3. Explain / describe i) basic principles of chromatography (GC and HPLC) and mass spectroscopy. ii) separation in GC / HPLC column. iii) Functioning and construction of GC / HPLC/ MS detectors.
4. Explain /Describe applications chromatography (GC and HPLC) in industry and in analytical laboratory.
5. Apply / select particular method / instrumental parameters for analysis for sample GC / HPLC.
6. Solve numerical problems on chromatography (GC and HPLC) and mass spectroscopy.
7. Integrate GC and HPLC chromatogram, Mass spectrum
8. Differentiate among the chromatography (GC and HPLC) methods of analysis.

CBOP-3, CHA-393: A) Bioanalytical Chemistry OR B) Analysis of Food and Controlled Substances

CBOP-3, CHA-393: A) Bioanalytical Chemistry [48L + 12T]

Section-I: Bioanalytical Techniques [24 L +6 T]

1. Introduction to Electrophoresis [6L]

General introduction to Electrophoresis: *Introduction and applications of electrophoresis*; Types of electrophoretic systems: *Moving boundary electrophoresis, Zone electrophoresis, Steady state electrophoresis;* Support media in Zone electrophoresis: *filter paper, cellulose acetate, gel media*; Factors Affecting Electrophoretic Mobility: *Characteristic of charged molecules, Characteristic of the electrophoretic system*; Detection in electrophoresis: optical methods, radiochemical methods, biological assay methods ***(Ref-1:*** 1-70)

2. Capillary Electrophoresis: Basics, Instrumentation and Application [10 L]

a) Basic Principles: Basic Electrophoretic Separation Modes, Zone Electrophoresis, lsotachophoresis, lsoelectric Focusing, Set-up for Capillary Electrophoresis, Theory of Electrophoretic Migration, Determination of Effective Mobility, Electroosmosis, Performance Criteria, Efficiency, Resolution. ***(Ref-2:*** *5-33)*

b)Instrumentation: Injection, Hydrodynamic Injection, Electro-kinetic Injection, General Aspects of Injection, Detection, General Aspects, Evaluation of Detector Performance, UV -VIS Absorbance Detection, Light Sources for UV -VIS Detection, Optical Layout of a UV -VIS Detector for CE, Design of the Detection Cell, Fluorescence Detection: Excitation Sources for Fluorescence Detection, Optical Layout of a Fluorescence Detector, Derivatization with Fluorescent Tags, Pre- and Post-Column Derivatization, Electrochemical Detection, Conductometric Detection, Amperometric Detection, Capillary Column, Sample Collection, Commercial Instruments. ***(Ref-2:*** *103-141, 151-158)*

c) Qualitative and Quantitative Analysis and Applications: General Aspects of Qualitative and Quantitative Analysis, Application: Drugs and Natural Products, Amino Acids, Peptides and Protein ***(Ref-2:*** *243-246, 261-274, 278-303).*

3. HPTLC and Detectors for HPTLC [8 L]

Thin layer chromatography, High performance thin layer chromatography. *(Ref-3)*

Planar Chromatography Detectors, Transmittance Measurements in Thin-Layer Chromatography, The Lambert-Beer Law, Reflectance Measurements in TLC and HPTLC, The Kubelka–Munk Equation, Reflectance Measurements with a Diode-Array Scanner, Spatial Resolution on the Plate, Spectral Distribution on HPTLC Plates, Spectral Evaluation Algorithm, Mass Spectrometric Detection in TLC, Direct Plate Extraction (SSSP), MALDI Techniques (MALDI-MS), Atmospheric Pressure Mass Spectrometry. Applications. ***(Ref-4:** 231-257)*

References:

1. Electrophoresis, Analytical chemistry through open learning Series, Wiley
2. Capillary Electrophoresis: Principles and Practice, R. Kuhn S. Hoffstetter-Kuhn, SpringerLaboratory, Springer-Verlag
3. Vogels's Textbook of Quantitative Chemical Analysis, 6th Ed.
4. Quantitative Thin-Layer Chromatography-A Practical Survey, Bernd Spangenberg, Colin F. Poole, Christel Weins, Published by Springer

Section-II: Clinical Analytical Chemistry [24 L +6 T]

1) Analysis of blood and urine[12 L]

a) Collection of Specimens: Blood: Collection of Blood specimens, storage and preservation, Urine: Collection of Urine, physical characteristics of urea, preservation and storage, Faeces: Collection and preservation. **b) Analysis of Blood and urine**: Determination of blood and plasma glucose by glucose oxidase method, Determination of urine for glucose, Determination of ketone bodies in blood, Oral Glucose tolerance test, Determination of serum creatinine, estimation of serum bilirubin, Estimation of serum cholesterol, determination of blood haemoglobin, Urate: determination of serum urate, Determination of urea in urine by urease method and by direct colorimetry, Estimation of Na, K, Ca by flame photometry, inorganic phosphate by colorimetry.**c) Determination of vitamins in body fluid:** Classification of vitamins with example, Each vitamin must be explained with respect of functions, deficiency diseases, daily requirement, and analytical method i) Retinol (determination of retinol and serum carotene in serum using TFA), Vit D_3 (cholecalciferol), Vitamin E (Tocopherols, Determination of serum tocopherol by spectrophotometry by dipyridyl method), Vitamin B_1 (thiamine determination by flurometry), Vitamin B_2 (riboflavin, Photofluorometric method), Vitamin B_6 (Pyidoxine, Fluorometric determination of Xanthuric acid), Nicotinic acid and Niacin: determination by fluorometry, Ascorbic acid (vitamin –c) Volumetric method using 2,6 dichlorophenol method, colorimetric determination of leucocyte ascorbate. **(Ref.-1,** Relevant pages**)**

2. Immunological methods of analysis [10 L]

a) Basic of immunology: The immune response, Antigen, Adaptive Immunity and Clonal Selection, Antibodies, Antigen (Antibody production in response to antigen stimulus, affinity and avidity, antibody production in response toimmunization vaccination, Antibody production in response to infectious agents, relation between antigen and antibody in vivo, diagnostic usefulness of antigen and antibody in infection disease), Antigenic Commonness, **b) Basic Principles of ELISA:** Reactions scheme, Direct

ELISA, Indirect ELISA, Sandwich ELISA, Competition EILISA, Choice of Assay, **Stages in ELISA:** Solid phase (Immobilization of antigen on solid phase coating, coating time and temperature, coating buffer, desorption, binding capacity, nonspecific binding, covalent antigen attachment), Washing, Addition of reagents, incubation, blocking conditions and non-specific reactions, enzyme conjugates, conjugation with enzymes, Development of label, stopping reactions, reading. **Practical Exercise for Direct ELISA**: Explain with respect to learning principles, reaction scheme, basis of assay, materials and equipment's, practical details, data explained, aspects of assay described, conclusions. The pregnancy test on urine. **(Ref-2, 3)**

3. Radioimmunoassay [2L]

Radioimmunoassay (RIA), Principle, RIA Reagents, RIA Steps, RIA Results Interpretation **(Ref-1, 4)**

References:

1. Varley's Practical Clinical Biochemistry, Gowenlock A. H., 6th Edition, 2006, CBS Publishers, New Delhi.
2. Methods in Molecular Biology, Vol-42, ELISA-Theory and Practice, by John R. Crowther, Humana Press, Totowa, New Jersey.
3. Enzyme-linked Immunosorbent Assay (ELISA) From A to Z, Samira Hosseini, Patricia Vázquez-Villegas, Marco Rito-Palomares, Sergio O. Martinez-Chapa, published by Springer,
4. Basic SerologicalTesting, Rowa Yousef Alhabbab, Published by Springer

Learning Objective - At the end of course students should able to-

1. Define / understand various terms in Electrophoresis, capillary electrophoresis, HPTLC, Body fluid analysis, ELISA, RIA.
2. Explain instrumentations in in Electrophoresis, capillary electrophoresis, HPTLC, Body fluid analysis, ELISA, RIA.
3. Explain / describe i) basic principles of chromatography (GC and HPLC) and mass spectroscopy. ii) Separation in GC / HPLC column. iii) Functioning and construction of GC / HPLC/ MS detectors.
4. Explain /Describe applications chromatography (GC and HPLC) in industry and in analytical laboratory.
5. Apply / select particular method / instrumental parameters for analysis for sample GC / HPLC.
6. Solve numerical problems on chromatography (GC and HPLC) and mass spectroscopy.
7. Integrate GC and HPLC chromatogram, Mass spectrum
8. Differentiate among the chromatography (GC and HPLC) methods of analysis.

CBOP-3, CHA-393: B) Analytical Methods of Food and Controlled Substances [48L + 12T]

Section-I: Analytical methods of Food [24 L +6 T]

1. Introduction to Food Analys *(Ref-1: 1-13)* **[1 L]**

2. Sampling and Sample Preparation [1 L]

Introduction, Selection of Sampling Procedures, Sampling Procedures, Preparation of Samples, Grinding, Enzymatic Inactivation, ***(Ref-1:** 71-80)*

3. Moisture and Total solids Analysis [1 L]

Introduction,Importance of Moisture Assay, Moisture Content of Foods, Forms of Water in Foods, Sample Collection and Handling, Oven Drying Methods:*General Information, Removal of Moisture, Decomposition of Other Food, Constituents, Temperature Control, Types of Pans for Oven DryingMethods, Handling and Preparation of Pans, Control of Surface Crust Formation (Sand Pan Technique), Calculations*; Distillation Procedures, Chemical Method: Karl Fischer Titration. ***(Ref-1** 87-96).*

4. Ash Analysis [1 L]

Introduction: *Definitions, Importance of Ash in Food Analysis, Ash Contents in Foods*; Methods: *Sample Preparation, Plant Materials, Fat and Sugar Products, Dry Ashing, Principles andInstrumentation, Procedures, Special Applications, Wet Ashing, Principle, Materials, andApplications, Procedures, Microwave Ashing, Microwave Wet Ashing, Microwave Dry Ashing, Other Ash Measurements, Comparison of Methods*

5. **Analysis of Lipids [5 L]**

a) Definition, Classification, General Considerations, Solvent Extraction Methods: Sample preparation, Solvent selection, Sample Preparation, Solvent Selection, Continuous Solvent Extraction Method: Goldfish Method, Semicontiguous Solvent Extraction Method: Soxhlet Method, Discontinuous Solvent Extraction Methods, Total Fat by GC for Nutrition Labelling (AOAC Method 996.06), Nonsolvent Wet Extraction Methods, Babcock Method for Milk Fat (AOAC Method 989.04 and 989.10), Gerber Method for Milk Fat, Instrumental Methods, Comparison of Methods. **(Ref.-1:** 119-130) **b) Characterization of Lipids** (bulk such as oils): Estimation of free fatty acids, Saponification value of oils, iodine value, Determination of acid value of oil, determination of peroxide value of oil, p-anisidine Value and Totox Value, Thiobarbituric Acid Reactive SubstancesTest, Conjugated Dienes and Trienes, Lipid Oxidation: Evaluating OxidativeStability, Methods for Lipid Components, Identification and quantification of fatty acids, Problem on quantitative methods. ***(Ref-1:** 241, 246-258, Supplimentory-2, 3).*

6. Proteins [5 L]

a. Protein Analysis: Introduction, Classification and General Considerations, Importance of Analysis, Content in Foods, Methods: Following methods with respect to principle, reactions, procedures and applications a) Kjeldahl's Method b) Dumas (Nitrogen Combustion) Method, c) Infrared Spectroscopy, d) Biuret Method e) Lowry Method f) Dye-Binding Methods g) Bicinchoninic Acid Method h) Ultraviolet 280nm, Comparison of Methods. (**Ref-**135 – 142, Supplimentory-2, 3). **b. Protein Characterization Procedures:** Amino Acid Analysis,Protein Nutritional Quality: Introduction, Protein digestibility, Protein efficiency ratio, and netprotein ratio, Other Protein Nutritional Quality Tests,Assessment of Protein Functional Properties, Determination of net protein utilization, digestibility and biological value, Problem on quantitative methods ***(Ref-1:** 271 - 277, Supplimentory-2, 3)*

7. Carbohydrates: [5 L]

Introduction, Mono- and Oligosaccharides: Extraction, Total Carbohydrate: Phenol-

Sulfuric AcidMethod, total reducing sugars by Nelson Somyogi method, Specific Analysis of Mono- and Oligosaccharides - High-performance Liquid, Gas Chromatography, Enzymic Methods, Chromatography, Mass Spectrometry, Thin-layer Chromatography, Polysaccharides: Starch, Total Starch, Degree of Gelatinization of Starch, Degree of Retrogradation of Starch, Non-starch Polysaccharides, Dietary Fibres: Major Components of Dietary Fibre, General Considerations, Methods. ***(Ref-1**: 149-169 Supplimentory-2, 3).*

8. Determination of food preservatives [5 L]

Definition, SO_2 legistration and determination by Tanners method, Nitrate and nitrites legistration and determination, boric acid legistration and determination, Benzoic acid legistration and determination, 4-hydroxybenzoate legistration and determination, ascorbic acid legistration and determination. Sweeteners: Saccharine identification and determination, Colours: Identification by general methods, Natural colours.Problem on quantitative methods. ***(Ref-4:** Relevant pages)*

References

1. Food Analysis, Edited by S. Suzanne Nielsen, Fourth Edition, Springer
2. Hand Book of Food Analytical Chemistry: Water, Proteins, Enzymes, Lipids, and Carbohydrates by Edited by Ronald E. Wrolstad, Terry E. Acree, Eric A. Decker, Michael H. Penner, David S. Reid, Steven J. Schwartz, Charles F. Shoemaker, Denise Smith, Peter Sporns, Wiley Interscience, a John Wiley &Sons, Inc., Publication.
3. Biochemical Methods, By S Sadashivan, A. Manickam; Third Edition, New Age International Publishers
4. Pearson's Chemical Analysis of Food

Section-II: Analytical Methods of Controlled Substances [24 L +6 T]

1. The narcotic drug and Psychotropic Substances (NDPS) Act-1985 [1 L]

Important Definition: *Drug, Cannabis (Indian Hemp), Cannabis Products, Coca-derivatives, Coca Leaf, Coca Plant, Illicit Traffic, Controlled Substance, Manufactured Drug, Opium, Opium Poppy, Poppy Straw, Poppy Straw Concentrate, Psychotropic Substance,* Prohibition Control and Regulation of NDPS (**Ref.-1**: 122-134, Ref-2)

2. Chemical Screening and Microcrystal Tests [2 L]

a) Chemical tests: Introduction, Chemistry of Color Formation, Limitations of Chemical Color Tests, Chemical Color-Test Methods, Documentation, Chemical Colour Tests: *Chen's Test, Dille–Koppanyi's Test, Mecke's Test , Marquis' Test, Nitric Acid Test, Primary Amine Test, Secondary Amine Test, Tertiary Amine Test, Van-Urk's Test, Duquenois–Levine Test, Froehde's Test, Janovsky Test, Weber Test.* **b)Microcrystal Techniques**: Introduction, Advantages of Microcrystal Techniques, Disadvantages of Microcrystal Techniques, Documentation, Microcrystal Test Techniques, Aqueous Test Technique, Volatility Test Technique, Acid and Anionic Test Technique, Aqueous Test Reagents, **(Ref-3:** 79-95)

3. Analysis of Drugs/Narcotics [21 L]

a) **Amphetamine and Related Compounds:** Introduction, Qualitative Identification of Amphetamines, Sampling and Physical Description of Amphetamines, Presumptive Testing of Amphetamines, Thin Layer Chromatography of Amphetamines, Definitive Identification of Amphetamines, Quantification of Amphetamines, Comparison and Profiling of Amphetamine Samples, The Leuckart Synthesis of Amphetamine, The Reductive Amination of Benzyl Methyl Ketone, The Nitrostyrene Synthesis, Impurity Extraction and Sample Comparison.***(Ref.-4:** 13-34)*

b) **The Analysis of LSD**: Introduction, Qualitative Identification of LSD, Sampling and Physical Description of LSD Blotter Acid, Extraction of LSD Prior to Analysis, Presumptive Testing for LSD, Thin Layer Chromatography of Samples Containing LSD, Confirmatory Tests for the Presence of LSD***(Ref.-4:** 37-43)*

***c) Cannabis sativa* and Products**: Introduction, Origins, Sources and Manufacture of Cannabis, Analytical Sequence, Bulk and Trace Sampling Procedures, Qualitative Identification of Cannabis, Identification of Herbal Material, Identification of Other Materials, Comparison of Cannabis Samples. ***(Ref.-4:** 49-65)*

d) **Diamorphine and Heroin:** Introduction, Origins, Sources and Manufacture of Diamorphine, Appearance of Heroin and Associated Paraphernalia, Bulk and Trace Sampling Procedures, Identification, Quantification and Comparison of Heroin Samples, Presumptive Tests for Heroin, Thin Layer Chromatography of Heroin Samples, Gas Chromatographic–Mass SpectroscopicIdentification of Heroin, Quantification of Heroin Samples, Comparison of Heroin Samples***(Ref.-4:** 73-92)*

e) **Cocaine:** Introduction, Origins, Sources and Manufacture of Cocaine, Extraction and Preparation of Coca Paste, Synthesis of Pure Cocaine, Qualitative Identification of Cocaine, Presumptive Tests for Cocaine, Thin Layer Chromatography, Definitive Identification of Cocaine, Quantification of Cocaine, Quantification of Cocaine by GC–MS, Quantification of Cocaine by UV Spectroscopy, Comparison of Cocaine Samples. ***(Ref.-4:** 97-109)*

f) Products from *Catha edulis* and *Lophophora williamsii*: Introduction, Products of Catha edulis, Identification, Quantification and Comparison of Khat Samples, Comparison of Khat Samples, Products of Lophophora williamsii, Physical Description and Sampling of Materials, Presumptive Tests for Mescaline, TLC Analysis of Mescaline, HPLC Analysis of Mescaline, GC–MS Analysis of Mescaline, Comparison of Peyote Samples. ***(Ref.-4:** 113-124)*

g) Analysis Barbiturates and Benzodiazepines: Introduction, Analysis of Barbiturates and Benzodiazepines, Extraction of Barbiturates and Benzodiazepinesfrom Dose Forms, Presumptive Tests for Barbiturates and Benzodiazepines, TLC of Barbiturates and Benzodiazepines, Confirmatory Analysis of Barbituratesand Benzodiazepines, Quantification of Barbiturates and Benzodiazepines, Introduction, Products of *Catha edulis,* Identification, Quantification and Comparison, of Khat Samples, Comparison of Khat Samples, Products of *Lophophora williamsii,* Physical Description and Sampling of Materials, Presumptive Tests for Mescaline, TLC Analysis of Mescaline, HPLC Analysis

of Mescaline, GC–MS Analysis of Mescaline, Comparison of Peyote Samples. ***(Ref.-4: 139-149).***

Reference

1. Textbook of Forensic Pharmacy, C. K. Kokate, S. B. Ghokhale, Pharma Med Press (2008)
2. Textbook of Forensic Pharmacy, B. M. Miital
3. Basic Principles of Forensic Chemistry, Javed I. Khan, Thomas J. Kennedy, Donnell R. Christian, Jr. Humana Press
4. Analysis of Controlled Substances, Michael D. Cole, Wiley (2003)

Learning Objective - At the end of course students should able to-

1. Define / understand various terms in food analysis techniques and methods, forensic science and drug substances.
2. Explain methods and principles of analysis of i) Food - carbohydrates, proteins, preservatives, ii) drug substances.
3. Select appropriate methods of food analysis for its quality.
4. Select appropriate methods for identification of drug and analysis of drug from sample.
5. Select and describe the parameters required for food quality.
6. Solve numerical problems on analysis food and drug substances.
7. Interpret food quality and drug substances from analytical results.
8. Differentiate among the different methods of analysis of food and drug substances.

CCPP-3:Practical I: Basics of Instrumental Methods of Chemical Analysis [96 L+24 T]

Section-1: Analytical method Development and Validation

Expt. No	Name of Experiments
Compulsory experiment	
1	**Demonstration Practical:**a. Calibration of UV-Visible spectrophotometer for control of absorbance as per IP or BP b) Theoretical basis for the choice of solvent for recording UV-Visible spectra of substances c) Theoretical basis for choice proper concentration for recording the UV-Visible spectrum d) Recording the UV-Visible spectrum of any one substance like caffeine, aspirin, paracetamol, $KMnO_4$ or any other substance of interest having characteristic UV-Visible absorbance i) identification of characteristics peaks in spectrum, b) Choice of λ_{max} for quantitative analysis c) Calculation of Molar absorptivity (ε) and d) Sp. absorbance (absorbance of sample solution for 1% solution). Theoretical interpretation of spectra. (Ref-6,7)
2	**Table Work:** a) Theorical basis of method development and validation – Accuracy, precision, noise level, detection limit, quantitation limit, Calibration curve and standard addition method and theoretical basis of choice between two, b) Expression of results: Calculation of mean, standard deviation, error and absolute error, elimination of data, c) Regression analysis of calibration curve and its importance. (Ref-3)
3-7	**Analytical method development and validation (Ref. 1, 6, 7)** Study of visible spectroscopic or colorimetric method for estimation of particular metal ion or non-metal ion or organic substance with respect to: a) Selection of ligand

/ reagent and colour formation method b) Choice of reaction cond. such as concentration of analyte and colour forming reagent, pH for colour formation reaction, etc. c) Determination of λ_{max} for quantitative analysis d) estimation of noise level, detection limit, quantisation limit and linearity range (Calculate R^2 value). Thereby set conc. limits for calibration curve method and standard addition method. e) Estimation of known of metal ion by calibration curve method and by standard addition method in triplicate for the validation of method. f) Estimation of metal ion from sample by calibration curve method and by standard addition method in triplicate (Regression analysis must be performed for both methods and results shall be accepted when R^2 is greater than 0.95) g) Detection of possible interfering metal ion.

Some suggested examples:

i) Colorimetric / visible spectrophotometery Cu(II) or Co(II) – R-nitrososalt and estimation of Cu(II) (Sample - alloy brass or bronze or coin) (Cent. Eur. J. Chem.10(5), 2012, 1617-1623, DOI: 10.2478/s11532-012-0081-7)

ii) Colorimetry / visible spectrophotometery Mn(II)-Formaldoxime or Mn(II)-oxidized to $KMnO_4$ (sample - tea leaves on ashing or plant micronutrient supplement). (Ref.- 1, 7)

iii) Colorimetry / visible spectrophotometery B as borate with curcumin reagent (Sample – Talcum powder can be taken) (Ref-1 and 3)

iv) Colorimetry / visible spectrophotometery Ni(II) or Co(II) by alfa nitroso beta-napthol (Sample - Steel alloy). Ref-1 and Monatshefte Fur Chemic 111, 1413 1425, Springer-Verlag 1980

Note: A student can select any other metal and own synthesized ligand system under the guidance of his mentor.

Some examples of non-metal ions

i. NO_3^- or NO_2^- by colorimtry / visible spectrophotometery (Ref- 1 and 2)

ii. NH_4^+ or NH_3 by colorimetry / visible spectrophotometery (alkaline phenol-perchlorate reagent) (Ref-1 and 2)

iii. SO_4^{2-} by Colorimetry/ visible spectrophotometeryetric (Ref-1)

Examples of Organic substances

i) Analysis of aspirin Colorimetry (Ref. 11)

ii) Assay of Vitamin-C by Colorimetry from lemon or orange juice (Ref- 12)

iii) Colorimetry / visible spectrophotometery phenolic compounds (Salicylic acid, salbutamol sulfate, phenol) by Folin-Ciocalteau reagent (Ref-4)

v) Colorimetry / visible spectrophotometery Analysis of paracetamol (Ref-8)

Note: i)A mentor can practice multiple examples in batch**.** ii)*Student shall prepare systematic report in the form of journal which will contain 1) introduction to UV-Visible spectroscopy, basic terms in absorption spectroscopy, Beer's law, construction and working of colorimeter and spectrophotometer, interpretation of absorbance spectra of organic and inorganic substances, basis of quantitative analysis by UV-Visible spectroscopy, calibration curve method, standard addition*

	method, advantages of graphical methods, basis for simultaneous method analysis of non-interfering substance by spectrophotometry. This part will be followed by experiment 3 to 7.
Any three experiments	
8	Analysis of Riboflavin by visible spectrometry and Photoflurometry. Compare results with respect to sample requirement, detection limit, accuracy of both methods. Give your choice for analysis of i) Riboflavin as raw material in pharmaceutical industry and ii) blood/ urine/vitamin supplement. Explain reason for choice of method. *(Ref-4, 6 and 9).*
9	Comparison of end point redox titration between $K_2Cr_2O_7$ and standard Fe(II) i) by potentiometry and ii) external indicator. Calculate amount of Fe(II) by both methods and compare with standard value. Give critical comment on Fe(II) content by two methods with respect to standard value i.e. accuracy of results and advantages and disadvantages of each method. *(Ref-3)*
10	Determine amount of $NaHCO_3$ from eating soda sample or from mixture of $NaHCO_3$ + Na_2CO_3: Determine amount of $NaHCO_3$ by thermal decomposition method (gravimetry) on burner as well as by volumetric method using standardized 0.05 N HCl. Compare purity or amount of $NaHCO_3$ in sample by both methods. Comment on advantages and disadvantages of each methods. Give your choice of method between two. *(Ref-3)*
11	Perform pH metric titration for estimation of CH_3COOH from vinegar using i) 0.1 M standardized NaOH simultaneously using phenolphthalein indicator and pH meter ii) 0.5 M standardized NaOH using pH meter. Compare the results of three methods and give your comment. *(Ref-3)*
12	Determine aspirin in tablet conventional titration and by potentiometric titration and compare the results of two method. *(Ref-10)*
13	Development of turbidimetric method for estimation of i) PO_4^{3-} at low level using ammonium molybadate reagent or ii) S^{2-} using reaction with suitable metal ion such as Cu(II). iii) estimation of Mg(II) by Nessler's reagent***. (for self development)***
14	**Qualitative and confirmatory test for (minimum four)** Test for aniline / para aminophenol, Test for antimony / mercury (No C.T.), Test for Borate (use talcum powder), Dinitrophenol pesticides, Ethanol / methanol, Formaldehyde, Hypochlorites, Iodates, Nitrate / nitrite, Paracetamol, Phenol, Salicylic acid its derivatives, Thiocynates (**Note:** Aq. Solutions shall be given containing prescribed conc. in monograph of the substance). (Ref-13).
	References: 1. Separation, Preconcentration and Spectrophotometry in Inorganic Analysis, by Z. Marczenko and M. Balcerzak, Analytical Spectroscopy Library – 10, Elsevier 2. Standard methods for the examination of water and wastewater, 23rd Ed. Roger B. Baird, Andrew D Eaton, Eugene W. Rice, American Public Health Association, Americal water works association, Water environment federation.

	3. Vogels textbook of Inorganic Quantitative Analysis, 4. Biochemical Methods, Third Edition, By S Sadashivan, A. Manickam; New Age International Publishers 6. Indian Pharmacopeia: 2007, Vol-1, 2, 3. 7. Chemical Analysis and Material Characterization by spectrophotometry, Bhim Prasad Kafle, Elsevier 8. Ultraviolet and Visible Spectrophotometry in Pharmaceutical Analysis, Sandor Gorog, Published by CRC press, Taylor and Fransis. 9. An introduction to Practical Bichemistry, David T. Plummer, Tata McGraw-Hill publishing Company Ltd. 10. Experiments in chemistry, D. V. Jahagirdar, Himalaya Publishing Company 11. Method Development for Analysis of Aspirin Tablets, Journal of Chemical Education, Volume 65 Number 10 October 1988. 12. Vitamin C as a Model for a Novel and Approachable Experimental Framework for Investigating Spectrophotometry, Journal of Chemical Education, DOI:10.1021/acs.jchemed.9b00197. 13. Basic Analytical Toxicology, R. J. Flangan, R. A. Braithwait, S. S. Brrown, B. Viddop, F. A. de Wolff, published by WHO.

Section – II: Introduction to Analytical Techniques (12 experiments)	
Nitrogen Estimation	
1	Estimation organic nitrogen by Kjeldahl's Method or semi-micro Kjedahl's method (example: milk powder, soil sample, cooked food containing pulses, fertilizer etc.). *(Ref-1)*
Solvent Extraction	
2	Extraction of organic substance by Soxhelet or semi micro Soxhelet extraction (such as Essential oils, carotenoids from carrot, Caffeine for tea powder) and their isolation from solvent. Purity by TLC, BP/MP. *(Ref-7)*
3	Isolation of carotenoids from spinach / lycopene from tomato. TLC separation to find out number of carotenoids. *(Ref-6, 15)*
Solid Phase Extraction, Ion exchange chromatography	
4	Determination of Ion exchange capacity of ion exchange resins *(Ref-1).*
5	**Solid Phase Extraction:** Isolation of amino acids from aqueous sample using ion exchange resin and their identification by colorimetric test (very dilute glycine solution can be used as an example of alfa amino acid) *(Ref. 5)* Or Isolation of caffeine using RP C-18 cartridge from cold drinks and quantitative estimation *(Ref-7)* Or Isolation of beta carotene from spinach leaves on silica gel cartridge by solid phase extraction and its quantification visible spectrophotometry. *(Ref-7)*
6	**Pre conc. using solid phase extraction on ion exchange cartridge and estimation.** You can any choose any metal ion which is present below detection limit. You will do preconcentration using ion exchange resin and will estimate by AAS or aqueous

	colorimetry (not solvent extraction). Example: Preconcentration of Cu(II) from brine (one can use aqueous solution of Cu(II) solution with less than 0.5 ppm conc.) and its estimation using R-Nitroso salt *(Ref-1, 4)*
Flame photometry	
7	Flame photometric analysis of water /soil sample for Na^+ and K^+ by calibration curve method (give regression analysis for both curves) *(Ref-1)*
8	Estimation of K^+ from soil/water sample by internal standard and its confirmation by standard addition method (give regression analysis of both curves) *(Ref-1)*
Methods of Trace Analysis of metals: Atomic Absorption Spectroscopy	
9	**Demonstration Practical by Mentor:** Handling of AAS and study on any metal ion estimation by AAS method with respect to 1) Effect of oxidant to fuel ratio on absorbance, ii) detection limit and iii) linearity range for calibration curve method. (give regression analysis) iv) Effect of other metal ion and absorbance of analyte. *(Ref-1, 15)*
10	Estimation of any two-metal ion by atomic absorption spectroscopy from soil or micronutrient supplement or food sample. *(Ref-1, 15)*
Turbidimetry / Nephelometry	
11	Selective estimation of Cl^- from water or saline sample or food sample by calibration curve method using turbidimetry (give regression analysis) and its confirmation by standard addition method. *(Ref-1)*
12	Selective estimation of SO_4^{2-} in presence of chloride from water sample or any other sample by calibration curve and its confirmation by turbidimetric titration method (give regression analysis for both curves).*(Ref-1)*
Photoflurimetry	
13	Estimation of quinine sulphate from tablet by calibration curve and its confirmation by standard addition method. *(Ref-1)*
14	Determination of Zn(II) by Photoflurimetry *(Ref-1)*
Polarimetry	
15	a) Determination of optical rotation thereby calculate specific rotation of dextrose (glucose) and sugar (sucrose). Express purity of glucose and sugar samples on the basis of specific rotation. (Ref-2) b) Determination of glucose in DNS saline and glucose supplement (Glucon-D) sample by polarimeter. *(Ref-2)*
Quantitative TLC	
16	Separation of Colours by TLC / Paper chromatography, their isolation by elution from paper or TLC and quantification by colorimetry. *(Ref-1)*
17	Analysis of the Composition of a Mixture of Nitroanilines by Thin-Layer Chromatography and Ultraviolet/Visible Spectrometry *(Ref.-8)*
HPLC	
17	**Demonstration Practical by Mentor** i. Handling of HPLC equipment, choice of mobile phase and column, sample

	preparation. ii. Record the chromatogram of pure substance and study a) Effect of conc. on peak area and peak height b) from retention time and length of column calculate number theoretical plates from. c) Qualitative analysis – spiking method and by using retention time d) Quantitative analysis by comparing peak height of sample with standard as well as by comparing peak area of sample with standard.*(Ref.-1, 14, 15)*
18	Estimation of APC tablet by HPLC method *(Ref-1, 3, 8)* or HPLC method developed in your laboratory.
Gas Chromatography	
19	**Demonstration Practical by Mentor** Study of GC chromatogram: Record the chromatogram of pure ethanol, acetone, methanol and their mixture. Identify peaks of respective substances in mixture and calculate relative percentage of these three substances by percent area method. Calculate N, resolution of chromatographic column. *(Ref-1)*
20	Analysis of vitamin-A acetate or alfa-tocopherol by GC according to IP method or any other reported method or method developed in your laboratory. *(Ref-2)*
Thermogravimetric Method	
21	**Demonstration Practical by Mentor** Study of GC chromatogram: Record the TGA of pure $NaHCO_3$ (room temp to 300 °C). Explain different characteristics of thermogram and quantitative analysis by TGA. Explain how thermal decomposition reaction can be predicted from wt. loss.
22	TGA analysis of dolomite ore for $CaCO_3$ and $MgCO_3$ content *(Ref-1)*
23	TGA analysis $CuSO_4\,5H_2O$ *(Ref-1)*
Cyclic Voltammetry	
24	Cyclic voltammetric study of Fe(II)/Fe(III) system. Basic principle and calculation of basic parameters from CV. *(Ref-1, 10, 11)*
25	Quantitative analysis using CV of any one -Vit-C / parathion / nitrobenzene / or any other substance for which your department has developed CV method. (Ref.-12,13).
Students Self activity	
1	**a) Compulsory:** Prepare report on construction, working, representation, uses and care of electrodes: Calomel electrode, silver-silver chloride electrode, platinum electrode, conductivity cell, and combine glass electrode. (***Ref-1).*** b) Actual construction of standard silver-silver chloride as reference electrode (Replacement to saturated calomel electrode as it contain highly toxic Hg(II), Hg(I) and Hg metal), salt bridge and their testing. ***(Ref-9).*** c. Construct graphite electrode using graphite rod or used dry pen-cell. Perform redox titration using graphite electrode prepared by you and calomel as reference electrode. Perform same titration using Pt electrode and calomel electrode. Report does Pt can be replaced by graphite or not. Give the reasons.
References: 1. Vogel's Textbook of Quantitative Chemical Analysis, 6^{th} Ed.	

2. Indian Pharmacopeia, 2007
3. Chemical Separations Principle techniques and Experiments, Clifton E Meloan, Wiley Interscience.
4. Separation, Preconcentration and Spectrophotometry in Inorganic Analysis, by Z. Marczenko and M. Balcerzak, Analytical Spectroscopy Library – 10, Elsevier
5. Standard methods for the examination of water and wastewater, 23rd Ed. Roger B. Baird, Andrew D Eaton, Eugene W. Rice, American Public Health Association, Americal water works association, Water environment federation.
6. Biochemical Methods, Third Edition, By S Sadashivan, A. Manickam; New Age International Publishers
7. Extraction technique in Analytical Science, John R. Dean, Wiley
8. Experiments in modern analytical chemistry, D. Kealey, Springer Science Business media, 1986.
9. Student Construction of a Gel-Filled Ag/AgCl Reference Electrode for Use in a Potentiometric Titration, Journal of Chemical Education, Vol. 76 No. 1 January 1999
10. https://chem.libretexts.org/Courses/University_of_California_Davis/UCD_Chem_115_Lab_Manual/Lab_1%3A_Cyclic_Voltammetry
11. Cyclic Voltammetry Experiment James J. Van Benschoten. Jane Y. Lewis, and William R. Heineman, Journal of Chemical Education, Volume 60, Number 9, September 1983 (772-776) and Volume 60 Number 9 September 1983 (702-706)
12. Voltammetric analysis of hydroquinone, ascorbic acid, nitrobenzene and benzyl chloride in aqueous, non-aqueous, micellar and microemulsion media, R. Sripriya M. Chandrasekaran M. Noel, Colloid Polym. Sci (2006) 285: 39–48.
13. Electrochemical Determination of Methyl Parathion using a Modified Electrode, Toxicol. and Environ. Chem., 2003, Vol. 85, Nos. 4–6, pp. 233–241.
14. Analysis of Soft Drinks: UV Spectrophotometry, Liquid Chromatography, and Capillary Electrophoresis, Journal of Chemical Education, Vol. 75 No. 5 May 1998
15. Analytical Chemistry for Technicians, John Kenkel, Third Edition, CRC Press LLC, 2003.

Learning Objective –

At the end of course students should able to-

1 Maintain proper record of analytical data in notebook. Observer personal safety in laboratory and able handle all chemicals, instruments, etc safely in laboratory.
2. Define / understand various terms involved practical methods of quantitative analysis.
3. Explain instrumentations of colorimeter, spectrophotometer, photoflurometer, TGA, HPLC, GC, Flame-photometer, CV, AAS, etc.
4. Explain / describe basic principles of chromatography different instrumental methods of analysis. Able to handle particular instrument according to SOP.
5. Design / modify and validate new analytical method for chemical analysis of particular sample.
6. Apply / select particular method / instrumental parameters for analysis of given sample.
7. Give mathematical treatment to analytical data and able to interpret the results accurately.
8. Verify theoretical principle practically or apply theory to explain practical observations.
9. To conclude the results able to take the decision regarding quality of sample.

10. Differentiate among the various analytical methods / techniques of chemical analysis.

Semester-IV

CCTP- 10, CHA-490: Advanced Analytical Spectroscopic Techniques

[48L + 12T]

Section-I: Atomic Spectroscopic Methods [24 L +6 T]

1. Sample preparation techniques [2 L]

Introduction, aqueous sample, liquid-liquid extraction, Ion exchange, co-precipitation, solid samples: decomposition techniques, microwave digestion, dry ashing, fusion, Extraction procedures: Single extraction, sequential extraction, enzymatic digestion *(Ref-1: 17-36, Supplementary reference - 2)*

2. Atomic Absorption and emission Spectroscopy [6 L]

Introduction, Atomic spectra, Instrumentation of AAS: Sample introduction system: Nebulizers, Laser Ablation technique, hydride vapour generators, automizers: Flame atomizer - premix burner, fuel gases and oxidants, graphite furnace, hydride generator, cold vapour technique, Hollow cathode lamps, spectrophotometers, detectors, Interferences in AAS (spectral and chemical), Quantitative analysis (calibration curve method, standard addition method, internal standard addition method), Practical applications of AAS from *Ref-3*. *(**Ref-3**: Relevant pages, Supplementary references4,5)*

3. Inductively Coupled Plasma AES and MS [10 L]

a. Inductively Coupled Plasma AES: Introduction to Atomic emission spectroscopy, inductively coupled plasma, Direct current plasma, microwave induced plasma, glow discharge, plasma spectroscopy, spectrometers, Detectors, interferences.

b. Inductively Coupled Plasma MS: Fundamental of MS, Inorganic mass spectroscopy, Interface, mass spectrometer, quadrupole mass analyser, detectors, interferences, isotope dilution analysis, mass spectral interpretation. ***(Ref-1:**57-117, supplementary Ref- 6)*

c. Applications: Forensic analysis of documents, Clinical analysis of blood and urine, ***(Ref-1:** Relevant pages).* Analysis of metals from waste water sample of ICP-MS method *(Ref-2, sec. 3120, 3125)*

4. Atomic Fluorescence Spectroscopy [6 L]

Atomic fluorescence, Apparatus for AFS, EMR source for AFS, LASERS, Cells for AFS, Plasmas- ICP and DCP, Detectors, theory of AFS, Analysis with AFS, Interferences with AFS, Resonant ionization Spectroscopy, LASER enhanced ionization spectroscopy.*(Ref-5)*

5. Elemental Analysis [2 L]

Particular analyses, Elemental organic microanalysis, Total nitrogen analysers (TN), Total sulphur analysers, Total carbon analysers, problems on empirical and molecular formula on CHONS analysis. ***(Ref. -7:** 441-450)*

Reference

1. Practical Inductively Coupled Plasma spectroscopy, John R. Dean, Wiley India Pvt. Ltd. (AnTs Series book)
2. Standard methods for the examination of water and waste water, 23rd Ed. Jointly published by American Public Health Association, American Water Work Association, Water

Environment Federation. 2017.
3. Vogels, Quantitative Chemical Analysis, 6th Ed.
4. Principles of Instrumental Analysis, Skoog, West, Holler, 6th Ed. Cengage Publication.
5. Introduction to Instrumental Analysis by R. D. Braun
6. Practical Guide to ICP-MS, Edited by Robert Thomas, CRC press, Francis and Taylor.
7. Chemical Analysis Modern Instrumentation Methods and Techniques, Francis Rouessac and Annick Rouessac, Second Edition, John Wiley & Sons Ltd.

Section-II: Molecular Spectroscopic Methods [24 L +6 T]

1. Molecular Luminescence spectrometry [6 L]

Introduction, theory of fluorescence and phosphorescence: *excited state producing fluorescence and phosphorescence, energy level diagram, rate of absorption and emission, deactivation process, variables affecting fluorescence and phosphorescence, Emission and excitation spectra*; Instruments for measuring fluorescence and phosphorescence: *Components of Fluorometers and Spectrofluorometers, Instrument Design, Correction andCompensation Schemes, Instrument standardization;* Applications of Photoluminescence Methods: *Methods for Organic and Biochemical Species, Phosphorometric method, Fluorescence Detection in Liquid Chromatography, Lifetime measurement, Fluorescence imaging;* **Chemiluminescence:** The Chemiluminescencephenomenon, measurement of chemiluminescence, analytical applications, problems. ***(Ref.-1:****399-426)*

2. Electron Paramagnetic Resonance Spectroscopy [12 L]

Basic Theory: general remarks, electron spin and magnetic moment, ESR transitions, Selection rules, g-factor, presentation of spectra, interaction of magnetic dipole with microwave radiations, Larmor precision, resonance phenomenon, relaxation process, transition probability. **Hyperfine Structure:** Nuclear hyperfine splitting, radical containing one proton, spin Hamiltonian, selection rules, radical containing a set of equivalent protons, radical containing a set of multiple protons, radical containing multiple sets of protons (I = ½), radical containing multiple sets of proton (I > ½), Atomic radicals, Origin of hyperfine interaction, sigma radicals, assignments of spectra using Huckel MOs, alternant hydrocarbons, hyperfine splitting constants, second order splitting, Applications.*(**Ref-3:**Relevant pages, Supplementary Ref-4)*

3. Electron Spectroscopy for Surface Analysis [6 L]

Basic principles, x-ray photoelectron spectroscopy, Auger Electron spectroscopy, Instrumentation: *ultra-high vacuum, source gun, electron gun, Ion gun, electron energy analysers*, Characteristics of Electron spectra: *photoelectron spectra, Auger electron spectra*, Qualitative and quantitative analysis: *qualitative analysis, peak identification, chemical shift, problems with insulating materials, Quantitative analysis: peak and sensitivity factor, composition depth profiling.**(Ref-2:** 221-250).*

References:

1. Principles of Instrumental Analysis, Skoog, West, Holler, 6th Ed. Cengage Publication.
2. Materials Characterization, introduction to microscopic and spectroscopic techniques, Yang Leng, 2nd Wiley-VCH.
3. Introduction to Magnetic Resonance of Spectroscopy ESR, NMR, NQR, D.N.

Sathyanarayana, I. K. International Publishing House Pvt. Ltd.

4. Structural Methods in Molecular Inorganic Chemistry, DavidW. H. Rankin, NorbertW.Mitzel, Carole A. Morrison, Wiley (JohnWiley & Sons, Ltd.), 2013

Learning Objective - At the end of course students should able to-

1. Define / understand various terms in atomic absorption, atomic emission, fluorescence, ESR and electron spectroscopy.
2. Explain instrumentation of atomic absorption, atomic emission, ICPAES, ICPAES-MS, fluorescence, ESR and electron spectroscopy.
3. To describe basic principles of atomic absorption, atomic emission, ICPAES, ICPAES-MS, fluorescence, ESR and electron spectroscopy.
4. Select appropriate methods for sample treatment in AAS / AES, ICPAES, ICPAES-MS.
5. Explain advantages of ICPAES-MS over AES spectroscopy, fluorescence spectroscopy.
6. Solve numerical problems on analysis all these spectroscopic methods.
7. Interpret ESR spectra, super hyperfine splitting and g value in ESR, and parameters affecting it.
8. Calculate theoretical parameters from ESR data and characterize compound.
9. Solve problems based on atomic absorption, atomic emission, ICPAES, ICPAES-MS, fluorescence, ESR and electron spectroscopy.

CCTP-11, CHA-491: Chemical Methods of Pharmaceuticals Analysis

[48L + 12T]

Section-I: Pharmaceutical Dosage forms and General Methods Analysis [24 L +6 T]

1. Pharmaceutical Dosage Forms [4 L]

Capsules: *Definition, types of capsules, Tests;* Creams: *Definition, tests;* Ear Drops: *Definition, tests;* Eye Drops: *Definition, tests;* Gels: *Definition*, Inhalation Preparations*: Definition, Uniformity of delivered, Number of deliveries per container dose, Uniformity of delivered dose (only);* Nasal preparations: *Definition and tests;*Ointments: *Definition and tests;*Oral Liquids: *Definition, types and tests;* Oral Powders: *Definitionand tests;*Parenteral Preparations: Introduction, Injections: *Definition and tests*, Infusion: *Definitionand tests;*Powder for Injection: *Definitionand tests;* Tablets: *Definition, types of tabletsand their tests.(Ref-2: 14 - 47)*, Shelf life of pharmaceutical preparation.

2. Chemical Test, Limit Test and Assay [6 L]

Important Note: Write the chemical reaction and explain theoretical basis of the limit tests and assay though it is not given in reference book.

a) Limit Tests: Aluminium, Aluminium in Adsorbed Vaccines, Arsenic, Calcium in Adsorbed Vaccines, Chlorides, Heavy metals, Iron, Lead, Potassium, Sulphates, Sulphated Ash, Total Ash, Free Formaldehyde, N-N-Dimethylaniline *(Ref-1: 74-80, Ref.-4, 93-149)*

b) Assays: Acetyl Value, Acid Value, Cineole, Ester, Ester Value, Hydroxyl Value, Iodine value, Nitrogen, Methoxyl, Nitrite Titration, Peroxide Value, Saponification Value, Assay of Steroids, Unsaponifiable Matter, Assay of Vitamin A, Assay of Vitamin D, Water-(*Titration method and azeotropic distillation method*), Zinc, Ethanol, Assay of Insulins*(Ref-1: 80-99, Ref-3)*

3. Pharmaceutical Methods of Determination [6L]

Disintegration Test, Dissolution Test, Uniformity of Weight of Single-Dose Preparations,

Uniformity of Content of Single-Dose Preparations, Friability of Uncoated Tablets, Contents of Packaged Dosage Forms, Powder Fineness, Particle Size by Microscopy, Particulate Contamination. *(Ref-1: 175-188*)

4.Microbiological Assay of Pharmaceuticals [8 L]

Biological assay in general, **a) Agar diffusion assay – Quantitative basis:***Introduction, The theory of zone formation, what happens in practice, principles of calculation of potency estimate*; **b) The Theory and Practice of Tube Assay- Growth promoting substances**: *Introduction, the mode of action of growth limited by amino acids, growth limited by vitamins, production of acid by lactobacilli, clinical factor in the assay of growth promoting substances*; c) **The Theory and Practice of Tube Assay-Growth Inhibiting Substances:***Introduction, measurement of response, the forms of response line, historical development of the turbidimetric method, linearization of sigmoid curve, the quantitative theory of microbial growth and inhibition, a practical determined log dose – response curve, factor affecting finals cell count, the influence of temperature, the influence of time,* **d) What do we want assay**: *pharmacopeial intension and control of antibiotic bulk materials, control in routine in manufacture, Research and development*; d**) General Practical Aspects of Microbiological Assay:** Introduction, test solutions (weighing – sample of unknown, dilution of primary solution to test level, problem with very dilute solutions, the assay medium), selection of Latin squares and plating routine, Aspects of technique (the test organism, inoculating the medium, assay plate, assay tube, diluents, the sample, test solution and the effect of contamination, application of test solution-agar diffusion assay, application of test solution-turbidimetric assay; Calculation of potency, **e) Standard and reference materials***(Ref-4: 1, 9-18, 23-35, 37-56, 59-64, 65-77, 79-84, Ref-1: 45-52)*

Section-II: Analysis of Raw Materials and Active Ingredients [24 L +6 T]

1. Introduction to Pharmaceutical Analytical Chemistry [1 L]

Introduction, Official European Pharmacopoeia definitions, Pharmaceutical Analytical Chemistry, Manufacture of Pharmaceuticals, Development of New Drugs, Use of Pharmaceuticals ***(Ref-3:** 1-7)*

2. Marketing Authorizations, Pharmaceutical Manufacturing, and International Pharmacopoeias [1 L]

Introduction, Marketing Authorization and Industrial Production, Pharmacopoeias, Life Time of Pharmaceutical Preparations and Ingredients. ***(Ref.3:** 9-14)*

3. Chemical Analysis of Pharmaceutical Ingredients [12 L]

Pharmaceutical Ingredients, Production, and Control, Pharmacopoeia Monographs, Melting point capillary method, (monograph on paracetamol and acepromazine malate tablet, acetaminophen, acetaminophen capsules, caster oil virgin, cefaclor), Impurities in Pharmaceutical Ingredients*: Impurities in Pure Chemical Ingredients, Impurities in Organic Multi-Chemical Ingredients*; Identification of Pharmaceutical Ingredients: IR Spectrophotometry *(identification of ibuprofen, Identification of spironolactone***)** , UV-Vis Spectrophotometry (*Identification of mianserin hydrochloride*), Thin-Layer Chromatography (*Identification of metrifonate***)**, Melting Point, Optical Rotation (*Optical*

*rotation for simvastatin***)**, Liquid Chromatography *(Identification of calcitriol),* Chloride *(Identification of chloride in chlorcyclizine hydrochloride)* and Sulfate, Identification, Impurity Testing of Pharmaceutical Ingredients (Pure Chemical Ingredients): Appearance of Solution (*Appearance of solution for ibuprofen***)**, Absorbance (*Absorbance and color of solution of esomeprazole magnesium***)** pH and Acidity or Alkalinity (*pH of esmolol hydrochloride, Acidity or alkalinity of dopamine hydrochloride***)**, Related Substances (*Related substances according to Ph. Eur. for omeprazole***)**, Residual Solvents (*Limit of acetone in olmesartan medoxomil***)**, Foreign Anions (*Test for foreign chlorides and sulfates in furosemide*), Sulfated Ash (*Residue on ignition for acetaminophen***)**, Elemental Impurities (*Test for foreign zinc in human insulin***)**, Loss on Drying (*Loss on drying for paracetamol***)**, Water (*Determination of water in ephedrine*), Identification and Impurity Testing of Organic Multi-Chemical Ingredients: *Oxidizing Substances,* ***Only importance of the should be explained*** *- Acid Value, Hydroxyl Value, Iodine Value, Peroxide Value, Saponification Value, Unsaponifiable Matter),* Other Tests (*Chromatographic profile for peppermint oil***)**, Assay of Pharmaceutical Ingredients, Aqueous Acid–Base Titration (*Assay of omeprazole, amitriptyline hydrochloride, ephedrine hydrochloride, ephedrine*), Non-Aqueous Acid–Base Titration (*metronidazole benzoate, lidocaine***)**, Redox Titrations (*ferrous fumarate*), Liquid Chromatography (*Assay of simvastatin*), UV-Vis Spectrophotometry (*Assay of hydrocortisone*). *(**Ref-3:** 305-388)*

4. Chemical Analysis of Pharmaceutical Preparations [10 L]

Chemical Analysis of Pharmaceutical Preparations, Monographs and Chemical Analysis (*BP monograph for paracetamol tablets***)**, Identification of the API: Identification by IR Spectrophotometry (*Identification of aspirin, fluoxetine in fluoxetine hydrochloride oral solution, Identification of mupirocin in mupirocin calcium nasal ointment*), Identification by Liquid Chromatography (*Identification of fluoxetine in fluoxetine hydrochloride, droperidol in droperidol injection, Beclomethasone Dipropionate in Beclomethasone Dipropionate Ointment*), Identification by UV-Vis Spectrophotometry (*Identification of Diazepam in Diazepam Tablets, Flupentixol Decanoate in Flupentixol Decanoate Injection, Miconazole in Miconazole Nitrate Cream*), Assay of the Active Pharmaceutical Ingredient, Assays Based on Liquid Chromatography (*Assay of Omeprazole, Fentanyl in Fentanyl Citrate Injection, Assay of Hydrocortisone in Hydrocortisone Ointment*), Assays Based on UV Spectrophotometry (*Assay of Paracetamol in Paracetamol Tablets, Assay of Doxapram in Doxapram Hydrochloride Injection*), Assays Based on Titration (*Assay of Fe^{2+} in Ferrous Fumarate Tablets, Diphenhydramine in Diphenhydramine Hydrochloride Oral Solution*), Chemical Tests for Pharmaceutical Preparations, Test for Related Substances (*Related Substances in Paracetamol Tablets*), Uniformity of Content (*Uniformity of Content for Phenindione Tablets*), Dissolution. ***(Ref-3:** 391-332)*

References

1) Indian Pharmacopeia Volume I, 7th Ed
2) Indian Pharmacopeia Volume II, 7th Ed
3) Introduction to Pharmaceutical Analytical Chemistry, Stig Pedersen-Bjergaard, Bente Gammelgaard, Trine Grønhaug Halvorsen, Second Edition, Wiley (2012).

4. Pharmaceutical Chemical Analysis: Methods for Identification and Limit Tests, Ole Pedersen, CRC press. Taylor & Francis Group, 2006.

Learning Objective - At the end of course students should able to-

1. Define / understand various terms in pharmaceutical raw material and finished product analysis.
2. Explain various pharmaceutical dosage forms and types of raw materials used.
3. To describe basic principles of methods of pharmaceutical analysis according to IP.
4. Explain importance particular test in pharmaceutical raw material and finished product analysis.
5. Perform and explain importance of limit tests, identification tests and micobiological limit test of raw materials and finished products.
6. Solve numerical problems on analysis pharmaceutical raw material and finished product analysis.
7. Interpret IR spectra, HPLC chromatogram, UV-Visible spectra of pharmaceutical materials.
8. To perform total analysis of pharmaceutical raw material and finished product analysis according to IP / BP / USP.
9. Standardize analytical instruments according IP /BP/ USP.
10. Take a decision on the basis of analytical results regarding quality of raw materials so that material can be accepted for production or rejected.

CBOP-4, CHA-492: A) Laboratory Automation and Environmental Analytical Chemistry

OR

CBOP-4, CHA-492: B) Analytical Chemistry of agriculture, Polymer and Detergents

CBOP-4, CHA-492: A) Laboratory Automation and Environmental Analytical Chemistry [48L + 12T]

Sensor-I: Laboratory Automation and Sensor Based Techniques [24 L +6 T]

1. Introduction to laboratory Automation [2 L]

Introduction, automation, miniaturization and simplification, lab automation, flow injection analysis, miniaturized analytical systems, fast response analytical systems, chemical sensors, screening systems, process on-line systems. *(Ref-1: Relevant pages)*

2. Laboratory Automation [4 L]

Definition and concept, objective of automation in analytical chemistry, automation of analytical tools and process, automation of preliminary operations, automation of calibration, automation of measuring and transducing of analytical signals, automation of data acquisition and processing, analysers, automated management system, advantages and shortcomings of automated system. *(Ref-1: Relevant pages)*

3. Flow Injection Analysis [6 L]

Batch and continuous flow analysis, principles, basic FIA instrumentation, dispersion in FIA, FIA for reproducible and precise sample preparation, FIA system with enzymes, flow injection hydride generation scheme, online sample conditioning, and preconcentration, exploiting the physical dispersion process, FIA gradient technique, Process control,

process control analysers. *(Ref-1: Relevant pages)*

4. Miniaturized Analytical systems [4 L]

Introduction, Concept, theory of miniaturization, microfabrication, silicon and glass micro-matching, polymer replication technology, miniaturized analytical components, sampling and sample pre-treatment, system integration, serial integration, parallel integration, commercialization.*(Ref-1: Relevant pages)*

5. Chemical Sensors [4L]

Introduction, definitions, Classification of chemical sensors, descriptions of chemical sensors (electrochemical sensors, potentiometric sensors, Volta-metric chemical sensors, sensors based on conducting properties), Optical sensors (light guides, the evanescent wave, design of fibre optic sensor, indicator mediated sensor), Calorimetric sensors (catalytic gas sensor, thermal conductivity sensor), mass sensor (piezoelectric quartz crystal resonator, surface acoustic wave sensor). *(Ref-1: Relevant pages)*

6. Biosensors in analysis [4L]

Introduction, producing biological surface, methods of immobilization, Achievement of biotransduction (amperometric, potentiometric, optical). *(Ref-1: Relevant pages)*

References:

1. Analytical Chemistry, Ed. by Kellner, Mermet, Otto, Valcarcel, Widmer, Second Ed. Wiley –VCH

Sec-II: Environmental Analytical Chemistry [24 L +6 T]

1. Water Pollution and Measurement of Water Quality [16 L]

a) Water Pollutants: Brief explanation of following with respect to their sources and toxic effects -Inorganic pollutants (Heavy Metals (CD, Hg, Pb), Metalloids, Organotin Compounds, Inorganic Species (CN^-, NH_3 and other species), Asbestos), Organic Pollutants (Soaps, Detergents, and Detergent Builders, Pesticides in Water, Polychlorinated Biphenyls), Emerging Water Pollutants, Pharmaceuticals, and Household Wastes, Radionuclides in the Aquatic Environment).***(Ref-2:*** *159-183*supplementary reference-3 and 4)

b) Analysis: Physical Properties: Colour (Visible Inspection, Spectrophotometric—Multi-Wavelength Method, Turbidity, Odour, Taste, Acidity, Alkalinity, Calcium Carbonate Saturation, (Introduction, Indices Indicating A Water's Tendency To Precipitate Or Dissolve Caco3, Indices Predicting The Quantity Of $CaCO_3$ That Can Be Precipitated Or Dissolved), Hardness, Oxidant Demand/Requirement (Chlorine Demand/Requirement, Ozone Demand/Requirement— Batch Method), Conductivity, Salinity. (**Ref-1:** 2.5, 2.8, 2.12-2.40, 2.48-2.62). **Metal ions:** Introduction, Preliminary Treatment Of Samples *(Introduction, Filtration for Dissolved and Suspended Metals, Treatment for Acid-Extractable Metals, Digestion for Metals, Nitric Acid Digestion, Nitric Acid-Hydrochloric Acid Digestion, Nitric Acid-Sulfuric Acid Digestion, Nitric Acid-Perchloric Acid Digestion, Nitric Acid-Perchloric Acid Hydrofluoric Acid Digestion, Dry Ashing, Microwave-Assisted Digestion*), Quantitative analysis by AAS, FES and ICPAES: *Only general explanation as this part is covered in detail in Analytical spectroscopy* Sec-I. (**Ref-1:** 3.1-3.35, 3.36-3.67, 3.70-3.71, 3.76-3.78, 3.82-3.84, 3.104-3.105). **c) Inorganic**

non-metal: Introduction, Determination of Anions By Ion Chromatography, Inorganic Anions By Capillary Ion Electrophoresis; Bromide (phenol red method), cyanide, Chlorine (DPD colorimetric method), Fluoride (ion selective method, complexone method), ammonia (titrimetric method, ions elective method and phenate method), NO_2^- - colorimetric method, NO_3^- (nitrate electrode and Cd reduction method), Organic nitrogen by MicroKjeldahl method, Dissolved oxygen (iodometric and membrane electrode method), phosphate (molybadate – $SnCl_2$ - colorimetric method), Sulfide (methylene blue and ion selective method), **d) Organic constituents:** Biochemical oxygen demand, Chemical oxygen demand, total organic carbon, phenols (direct photometric method), surfactants. *(**Ref-1:** 4.1-4.14, 4.17, 4.30-4.31, 4.39-4.46, 4.61, 4.72, 4.86-4.90, 4.114-4.120, 4.124 -4.131, 4.139, 4.114, 4.149, 4.156-4.161, 4.181-4.184, 5.5-5.29, 5.49-5.58, supplementary reference-3 and 4)*

2. Air Pollutants and Analysis of the Atmosphere and Air Pollutants [8 L]

a) Air Pollutants: Explanation only with respect to source and health hazards of: CO, SO_2, NO_x, NH_3, Cl_2 and F_2; Organic Pollutants (Aromatic Hydrocarbons, Carbonyl Compounds, Miscellaneous Oxygen-Containing Compounds, Organonitrogen Compounds, Organohalide Compounds, Organosulfur Compounds, Organic Particulate Matter, Hazardous Air Pollutants Organic Compounds)*(Ref-2: 285 to 329 only relevant information from these pages)*

b) Pollutant Analysis: Atmospheric Monitoring, Air Pollutants Measured, Sampling, Methods of Analysis, determination of Sulfur Dioxide, Nitrogen Oxides, Analysis of Oxidants, Contents, Analysis of Carbon Monoxide, Determination of Hydrocarbons and Organics, Determination of Specific Organics in the Atmosphere, Analysis of Particulate Matter**,** Filtration, Collection by Impactors, Particle Analysis, X-Ray Fluorescence, Determination of Lead in Particulate Matter, Direct Spectrophotometric Analysis of Gaseous Air Pollutants. *(**Ref-2:** 707-718).*

Reference

1.Standard methods for the examination of water and waste water, 23rd Ed. Rodger Baird, Andrew Eatson, Eugene Rice, jointly published by: American Public Health Association, American Water Works Association, Water Environment Federation.

2. EnvironmentalChemistry, Stanley E. Manahan, Ninth Edition, CRC press, Taylor and Francis, 2010.

3. Handbook of Environmental Analysis Chemical Pollutants in Air, Water, Soil, and Solid Wastes by Pradyot Patnaik, Third Edition, CRC press, Taylor and Francis, 2018.

4. Environmental Chemistry, A. K. Day, New Age Publication Company

Learning Objective - At the end of course students should able to-

1. Define / understand various terms in – i) Laboratory automation and sensors, ii) environmental pollution, analysis water and air.
2. Explain instrumentation of automated laboratory analysis and sensors.
3. To describe basic principles of automated laboratory analysis and sensors.
4. Explain importance of automated laboratory analysis and sensors.
5. Describe sources of water and air pollution and pollutants.
6. Describe / explain methods / techniques of sampling of water and air and their analysis.

7. Solve numerical problems on analysis water and air.
8. Draw conclusion regarding water and air quality from analytical results.

CBOP-4, CHA-492: B) Analytical Chemistry of agriculture, Polymer and Detergents [48L + 12T]

Section-I: Agricultural Analytical Chemistry [24 L +6 T]

1. Analysis of soil [10 L]

a) Sampling of soil, sample preparation, Pre-treatment of Samples and Contamination, Trace Element Analysis, Sub-sampling, Drying Techniques, Milling, Grinding and homogenization, **b) Weighing and Dispensing:** Weighing Errors, Dispensing Errors, **c) Acid-digestion, Ashing and Extraction Procedure:** Acid-digestion and Washing: *Acid-digestion of soils, Total soil nitrogen; Microwave acid-digestion, Dry ashing, Nitrate and water-soluble carbohydrate;*Extraction Procedures for soils: *pH extractants, Phosphate extractants, Potassium extractants, Trace element extractants, **d)*** **Analysis of Soil:** Soil Analytical Procedures - Determination of extractable boron, Cation exchange capacity, exchangeable bases and base Saturation, Determination of CEC and exchangeable cations, Measurement of calcium and magnesium by AAS, Measurement of potassium and sodium by flame photometry, Determination of cation exchange capacity (CEC), Determination of effective cation exchange capacity (ECEC), Determination of fulvic and humic acids, Discussion - Determination of available nitrogen, Method-a: Determination of nitrate by selective ion electrode, Discussion - Determination of total mineralized nitrogen, Method-b: Determination of extractable ammonium-N, Method-b: Determination of extractable nitrate-N, Discussion, Determination of organic plus ammonium nitrogen, Method-a: Determination of soil nitrogen by autoanalysis, Method-a: Reduction of nitrate before digestion and colorimetric auto analysis, Method-b: Determination of organic plus ammonium-N by digestion and distillation, Discussion, Determination of soil organic matter, Method-a: Determination of soil organic matter by loss on ignition, Method-b: Determination of easily oxidizable organic C by Tinsley's wet combustion, Discussion 5.8. Determination of pH and lime requirement, Method-a: Measurement of pH, Method-b: Determination of lime requirement, Method-c: Determination of pH in soils with soluble salts, Discussion - Determination of extractable phosphorus, Method-a: Determination of extractable phosphorus (manual method), Method-b: Determination of extractable phosphorus (automated method), Method-c: Determination of resin extractable phosphorus (automated method), Determination of extractable magnesium, potassium and Sodium, Determination of extractable trace elements, Discussion-Determination of extractable sulphur, Method-a. Determination of extractable sulphur (manual method), Method-b. Determination of extractable sulphur (automated method*). **(Ref**-1: 17-35, 50-104, Ref.-2: 1-14, 71-331)*

2. Fertilizer Analysis: [6 L]

Discussion -Determination of total nitrogen in presence of nitrate and organic, Method-a: Determination of total nitrogen in presence of nitrate and organic N, with final determination by distillation, Method-b: Determination of total nitrogen in presence

ofnitrate and organic N, with final determination by auto-analysis, Discussion - Determination of phosphorus in fertilizers, Method-a. Determination of water-soluble phosphorus(extraction), Method-a: Determination of water-soluble phosphorus, (auto-analysis), Method-a: Determination of water-soluble phosphorus(manual method), Method-b. Determination of 2% citric acid-soluble phosphorus– method for basic slags (Thomas phosphate), Method-c: Determination of total phosphorus in the aciddigest from Method-b. with final determination by auto-analysis, Discussion-Determination of potassium in fertilizers, Method-a: Determination of water-soluble potassium, Method-b. Determination of ammonium oxalate-solublepotassium, Method-c: Determination of potassium in the acid digest from, Liming Materials, Determination of the moisture and neutralizingvalue of liming materials, Determination of fineness of grinding. ***(Ref.-1:*** *106-123)*

3. Analysis of Pesticide Residues [8 L]

Preparation of Samples, Collection and Preparation of Soil Samples, Collection and Preparation of Water Samples, **Individual Pesticide Residue Analytical Methods:** Aldicarb(GC), Captafol (GC Method), Captafol (HPLC), Captan (HPLC), Chlorothiophos (GC), Ethylene Thiourea (GC), Folpet (HPLC), 1,naphyl acetic acid (GC), Paraquat (photometric); **Multiple Pesticide Residue Analytical Methods:** Substituted Phenyl Urea Herbicides (GC), Organochlorine and OrganophosphorusPesticides (GC and TLC), Dithiocarbamate and Thiuram Disulphide Fungicides (photometric), Phthalimide fungicides (HPLC). ***(Ref-3:*** *17-23, 87-116, 135-148, 167-172, 241-250, 297- 307, 353-359, 401-406).*

References:

1. Methods in Agricultural Chemical Analysis: A Practical Handbook, N.T. Faithfull, CABI Publishing, Typeset by Wyvern 21 Ltd, Bristol (2002).
2. Soil Sampling and Methods of Analysis, Edited by M.R. Carter E.G. Gregorich, Canadian Society of Soil Science, Second Edition (2008)
3. Manual of PesticideResidue AnalysisVolume I, Edited by Hans-Peter Thier and Hans Zeumer, Pesticides Commission, VCH, New York.

Sec-II: Analytical Chemistry of Polymer and Detergents [24 L +6 T]

Section-II: Polymer Analysis and Detergent analysis

1. Polymer analysis

a. Introduction [1 L]

Introduction and Types of polymers. ***(Ref-1: 1-28)***

b. Identification: [4 L]

Introduction, Preliminary Identification Methods: Solubility, Density, Behaviour on Heating; Infrared Spectroscopy, Raman Spectroscopy, Nuclear Magnetic Resonance Spectroscopy, Ultraviolet-Visible Spectroscopy, Differential Scanning Calorimetry, Mass Spectrometry, Chromatography, Emission Spectroscopy. ***(Ref-1:*** *31-64, Supplimentory-2)*

c. Molecular Weight [3 L]

Introduction, Molecular Weight Calculations, Viscometry, Chromatography, Ultracentrifugation, Osmometry, Light Scattering, End-Group Analysis, Turbidimetric

Titration. *(**Ref-1:** 103-119, Supplimentory-2)*

d. Structural Methodology [4 L]

Introduction, Isomerism, Chain Dimensions, Crystallinity, Orientation, Blends, Thermal Behaviour, Dilatometry, Infrared Spectroscopy, Raman Spectroscopy, Nuclear Magnetic Resonance Spectroscopy, Optical Microscopy, Transmission Electron Microscopy, X-Ray Diffraction, Neutron Scattering,***(Note:** Thermal Analysis and thermal degradation are excluded as explained in TGA);(**Ref-1:** 121-149, 161-170, Supplimentory-2)*

e. Mechanical Properties [4 L]

Introduction, Stress-Strain Behaviour, Viscous Flow, Viscoelasticity: *Creep, Models, Stress Relaxation*; Elasticity, Processing Methods, Tensile Testing, Flexural Testing, Tear-Strength Testing, Fatigue TestingImpact Testing, Hardness Testing, Viscometry, Dynamic Mechanical Analysis. *(**Ref-1**: 209-233).*

2. Analysis of Surfactants [8 L]

a) Surfactant types; classification, identification, separation: Why analyse surfactants, Features peculiar to surfactant analysis, Basic Definitions (surfactant, anionic surfactant, cationic surfactant, non-ionic surfactant, amphoteric surfactant, weakly acidic and basic surfactants), Common types of surfactants of all four classes, b) **Elemental analysis:** Metals, Determination of nitrogen, Determination of sulphur, Determination of phosphorus. c) **Basic techniques:** Extraction of surfactants (Liquid-solid extraction: *Liquid-liquid extraction using separating funnels, Liquid-liquid extraction using extraction columns),*Acid-base titration**:** *(general principles, end point detection, Determination of weak acids and bases and their salts,* Potentiometric titration:*Principle,Applications, Methods for esters, amines, alcohols and unsaturated fatty materials, Two-phase titration of ionic surfactants with surfactants of opposite charge,Introduction, ISO 2271: Principle and procedure, Potentiometric titration with surfactants of opposite charge using a surfactant-sensitive electrode,Advantages of potentiometric titration, Construction and performance of surfactant-sensitive electrodes, Titration procedure,* Open-column chromatography. d**) Analysis of Representative surfactants: i) Analysis of Anionics:** Introduction,general methods- *Para-toluidine precipitation/titration method,* Analysis of Alkane sulphonates:*Determination of total alkane sulphonate, Determination of mean molecular weight of alkane monosulphonates, Separation and determination of alkane mono- and disulphonates,* Carboxylates: *Titration with benzethonium chloride, Solvent extraction, Acid-base titration, Determination of soaps in fatty products,* **ii)Analysis of nonionics:** Analysis of Ethoxylated alcohols, alkylphenols and fatty acids: *Composition, Determination by potentiometric titration, Determination by the cobaltothiocyanate colorimetric method, Determination of total nonionics and polyethylene glycols, Volumetric determination of polyethylene glycols, Determination of oxyethylene groups, Fatty acid ethoxylates: determination of polyethylene glycols, free fatty acid and mono- and diester;* **iii)Analysis of cationics and amphoterics:** Introduction, Analysis of Quaternary ammonium salts:, *Two-phase titration with sodium dodecyl sulphate, Two-phase titration with sodium tetraphenylborate, Determination of free amine and amine hydrochloride,* Amines:*Determination of molecular weight and total, primary, secondary and tertiary amines*

(Ref-3: 1, 8, 17-24, 31-36, 42-75, 105-109, 119-124, 142-143, 149-160, 171-177, 222-226, 264-280, 310-317, Supplementary reference-4)

Reference

1. Polymer analysis, Barbara H. Stuart, Analytical Techniques in the Sciences (AnTS), John Wiley and Sons Ltd.
2. Analytical Methods forPolymer CharacterizationRui Yang, CRC PressTaylor& Francis Group, 2018
3. Introduction to Surfactant Analysis, Edited by D. C. Cullum, Springer-Science + Business Media, B.V, 1994.
4. Handbook of Detergents, Editor-In-ChiefUri Zoller, Part-C, Heinrich Waldhoff, Rüdiger Spilker, Marcel Dekker, New York, 2005.

Learning Objective - At the end of course students should able to-

1. Define / understand various terms in soil analysis, pesticide residue analysis, detergent analysis and polymer analysis.
2. Explain / describe techniques / methods of soil analysis, pesticide residue analysis, detergent analysis and polymer analysis.
3. To describe basic principles techniques / methodssoil analysis, pesticide residue analysis, detergent analysis and polymer analysis.
4. Explain importance of soil analysis, pesticide residue analysis, detergent analysis and polymer analysis.
5. Choose suitable method / techniques to characterize quality of soli polymer and detergent.
6. Describe / explain results of analysis soil, pesticide residue, detergent and polymer.
7. Solve numerical problems on analysis soil, pesticide residue, detergent and polymer.
8. Draw conclusion regarding soil, detergent and polymer quality from analytical results.

CBOP-5, CHA-493: Practical III

CHA-493-A: Optional Analytical Chemistry Practical

OR

CHA-493-B: Project

CBOP-5, CHA-493: A) Optional Analytical Chemistry Practical [96 L +24 T]

Section-I: Any 12 experiments

1	**Table Work:** Characterization of organic compounds by VU-Visible, IR and NMR spectroscopy (any two compounds, Example- paracetamol and aspirin - actual spectra must be given for analysis)

Analytical Chemistry for Self-Employment: (any five experiments from 2 to 9): Preparation / Isolations Analytical Standards or reference material for analytical laboratories **(Imp. Note:** all these materials can be used for further experiments).

2-3	Solvent extraction: Isolation and purification caffeine. Impurity present if any by TLC. Indian Pharmacopeia Tests: identification tests, MP, loss on drying, Total heavy metal and assay. (Spectral characterization may be performed) (Ref-5)
4-5	Synthesis of Paracetamol (or any other medicinal compound) by green chemistry route and recrystallization. Test as per IP: TLC, MP, Identification tests, limit test for chloride, LOD and assay. (spectral characterization may be performed) (Ref-5 and 4)

6-7	Synthesis, recrystallization of ligands used in analytical chemistry: Example-diethyldithiocarbamate (or other dithiocarbamate ligand), salicylaldehyde ethylenediamine, 8-Hydroxyquinoline, or any other, purity by suitable method. (Packaging and labelling - student self-work).
8	Preparation of Analytical Reagent Kit (any one) which will contain all the reagents for determination of specific analyte, labelling and packaging of reagents and writing of standard protocol to use the kit and testing of kit, detection limits should be mentioned. (such kits are used in commercial analytical laboratories) (You cannot adopt procedures from commercialized kits which available in market). Suggested examples: a student can select other example with permission of his mentor. 1) Analysis of creatinine (trinitrophenol method) (Ref-3) 2) Blood cholesterol (ferric chloride method) (Ref-3) 3) Analysis of proteins by Lowry method (Ref-3, 6) 4) Analysis of reducing sugar by colorimetry method. (Ref-3, 6) 5) Regents for qualitative test of carbohydrates and protein for higher secondary laboratories – Fehling solution-A, Fehling solution-B, Iodine solution, Molisch reagent, Barford reagen, Benedicts reagent, Seliwanoff reagent, Bials reagent, biuret reagent. (Ref-6) 5. Preparation of standard solutions required for limit tests of pharmaceuticals as per I. P. **(Note:** These kits should be used for experiments and can be prepared 1 week before the schedule of such an experiment)
9	Synthesis of Methyl red indicator, purification, MP/ TLC and test for colour change with respect to change in pH of indicator, (packaging and forwarding – student self-work) (Ref-8)
	Chromatographic Methods (any three)
10	Identification of amino acids / sugars / or any other mixture by two-dimensional chromatographic method (TLC or paper) (Ref.-3)
11	Sephadex gel separation of proteins (Ref-6)
12	Determination of molecular weight by gel permission column chromatography (Sephacryl S-200 column) (Ref-6)
13	Separation of leaf pigments by adsorption Chromatography (Ref-6)
14	Separation of amino acids by ion exchange chromatography (Ref-6)
15	Separation of proteins by ion exchange (DEAE cellulose) chromatography (Ref-6)
	Part-III (any three)
16	Analysis of phenolics in Aurvedic solution / syrup preparations / black tea – hence determine their antioxidant activity (Ref-3)
17	Estimation of total proteins Lowry method (Ref-3)
18	Estimation of thiamine by photoflurimetry from multivitamin capsule by

	calibration curve and its confirmation by standard addition method. (Ref-3)
19	Determination of total sugars or Glucose content in glucose supplement by (glucon-D) by titration with Fehling solution (FSSAI manual)
Section – II: 12 experiments from 1 to 23	
Part-I: Volumetric and Gravimetric methods for quantitative analysis of complex materials (Any six)	
1-2	Analysis of Cement for: SiO_2, Calcium, Iron, Magnesium and Aluminium (Ref-1)
3-4	Analysis of mixed fertilizer sample for total nitrogen, K and phosphate content. (Ref-1)
5	Analysis of dolomite ore with respect to SiO_2, Ca and Mg (Ref-1)
6	Analysis of brass alloy for Cu and Sn (Ref-1)
7	Determination of total Ash, Ash Insoluble in Hydrochloric acid, Alkalinity of soluble ash in coffee [FSSAI manual]
8	Separation of Chloride and Bromide on anion exchange resin and quantitative estimation (Ref.-1)
9	Electrogravimetry determination of Cu(II) or Ni(II) (Ref-1)
10	Idetification of form of iodine (qualitative test) in table salt and its quantitative estimation by volumetric method. (Ref. 9)
Part-II: Instrumental Methods of selective analysis from complex materials (Any five)	
10-11	Analysis of fertilizer Micronutrient Supplement for Fe, Mn, Cu, and B. **Colorimetry**: Fe with thiocyanate, Mn as $KMnO_4$, B using curcumin reagent, and Cu using diethyldithiocarbamate ligand. (Ref-1, 2) (any two)
12	Analysis of Chloride, Bromide and Iodide from mixture by potentiometry (Ref-1)
13	Use of ion selective electrodes for determination (F, Cl, Ca, NH_4^+ etc. from water)
14	TGA/DTA analysis of polymer for binders, polymer content, etc. (Ref-7)
15	Determination of Ca in milk powder by flame photometry by standard addition or calibration curve method (FSSAI Manual]
16	Estimation of Fe(III) from detergent by solvent extraction (Ref.-1)
17	Selective estimation of Ni(II) from steel alloy or (Ni(II) -Fe(III) synthetic solution) by solvent extraction (Ref.-1).
Part-III: Ane one of the following	
18	Apply Limit test of heavy metals and iron to Aurvedic medicinal preparations (Ref-4)
19	Determination of total cation in water by cation exchange method (Ref-1)
Students self-activity - Compulsory: Review of five research paper on the same research topic must be performed by an individual students and report must be submitted to the mentor. This is evaluative part of internal assessment. **All the papers must be selected from UGC care list for which mentor should help to the students.**	
Refences	
1. Vogel's Textbook of Inorganic Quantitative Analysis, A. I. Vogel, 3rd Ed.	
2. Separation, Preconcentration and Spectrophotometry in Inorganic Analysis, by Z.	

Marczenko and M. Balcerzak, Analytical Spectroscopy Library – 10, Elsevier
3. Lab Manual in biochemistry, immunology and biotechnology, Arti Nigam, Archana Ayyagari, Tat-McGraw-Hill Publication.
4. Indian Pharmacopeia, 7th Ed.
5. Green Chemistry Synthesis, Pawia
6. An introduction to Practical Bichemistry, David T. Plummer, Tata McGraw-Hill Publishing Company Ltd.
7. Polymer Synthesis and Characterization, A Laboratory Manual, Stanely R Sandler, Wolf Karo, Jo-Anne Bonesteel, Eli M Pearce, Published by Academic press (Elsevier).
8. https://pubs.acs.org/doi/pdf/10.1021/ie50163a037, *Org. Synth.* **1922**, *2*, 47DOI: 10.15227/orgsyn.002.0047
9. General Chemistry Experiments by Anil J. Elias

Learning Objective / Course Outcomes- At the end of course students should able to-

1. Maintain proper record of analytical data in notebook. Observer personal safety in laboratory and able handle all chemicals, instruments, etc safely in laboratory.
2. Define / understand various terms involved practical methods of quantitative analysis.
2. To analyse organic and inorganic materials using appropriate chemical / instrumental methods
3. Explain / describe basic principles of chemical / instrumental methods used for analysis. Able to handle particular instrument according to SOP.
4. Perform analysis of sample with described procedure. Able to handle analytical instruments.
5. Apply / select particular method / instrumental parameters for analysis of given sample.
6. Maintain appropriate reaction conditions as described in procedures.
7. To perform i) selective analysis of particular component from sample. ii) Analysis at trace level from sample.
8. To conclude the results able to take the decision regarding quality of sample.
9. To perform calculations and interpret the results.

CBOP-5, CHA-493: B) Project [96 L + 24 T]

a) At least 1/3 students of total strength at M. Sc.-II must be allotted projects

b) Each student will perform project separately. Working hours are same as practical of CHA-493(A) project length should be sufficient and should be equivalent to 24 practical. ***Project report must be written systematically and presented in bound form: The project will consist of Title page, certificate, content, summary of project (2-3 page) followed by introduction (4 to 7 pages), literature survey (4-7) pages (recently published about 30 papers must be included), experimental techniques, results, discussion, conclusions, Appendix consisting of 1) references, 2) standard spectra / data if any and 3) safety precautions.*** If student is performing project in another institute, for such a student, internal mentor must be allotted and he will be responsible for internal assessment of a student. In this case student has to obtain certificate from both external and internal mentor. ***Systematic record of attendance of project students must be maintained by a mentor.*** Project will be evaluated jointly by three examiners and there will not be any practical performance during the examination. Typically, student has to present his practical work and discuss results and conclusions in details (20 min.) which will be

followed by question-answer session (10 min). It is open type of examination.

Learning Objective / Course Outcomes- At the end of course students should able to-

1. Maintain proper record of analytical data in note book for research purpose.
2. Perform review of literature related to the topic of project work and design the problem for project work.
3. Decide and describe methodology for problem to solve proposed problem in the form of project. Decide and perform application of research work.
4. To design experiment for research work. Collect the resources, design small equipment, etc. for completion of research work.
5. Collect experimental data (raw data) and analyse the data in the perspective of problem. Present data in graphical forms for the conclusive results.
6. Use computer as a tool for result analysis, presentation and writing the project.
7. To obtain concrete conclusion from the results on the basis of reported theory / research work and analytical results.
8. To perform report writing, scientifically.
9. To write research project / paper in scientific manner.

CCPP-4, CHA-494: Practical II: Applied Analytical Chemistry

[96L + 24T]

Sec-I: Analysis of Pharmaceuticals

Sr. No.	Compulsory Practical
1-4	Total analysis of aspirin as raw material as per Indian Pharmacopeia **except** limit test for arsenic (In assay part perform standardization of HCl). Express result as aspirin content ± Standard deviation. (Ref-1)
Any 4 from 5-9	
5	Tablet dissolution test on paracetamol Indian Pharmacopeia (Ref-1) or UV-absorbance based assay of plane paracetamol table using specific absorbance (British Pharmacopeia). (Ref-4)
6	Analysis of Ca-Gluconate or any Ca-supplementary tablet with respect to identification test, average wt. of 20 tablet, and Ca(II) content per tablet as per Indian Pharmacopeia. Express result as Ca-gluconate content ± Standard deviation. (Perform standardization of Na_2EDTA) (Ref-1)
7	Moisture content by i) Loss on drying of caffeine (oven drying method) and water content of dextrose (anhydrous or monohydrate) by Karl Fischer Method. (Ref-1 and 2)
8	Estimation of Benzocaine after extraction in chloroform by non-aqueous titration (Ref-3) or Estimation of Nicotinamide **or** caffeine by non-aqueous titration method according to IP (Ref-3) [standardize perchloric acid with potassium hydrogen phthalate]
9	Limit Tests for Fe, Ba and nitrate on dibasic calcium phosphate.
Table Work (student self-activity): Analysis of IR spectra **for identification** of at least four pharmaceutical compounds from Indian Pharmacopeia or British Pharmacopeia (Spectrum from IP or BP can be used or you can record the IR spectra and analyse. (Ref-1, Ref-4)	
Any 4 from 10-14	
10	Determination of NaCl (Cl by potentiometric titration or Na by flame photometry) and Dextrose (by polarimetry) in dextrose – sodium chloride type of saline solution.

	(Ref-1, 3).
11	a) Determination of refractive index of four liquids as per IP. b) Viscosity of ethyl cellulose by Oswald viscometer using viscometer which comply specification of IP.
12	The Determination of Aspirin and caffeine in a Proprietary Analgesic or given mixture by Ultraviolet (UV) Spectrometry. (Ref. – 8)
13	Analysis of Caffeine and benzoic acid from cold drink by HPLC (Ref-6, 9) **Or** HPLC Analysis of an Asthma Medication (Ref-7) **Or** Assay of Omeprazole in Gastro-Resistant Omeprazole Tablets (Solid Preparation) by LC (Ref.-6) **Or** Quantitative Determination of Methyl Parabenin a Prepared Sample by HPLC (Ref-9)
14	Kit method (any two): a) Analysis of glucose from blood or hydrolysed food sample and b) urea from urine, c) Cholesterol from blood or fatty material. d) Creatinine (Ref: Perform experiment as per the instructions of manufacturer of kit).
15	Visit to waste water treatment plant (industry or municipal corporation) and writing a detailed report on methods and parameters used for treatment process. Or Visit to Pharmaceutical Industry and report on function of QC department in pharmaceutical industry

Reference

1) Indian Pharmacopeia Volume I, 7th Ed
2) Indian Pharmacopeia Volume II, 7th Ed
3) Indian Pharmacopeia Vol-III, 7th Ed.
4) Introduction to Pharmaceutical Analytical Chemistry, Stig Pedersen-Bjergaard, Bente Gammelgaard, Trine Grønhaug Halvorsen, Second Edition, Wiley (2012).
5. Vogel's Textbook of Quantitative Chemical Analysis, 6th Ed.
6. Analysis of Soft Drinks: UV Spectrophotometry, Liquid Chromatography, and Capillary Electrophoresis, Journal of Chemical Education, Vol. 75 No. 5 May 1998
7. HPLC Analysis of an Asthma Medication, Man L. Muellerl and Lawrence W. Pott,Journal of Chemical Education, Volume 85 Number 10 October 1988.
8. Experiments in modern analytical chemistry, D. Kealey, Springer Science Business media, 1986.
9. Analytical Chemistry for Technicians, John Kenkel, Third Edition, CRC Press LLC, 2003.

	Section-II
Any four from 1-6	
1	Analysis of waste water /natural water sample for pH, dissolved oxygen, total dissolved salts (conductometry) (Ref-1)
2	Analysis of waste water sample: turbidity, colour, total hardness (Ref-1 and 2)
3	Alkalinity and Buffering capacity of water (Ref-1)
4	COD of waste water sample (Ref-3) (Note: small scale experiment is possible where visible spectrometric method can be used for determination of Cr(VI) (Ref.-2)
5	Aqueous carbonate equilibria and corrosiveness (calcium carbonate saturation) (Ref-1, 2)

6	Biological oxygen demand (Ref-2)
Any two from 7-10	
7	Qualitative test for phosphate in hard water / soil sample /food / detergent and its estimation by colorimetry. (Ref-2, 3, 10)
8	Pre-treatment to sulphide containing water (municipal waste water sample or artificially prepared water containing sulphide) its analysis for sulphide (Ref-2)
9	Determination of Cr(VI) by diphenyl carbazide method.
10	Demonstrating the Presence of Cyanide in Bitter Seeds while Helping **s**tudents Visualize Metal–Cyanide Reduction and Formation in a Copper Complex Reaction. (Ref.: 12,13)
11	Determination anionic detergents from waste water (artificially prepared water sample containing detergent or shampoo which contain sodium lauryl sulphate or ammonium lauryl sulphate) (Ref-1, 2, 3)
Any two from 12-14	
12	Electrochemical treatment to liquid waste (water soluble organics) (Ref-1, 4)
13	Photochemical remediation of pollutants (Ref-1)
14	Chemical mineralization of pollutants by Fenton's Process (Ref-1)
Any two from 15-18	
15	Vit-C in food / Lemon juice / or related juice by titration with 2-6 dichlorophenol indophenol (Ref-6, 7) **or** Estimation of Vitamin-C by reaction with Fe(III) and estimation of Fe(II) colorimetrically. (Ref-5)
16	Determination of total casein and lactose in milk [FSSAI Manual] (Ref.-8)
17	Saponification and iodine value of edible oil (Ref-6)
18	Adulteration Test for Milk and Milk product (Ref-8, 9)
Any two from 19-24	
19	Determination of molecular wt. of anionic detergent (Ref-10: 107-108, 120-121)
20	Determination Critical Micelle Concentration of detergent powder or pure detergent by conductometry / viscometry (Ref.-14)
21	a) Molecular weight of polystyrene by viscometer b) Determination of water absorption by polymer (Ref-11)
22	Determination of chlorine content in PVC (Ref-12)
23	a) Determination of carbon black content in polymer b) Determination of swelling network in polymers (Ref-11)
Students activity	
	Estimation of Glucose – Glucose in different samples can be analysed by i) titration with Fehling solution b) Titration with Iodine c) Colorimetry Folin-Wu method or DNSA method d) Colorimetry-Glucose by oxidase peroxidase method. Samples are – a) glucose in saline (DNS), b) glucose in urine / blood sample c) glucose in glucose supplement d) glucose in food. Give your choice of method for sample assigned to you by your mentor and analyse the sample. **Note:** Such many experiments can be designed by a mentor for internal evaluation of

	a student.

References

1. Environmental Chemistry, Microscale Laboratory Experiments, Jorge G. Ibanez, Margarita Hernandez-Esparza, Carmen Doria-Serrano, Arturo Fregoso-Infante, Mono Mohan Singh, published by Springer.
2. Standard methods for the examination of water and waste water, 23rd Ed. Jointly published by American Public Health Association, American Water Work Association, Water Environment Federation. 2017.
3. Vogel's Textbook Quantitative Chemical Analysis, 6th Ed.
4. Laboratory Experiments on Electrochemical Remediation of the Environment. Part 4: Color Removal of Simulated Wastewater by Electrocoagulation–Electroflotation, Journal of Chemical Education, Vol. 75, No. 8, August 1998.
5. Vitamin C as a Model for a Novel and Approachable Experimental Framework for Investigating Spectrophotometry, Journal of Chemical Education, DOI:10.1021/acs.jchemed.9b00197
6. Biochemical Methods, Third Edition, By S Sadashivan, A. Manickam; New Age International publishers.
7. Lab. Manual: Manual of Methods of Analysis of Foods, Vegatables: Fruit and vegetable products: https://old.fssai.gov.in/Portals/0/Pdf/Draft_Manuals /FRUITS_AND_VEGETABLE.pdf
8. Manual Of Methods Of Analysis Of Foods Food Safety And Standards Authority Of India Ministry Of Health And Family Welfare Government Of India New Delhi 2015 Milk And Milk Products: https://old.fssai.gov.in/Portals/0/Pdf/Draft_Manuals/MILK_AND_MILK_PRODUCTS.pdf
9. Common milk adulteration and their detection techniques, Azad and Ahmed International Journal of Food Contamination (2016) 3:22 DOI 10.1186/s40550-016-0045-3
10. Introduction to Surfactant Analysis, Edited by D. C. Cullum, Springer-Science + Business Media, B.V, 1994.
11. Experiments in polymer science, D. G. Hundawale, V. D. Athawale, V.R. Kapadi, V.V. Gite, New Age International Publishers.
12. Improved ninhydrin-based reagent for spectrophotometric determination of ppb levels of cyanide, Environmental Forensics, Volume 17, 2016 - **Issue 1**, **https://doi.org/10.1080/15275922.2015.1091404.**
13) Demonstrating the Presence of Cyanide in Bitter Seeds while Helping students Visualize Metal–Cyanide Reduction and Formation in a Copper Complex Reaction, *J. Chem. Educ.* 2016, 93, 5, 891-897.
14. Practical Physical Chemistry, Viswanathan B., Raghawan, Viva Books

Learning Objective –

At the end of course students should able to-

1. Maintain proper record of analytical data in notebook. Observer personal safety in laboratory and able handle all chemicals, instruments, etc safely in laboratory.

2. Define / understand various terms involved practical methods of quantitative analysis.
3. To analyse organic and inorganic materials using appropriate chemical / instrumental methods
4. Explain / describe basic principles of chemical / instrumental methods used for analysis. Able to handle particular instrument according to SOP.
5. Perform analysis of sample with described procedure. Able to handle analytical instruments.
6. Apply / select particular method / instrumental parameters for analysis of given sample.
7. Maintain appropriate reaction conditions as described in procedures.
8. To perform i) selective analysis of particular component from sample. ii) Analysis at trace level from sample.
9. To conclude the results able to take the decision regarding quality of sample.
10. To perform calculations and interpret the results.

Important Notes for Practical Courses of all Subjects

1. For all three practical papers - ***Journal should be completed by the candidate on the same day before leaving of the lab***. *This is to i) avid manipulation of data by a student ii) make habitual of writing the experimental data and calculations systematically.* Chance should not be given to manipulate original data to the candidate. In fact, many students adjust or manipulate data from their lab work very close to expected or theoretical values. If journal is completed before leaving the lab it will not encourage students to "adjust" the facts from their lab work. (**Ref-Journal of Chemical Education, Min J. Yang and George F. Atkinson, Designing New Undergraduate Experiments, Vol. 75, No. 7, July 1998**). Higher marks should be given in internal evaluation to the systematic working and accuracy of the results and not to the journal writing.
2. Laboratory safety rules must be followed by all the students and Chemistry Department should take care of safety laboratory. Wherever required personal protective equipments must be used. A student without laboratory coat and foot wares should not be allowed in laboratory.
3. Chemistry Department should make appropriate arrangement of waste chemical treatment and management.
4. Reference books / experimental procedure should be made available to the students before laboratory hours. Before each practical, mentor must discuss procedure, precautions and safety guidelines with students.
6. During start of the practical course students should be discussed with methodology of internal evaluation. Internal evaluation is continuous type (CA). Hence during each practical, internal evaluation must be done with different tools. **Guideline for internal evaluation:** To each practical 30 marks can be assigned which can be distributed as follows:

Overall performance	Discussions during practical	Accuracy of results	Lab report / Journal	Post laboratory quiz / assignment / oral
6	4	8	6	6

At the end of semester, average marks of 24 experiments are assigned as marks of internal

evaluation i.e. out of 30. Systematic record of internal evaluation must be maintained which is duly sign by mentor and student.

For absentee of a student in regular practical zero marks will be assigned. However, pre-intimation absentee will be allowed but student have to complete the experiment in the same week with the permission of your mentor.

5. Printed journal *is allowed. It should consist of Name of the student, Roll No.(first page of each experiment), date, name of experiment, principle, special instructions regarding the safety precautions and special care to be taken (if any), chemicals, apparatus, brief procedure and blank tables is allowed. It should* ***not contain*** *any details of calculations, dilutions factors, calculated amounts, reactions, and structures. At the end 5 to 7 tricky questions on experiment should be given for solving and it is compulsory activity.*

6. Wherever possible use / prepare minimum amounts / required amounts of solutions. Use micro burette for titrations involving instrumental methods. Micropipettes shall be used for measuring small volumes accurately which helpful to prepare small volumes of solutions for instrumental analysis. For flame photometry / AAS typically 10 ml solution is sufficient, HPLC – 1-5 ml, colorimetry / spectrophotometry 5 ml, etc.

7. Similar strategy can be used for internal evaluation of a candidate performing project.

8. In colorimetric estimation ***do not prepare more than 5 ml solution*** for measurement of absorbance. Add all of the reagent with micro-burette or 1 / 2 ml graduated pipette so that student will ***not require volumetric flask***. If possible, use **1 ml cuvette** with spectrophotometers (It is available in market). Solvent extraction procedure can be typically performed with total 5-ml organic solvents to decrease toxic waste.

9. Wherever feasible develop and practice micro or semi-micro methods form known / recommended procedures from the reference books. This is to i) minimization cost of experiment ii) decreases wastage of chemicals iii) decrease environmental pollution.

10. Avoid use of toxic chemicals and reagents. If possible, replace toxic reagent by non-toxic or less toxic reagent. Example: in volumetric estimation of Fe (III) $SnCl_2$ and then $HgCl_2$ is used to convert Fe (III) to Fe(II). Sn (IV) and Hg(I) produced in reaction are toxic. This can be done by using Zn metal powder. Avoid use of $K_2Cr_2O_7$, and no alternative prepare minimum /required amount of it.

11. Wherever required, s***tandardize $Na_2S_2O_3$ with oven dried KIO_3 in place of $K_2Cr_2O_7$ as Cr(VI) is carcinogenic and mutagenic.***

12. By trial replace $CHCl_3$ by other extracting solvents as chlorinated solvents are highly toxic.

13. Metal like Ag can be recovered after experiment. Device suitable method.

14. Wherever possible replace calomel electrode by Ag/AgCl reference electrode as Calomel consists of toxic element Hg and Hg(I). (**Ref-Student Construction of a Gel-Filled Ag/AgCl Reference Electrode for Use in a Potentiometric Titration, Journal of Chemical Education, Vol. 76, No. 1, January 1999).**

15. College / Chemistry Department of the respective college must follow all the rules of EPA / WHO regarding the toxic waste management of the chemistry laboratory produced during practical.

16. In each practical course a mentor can introduce one or two Novel experiment of

analytical chemistry. Experiment should be equivalent to one practical session (4 h duration) or two practical sessions (long experiment). For such replacement students can be exempted one or two regular experiment respectively. A teacher can promote to a student for such Novel analytical chemistry experiments provided that department is ready to support such experiment. The newly introduced experiment will be the inherent part of **external** evaluation. Example-identification and estimation of melamine from milk powder, pesticide residue from vegetables, estimation of As(III) from bore well water, synthesis / extraction of novel organic compound and its total spectral characterization, etc.

6. M. Sc.(II) Biochemistry

Outline for Semester III and IV – Biochemistry

Paper No.	Course name	Credits
	Semester III	
CCTP-7, BCH-311	Molecular Biology	4
CCTP-8, BCH-312	Immunology	4
CCTP-9, BCH-313	Recombinant DNA Technology	4
CBOP-3, BCH-314 (any one)	**CHB-314(A):** Bio-processing and Industrial Biochemistry	4
	CHB-314(B): Pharmacology and Forensic Biochemistry	4
CCPP-3, BCH-315 Practical I	Practical I: Molecular Biology and Immunological techniques	4
	Semester IV	
CCTP-10, BCH-411	Neurochemistry & Endocrinology	4
CCTP-11, BCH-412	Medical and Physiological Biochemistry	4
CBOP-4, BCH-413 (any one)	**CHB-413(A):** Evolution and developmental biology	4
	CHB-413(B): Clinical Nutrition and Food Technology	4
CBOP-4, BCH-414 (any one) Practical III	**CHB-414(**A): Principles Of Downstream Techniques In Bioprocess	4
	CHB-414(B): Clinical Biochemistry and Research Methodology (Presentation of research paper/Preparation of research project) Data interpretation	4
CCPP-4, BCH-415 Practical II	Project	4

Detailed course-wise Syllabus of M. Sc-II, Biochemistry

SEMESTER III

CCTP-7, BCH-311: Molecular Biology [48L + 12T]

Section I: [24L + 6T]

1. DNA Replication: Enzymes involved in DNA synthesis e.g. topoisomerase, helicase,ligase and others. DNA polymerase I, II, III, origin of locus, Okazaki fragments,replication fork. Mechanism in Prokaryotes and Eukaryotes.
2. DNA Repair: DNA damages, detection and repair systems. Pyrimidine dimer formationand its repair. DNA damage and repair mechanisms : Introduction, DNA damage, types of DNA repair and their mechanisms – Direct repair, Base excision repair, Nucleotide excision repair, mismatch repair, recombinational repair, SOS repair; DNA repair genes, role of P53 gene in DNA repair and apoptosis
3. Gene rearrangements: Recombination pathways, Holliday structures, rec A,B,C,D. SOS response, mobile genetic elements, Transposable Elements.
4. Transcription and splicing: RNA polymerases, promoters, sigma and Rho factors,initiation,

elongation and termination of transcription (Prokaryotes), Inhibitors oftranscription. Transcription in Eukaryotes, RNA pol I,II,III, enhancers. Posttranscriptional modifications of t,r and m-RNA, 5' capping, 3' poly A tailing, RNAediting, Transcription factors.
5. Splicing: Splicing phenomenon. Mechanism, spliceosomes, alternative splicing, selfsplicing, ribozyme (catalytic RNA).

Section: II [24L + 6T]

1. Translation: Role of t-RNA and Ribosome in protein synthesis. Mechanism inProkaryotes and Eukaryotes. Epigenetic modification.
2. Protein targeting
3. Protein trafficking
4. Proteasomal degradation
5. Genome protection (RNAi, CRISPR-Cas9) Bacterial Defence Mechanism

Reference Books

1. Biochemistry (III/IV/V/VI edition, 2008) L. Stryer, WH Freeman and Co.
2. Molecular biology of the gene (V edition, 2004) J D Watson, Person education Inc.
3. Molecular Cell Biology (7th edition.2013) by Harvey Lodish et al.
4. Molecular biology of the cell (2008) B. Alberts, Garland Pub. In., NY
5. Genes X (2010), B. Lewin, John Wiley and sons, NY.
6. CRISPR-Cas: Converting A Bacterial Defence Mechanism into A State-of-the-Art Genetic Manipulation Tool, Antibiotics (Basel). 2019 Mar; 8(1): 18.

CCTP-8, BCH-312: Immunology [48L + 12T]

Section I: **[24L + 6T]**

1. Cellular basis of immunity: immunological memory, specificity, diversity, discrimination between self and non self, primary and secondary lymphoid organs, T and B lymphocytes, T cell subpopulation,
2. Innate Immunity, mechanism barriers against infection, PRRs,TLR, innate versus adaptive immunity, cells of the immune system, phagocytic cells engulf and kill microorganisms, complement facilitates phagocytosis, complement mediated acute inflammatory reaction, humoral mechanism provide an additional defensive strategy, extracellular killing , cytokines, cell mediated and humoral immune responses, Clonal selection theory of antibody production, monoclonal and polyclonal antibodies, catalytic antibodies (abzymes)

3. Antigen: Antigen, antigenic determinant, Blood antigens: blood group substances and Rh factor, super antigens, Lipopolysaccharides, Adjuvant complete and incomplete antigen

4. Ig super family: Tcell receptor, B cell receptor, MHC I & II structure, CD receptors. Antibody: structure of antibody, constant and variable regions, Fab, F(ab2) and Fc fragments, different classes of antibodies and their functions, fine structures of antibodies, X ray diffraction studies, isotypes, allotypes and idiotypes,

5. Organization and Expression of Immunoglobulin Genes. Genetic Model Compatible with Ig Structure, Multi-gene Organization of Ig Genes: variable gene rearrangement, generation of antibody diversity and class switching among constant region genes. Expression of Ig genes, synthesis, assembly and secretion of immunoglobulins. Regulation of Ig-Gene transcription, antibody genes and antibody engineering.

6. Major Histocompatibility Complex: General Organization and Inheritance of the MHC,MHC molecules and genes , Detailed Genomic Map of MHC Genes, Cellular Distribution of MHC molecules , Regulation of MHC Expression , MHC and Immune

Responsiveness

Section II: [24L + 6T]

1. Antigen Processing and Presentation: Self-MHC Restriction of T Cells, Role of Antigen-Presenting Cells , Evidence for Two Processing and Presentation Pathways, Endogenous Antigens: The Cytosolic Pathway, Exogenous Antigens: The Endocytic Pathway , Presentation of Nonpeptide Antigens
2. Immunodeficiency: primary B-cell deficiency, primary T cell deficiency, SCID, AIDS
3. Hypersensitivity: Type I anaphylactic hypersensitivity, Type II antibody dependant cytotoxic hypersensitivity, Type III immunecomplex mediated hypersensitivity, Type IV DTH, Type V Stimulatory Hypersensitivity, Mast cells, eosinophils, basophils.
4. Transplantation: graft rejection, types of grafts,types of rejection, mechanism of graft rejection, graft versus host response.
5. Tumor immunology: classes of tumor antigens,immune response to tumor, approaches to cancer immunotherapy , CAR-T cell therapy.
6. Autoimmune diseases
7. Immunological techniques: immuno-diffusion, immunoelectrophoresis, radioimmunoassay, immunofluorescence, ELISA, Western blotting, FACS, ChIP assay, FISH.
8. Vaccines : Passively acquired immunity,Principles of vaccination, Killed organisms as vaccines,Live attenuated organisms, Subunit vaccines, Newer approaches to vaccine development, Current vaccines,Vaccines under development

Reference:

1. Essential immunology; Ivan Roitt, 13 th edition
2. Kuby-Immunology 8th edition
3. Fundamental Immunology; William E. Paul 7th edition

CCTP-9, BCH-313: Recombinant DNA Technology [48L + 12T]

Section I: [24L + 6T]

1.Isolation and Quantification of DNA
2. Genetic engineering concepts: Early development in genetics, concept of gene cloning and its importance.
3. Promoter analysis. Chip-seq assay, EMSA
4. Manipulation of DNA: Enzymes in genetic engineering, Restriction endonucleases, restriction map, Ligase, polymerase modifying enzymes, ligation; putting sticky ends to blunt ended molecules.
5. Cloning and expression vectors: Vectors for *E. coli*: Plasmids, M 13 bacteriophage vectors, λ bacteriophage,. Eukaryotic cloning vectors: Cloning vectors for yeast, cloning vectors for higher plants, Ti plasmid, cloning vectors for insects, viruses as cloning vectors for mammals.
6. Introduction of DNA in living cells: Transformation/ transfection methods, identification of recombinants. Selection of recombinant DNA.
7. Construction of genomic and cDNA library.
8. Expression of foreign gene: gene expression in *E. coli*, production of recombinant proteins in eukaryotes, fungi, yeast, mammalian and insect cells systems.

Section II: [24L + 6T]

1. Polymerase chain reaction: concept, types, methods and applications.
2. Sequencing genes and genomes: chain termination using ddNTPs, NGS: Oxford Nanopore, PacBio and Illumina technologies, pyrosequencing.
3. Gene Expression analysis: qPCR: delta-delta Ct method, SYBR Green and TaqMan, NGS, Northern bolting,
4. Transgenic animals: Gene transfer strategies, production of recombinant proteins and other

applications.
5. Protein Engineering: In vitro mutagenesis, Oligonucleotide directed, PCR based, applications of protein engineering.
6. Study of genomes: genome annotations, study of transcriptome, proteome.
7. RNA interference: miRNA, siRNA.
8. Genome editing: Meganucleases, talen, Zinc finger nucleases, CRISPR/Cas9
9. Reporter Genes, GUS assay.
10. Human genome project: Project period and accomplishment, Genome mapping approach, Application and proposed benefits, Ethical, Social and legal issues.

Reference Books

1. Gene cloning- An introduction, T.A Brown, 2nd and 3rd ed, Chapman &Hall.
2. Recombinant DNA- genes and genomes a short course JD Watson, R.M.Myers, A.M.Caudy, J.A.Witkowski, WH Freeman &Co. 2007 (II/ III rded)
3. Principles of gene manipulation, SB Primrose.
4. Principles and Techniques of Biochemistry and Molecular Biology, K Wilson and J Walker, 7th edn
5. Molecular Cloning: A Laboratory Manual (Fourth Edition) Michael R. Green & Joseph Sambrook
6. Genetic Engineering, SmitaRastogi, Neelam Pathak, Oxford University press, 2009.

CBOP-3, BCH-314: (Any one subject) ,

BCH-314(A): Bio-processing and Industrial Biochemistry [48L + 12T]

OR BCH-314(B): Pharmacology and Forensic Biochemistry [48L + 12T]

CBOP-3, BCH-314(A): Bio-processing and Industrial Biochemistry [24L + 6T]

Section I: Bio-processing [24L + 6T]

1. Characteristics of industrial microorganisms
2. Strain improvement, use of auxotrophic mutants
3. Methods and parameters of cultivation of microorganisms , media for industrial fermentation
4. Fermenters, design of fermenters, fermentation process, and maintenance of aseptic conditions, aeration and agitation.
5. Downstream processing, recovery and purification of fermentation products, effluent treatment.
6. Applications of fermentation technology.
7. Manufacturing by fermentative process: beer, Citric acid, Glutamic acid, lipase, Penicillin, L-asparginase, cephalosporin.

Reference Books

1. Principles of Fermentation technology, PF Stanbury, A Whitaker, SJ Hall (2008)
2. Molecular biology and biotechnology- edited by JM Walker and FB Gingold, Royal society of chemistry 5th edition (2009)
3. Industrial Microbiology – Casida 2nd edition (2016).
4. General Microbiology Stainer R.Y. et al (1987) 5th Ed., Macmillan Press Ltd. London

Section II: Industrial Biochemistry [24L + 6T]

1. Media requirements: Sterilization and role of growth regulators, Requirements of aplant tissue culture laboratory.
2. PTC Techniques: Callus and cell suspension culture, Micropropogation, Conditioning of tissue culture plants (weaning and hardening),Somatic cell hybridization, Haploid (anther) culture, Embryo culture, Protoplast fusion, Somatic embryogenesis, Somaclonal variations, Cybrids and Allopheny, Agrobacterium mediated hairy root culture
3. Active principles in medicinal plants and phytochemistry of the metabolites of medicinal

importance.

Animal tissue culture

1. Media requirements: preparation of medium and sterilization techniques, Advantages and disadvantages of natural and synthetic media.
2. Cell culture methods: Hanging drop, suspension and monolayer culture, Behavior and characteristics of cells in culture, Primary and established cell lines, characteristics of transformed cells, Methods of cell preservation.
3. ATC techniques: Primary cultures and secondary cultures, cloning, heterocaryons, variant cells, contact inhibitions, Organ culture and cell and tissue banking

Reference Books:

1. Principle and practice of Animal tissue culture by SudhaGangal, 2nd edition (2010).
2. Tissue Culture by John Paul, 4th edition (1970).
3. Plant cell tissue and Organ culture by Gamborg Phillips (1995).
4. Plant tissue culture basic and applied T B JhaandB Gosh (2005).
5. Culture of Animal Cells by Ian Freshney 6th edition (2011)

CBOP-3, BCH-314(B): Pharmacology and Forensic Biochemistry [48L + 12T]

Section I: Pharmacology [24L + 6T]

1. Concept of evidence-based medicine, Importance of Biochemistry and pharmacy: Metabolites and anti-metabolites;
2. Drugs - Classification of drugs, routes of drug administration. Receptor interaction, involvement of binding forces in drug receptor interaction, drug action not mediated by receptors
3. Pharrmacokinetic considerations: drug absorption, distribution, biotransformations and excretion
4. Pharmacokinetic concepts of bioavailability, apparent volume of distribution (aVd), half life (t½), and clearance (CL) that are used to decide the doses and rational dosing during the drug treatment.
5. Pharmacodynamics; site and mechanism of drug action, drug receptors and receptor regulation, concepts of agonists, antagonists, partial agonist and inverse agonist drugs
6. Drug interactions and concept of pharmacogenomics/-genetics in drug action, effects and ADRs
7. Adverse drug reactions (ADRs) and role of pharmacovigilance activity in ADR monitoring
8. Drug Development: Challenges, Discovery, use of genomes for drug discovery, stages of drug development.

Section II: Forensic Biochemistry [24L + 6T]

1. Forensic Toxicology: - Introduction and concept of forensic toxicological. Different areas of toxicology, spectrum of toxic dose, risk and safety. Classification of toxic agents, characteristics of exposure, route and site of exposure. Duration of frequency of exposure. Spectrum of undesired effects: Allergic reactions, Idiosyncratic reactions, Immediate verses delayed toxicity, Reversible verses irreversible toxicity, Local verses systemic toxicity. Interaction of chemicals, Tolerance, Dose response. Selective toxicity.
2. Evaluation of Toxicity: Descriptive Animal toxicity tests: Acute lethality, Sub acute, sub chronic and chronic toxicity testing. Teratology and reproduction, Mutagenecity.
3. Biotransformation of toxicants: Phase I and II biotransformation reactions, Detoxication and toxication. Components of Cytochrome P-450 monooxygenase system. Mechanism of phase I and II reactions. Bioactvation, Toxicity of insecticides/drugs i.e. carbamates, organophosphorous, and chlorinated insecticides metals, animal and plant toxins, solvents and vapors.
4. Applications of toxicology: forensic, clinical and occupational health and industrial

hygeine
5. Enzymes in forensic biochemistry, role of DNA in analysis, role of enzymes to determine the times since death.

Reference books:

1. Haye's principles and methods of Toxicology Ed. A Wallace Hayes, Pub. Raven press, NY, 6th Edition (2014).
2. Casarett and Doull's Toxicology ed. John Doull, Curtio D Kleassen and Mary D Aunder, McMillan publisher Co, NY, 3rd edition (2003).
3. Appraisal of the safety of chemicals in foods, drugs and cosmetics. Ed. The Editorial Committee of Association of Food and Drug Officials of the United States (1959).
4. Toxicology- Mechanisms and analytical methods, Vol I and II, ed Stewart CP and Stolman A, Pub Academic press (1960).
5. Veterinary toxicology by RJ Garner edBeilliere, tindall and Cox London, 3rd edition (2007). 6. The chemistry and microbiology of pollution (1975) IJ Higgins and RG Burns Acad Press, NY 7. Introduction to ecological biochemistry JB HarboneAcad Press, NY 4th edition (2004).

CCPP-3, BCH- 315: Practical, Molecular Biology and Immunological techniques

[96L + 24T]

Molecular Biology

1. Melting Temperature
2. Spectrophotometric analysis of nucleic acids
3. Primer Designing
4. DNA amplification (PCR)
5. Isolation of plasmid DNA
6. Restriction digestion of DNA
7. Ligation
8. Competent cell preparation
9. Transformation
10. Agarose gel electrophoresis of DNA and molecular size determination.

Immunological techniques.

1. Blood group typing, Rh blood typing
2. Ouchterlony double diffusion assay
3. Single Radial immunodiffusion
4. Immunoelectrophoresis
5. Rocket immunoelectrophoresis
6. ELISA
7. WIDAL Test
8. Lateral flow immunodiffisuion assay
9. Separation and purification of Immunoglobulin
10. Western Blotting (Demo Experiment)
11. Quantitative precipitin assay

12. Reverse blood grouping

SEMESTER IV

CCTP-10, BCH-411: Neurochemistry& Endocrinology [48L + 12T]

Section I: Neurochemistry [24L + 6T]

1. Brain and behavior, Nerve cells and behavior
2. Anatomical organization: Central nervous system, spinal cord, different regions of the brain, peripheral and autonomic nervous system afferent and efferent pathways.

3. Neurotransmitters: Synthesis, storage, uptake degradation and action of neurotransmitters. Acetyl choline, GABA, Serotonin, Dopamine, Glutamate Aspartate, Nitrous Oxide etc., Neuropeptides.
4. Receptors: Types of receptors, properties of receptors, sensory modalities and sensory circuits. Sensory perception, cerebrospinal fluid, blood- brain barrier.
5. Learning and memory: Mechanism of short term memory and long term potentiation. NMDA and AMPA glutamate receptors. Retrograde messengers in synaptic transmission. Role of CAM kinase II, Calcium, Protein kinase, CAMP, NO, Calpain and other proteins in memory and learning process.
6. Circadian rhythms.

Reference books

1. Text book of physiology- Guyton, 12th edition (2010)
2. Principles of neural science Kandel ER, Schwartz JH, Elsevier, N.Holland, NY, 5th edition (1991)
3. Neurobiology, Shepherd GM , Oxford Univ. Press (1993).
4. Nerve and muscle excitation Junge D, Sinauerassoc, Sanderland, mass (1976).
5. Biochemistry , L Stryer, Freeman and Co, NY, 8th edition (2015).
6. Biochemistry, Zubay, Addison Wesley and Co.2nd edition (1994)

Section II: Endocrinology [24L + 6T]

1. General characteristics of hormones: chemistry, structure, synthesis, secretion, transport, metabolism & mechanism of action of hormones of the thyroid, hypothalamus, pituitary, pancreas, adrenals, glands, prostaglandins and gastro intestinal hormones, secondary messengers and their mode of action, calcium signaling, zinc fingers.
2. Disorders related to hormones.
3. Cell membranes and intracellular receptors for hormones.
4. Hormonal inter relationship.
5. Biosynthesis of steroid hormones, cholera toxin, adenylate cyclase and TP, hormone overproduction and target cell insensitivity.
6. EGF, NGF, PDGF, Enkephalin.

Reference books:

1. Vertebrate endocrinology- Noris DO 5th ed (2013).
2. Endocrine physiology- Martin, CR (1985(O xfordUniv press (NY)
3. Physiological chemistry –Harper 17ed Lange medical
4. Biochemistry- Zubay (1983) Addison, Wesley publ. Co.
5. Text book of endocrinology –Williams, 13th edition Saundes Co (2016).
6. Biochemical endocrinology E. Frieden (1983)

CCTP-11, BCH-412: Medical and Physiological Biochemistry [48L + 12T]

Section I: Medical Biochemistry: [24L + 6T]

1. Mechanism of action at molecular level of selected antibiotics: inhibitors of cell wall, plasma membrane, nucleic acids and protein synthesis. Mechanism of action of anti metabolites, analgesics, hallucinogens, antiviral, antifungal, antiprotozoal and mechanism of resistance to antibiotics and other drugs.
2. Lysosomes and their physiological role: Structure and function of lysosomes, role in animal and plant cells. Physiological role in various types of digestive phenomenon disturbances to lysosomes (lysosomal pathology), lysosomal storage disease.
3. Molecular basis of hemoglobinopathies: concept of hemoglobinopathies, β and α thalassemia's, sickle cell anemia, pathophysiology, biochemistry, types of mutations.
4. Ischemic heart disease/CHD: myocardial infarction and coronary heart diseases (pathophysiology); laboratory findings, enzymes involved.
5. Cancer: carcinogenesis, microevolution process, molecular genetics of cancer, causative

agents, role of viruses.
6. Biochemistry of diseases: Influenza: life cycle, transmission, biochemical mechanism, Malaria: epidemiology, life cycle, biochemical mechanism; Alzheimer: dementia, biochemical mechanism, formation and tangles and plaques.
7. Apoptosis: extrinsic and intrinsic mechanism, role in diseases and physiology.

Reference Books

1. Biochemistry of antimicrobial action (4th ed) TJ Franklin, Chapman hall (1989)
2. Mechanism of microbial diseases, M Schaechter et al,Williams and Wilkino Int. 5th Ed.(2012)
3. Microbiology an application based approach, M.J Pelczar, ECS Chan, N.R.Krieg (2009).
4. Biochemistry, L Stryer (3rd ed), Freeman and Co, 8th edition (2015).
5. Biochemical aspects of human diseases (1983), RL Elkeles, Slackwell scientific publishers,Oxford
6. Biochemistry and diseases, Robert Cohn Carl S Roth (1996).
7. Molecular biology of the cell, third edition, Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, JD Watson, 6th edition (2014).

Section II: Physiological biochemistry [24L + 6T]

1. Liver: anatomy, physiological functions, Liver function tests, Liver disorders:- hepatitis, cirrhosis, Jaundice: etiology and symptoms.
2. Kidney: anatomy, physiological functions, diseases/disorder, diagnostic tests.
3. Respiration: Principles of gaseous exchange during respiration, Bohr effect, transport of oxygen and carbon dioxide in the blood, regulation of respiration.
4. Digestion and Absorption of food: Generalized structure of digestive tract and associated digestive gland. Function of different parts- peristalsis, regulation of saliva, gastric, pancreatic, Intestinal and bile secretion (i.e. digestion), Absorption – (carbohydrate, protein, lipid, minerals and vitamin) transport and excretion of nutrients.
5. Biochemistry of blood clotting ,clotting factors, intrinsic and extrinsic pathways, mechanism of formation of thrombin, fibrin, fibrin clot, role of vitamin K clotting process, lysis of fibrin clot. Conditions that cause excessive bleeding in humans.
6. Regulation of acid-base balance, types and functions of acid-base buffers, clinical abnormalities associated with acid-base imbalance.
7. Water and Mineral metabolism.

Reference Books

1. Biochemistry, L Stryer, Freeman and Co, NY, VI edition (2008).
2. Biochemistry, Zubay, Addison Wesley and Co. (1983).
3. Textbook of Physiology, Guyton, 12th edition (2010).
4. Physiology, Berne and Levy, 7th edition (2017).
5. Harper's Biochemistry- 30th edition (2015).
6. Text book of Biochemistry and Human Biology - Ed. G. P. Talwar (2002).

CBOP-4, BCH-413 (Any one), BCH-413 (A): Evolution and developmental biology
OR BCH-413 (B): Clinical Nutrition and Food Technology

CBOP-4, BCH-413 (A): Evolution and developmental biology [48L + 12T]

Section I: Evolution [24L + 6T]

1. Theories of Evolution.-the time scale and some evolutionary principles. Chemical evolution and origin of life. Prototypes of metabolic pathways.
2. Genesis of oxygen generating photosynthesis and aerobic respiration. Methanogensevolution of prokaryotes
3. Evolution of protists
4. Origin of eukaryotes

5. Theories regarding origin of mitochondria and chloroplast, the five kingdom classification of living organisms, outline of eukaryote evolution- evolution of primates.
6. Construction of phylogenetic trees- molecular data set based on sequences
7. Evolution of proteins and nucleic acid – elastic analysis.
8. Evolution of introns
9. Evolutionary view of exon domain relationships

Section II: DEVELOPMENTAL BIOLOGY [24L + 6T]

1) Basic concepts of development : Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development
2) Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.
3) Morphogenesis and organogenesis in animals : Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibia and chick; organogenesis – vulva formation in Caenorhabditis elegans, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.
4) Programmed cell death, aging and senescence
5) Developmental Biology—Cell differentiation, hierarchy of genes, measurement of time during development, nature of differentiation, DNA rearrangements& amplification, genetic control of morphogenesis, plant molecular genetics.

Reference Books:

1. Evolution and Diversity of life, E. Mayer Belknap Press Pub, 1976
2. Population species and evolution (1973), E Mayer Press Pub.
3. Biochemistry ,Lehninger 7th edition, (2012) Worth pub
4. Origin of Eukaryotic cells, Margulis L.(1977)
5. Developmental Biology: Scott F. Gilbert.
6 . Evolution and Diversity of life, E. Mayer Belknap Press Pub, 1976
7. Population species and evolution (1973), E Mayer Press Pub.
8. Origin of Eukaryotic cells, Margulis L.(1977)

CBOP-4 , BCH-413 (B): Clinical Nutrition and Food Technology [48L + 12T]

Section I: Clinical Nutrition: [24L + 6T]

1. Diet and nutrition in India: Assessment of nutritional status
2. Food and Nutritional Security
3. Effects of irradiation, cooking, refining, sprouting and fermentation on nutritional quality of food
4. Food Habits, Food Faddism and Nutrition
5. Interrelationship between dietary lipids and cholesterol metabolism
6. Malnutrition
7. Weight Management and Eating Disorders
8. Nutrition and Anemia
9. Food Allergy
10. Nutrition and metabolic disorders: Diabetic and Obesity
11. Factors affecting digestion and absorption of food

12. Dietary fiber- chemical composition and importance
13. Physiological effects and metabolic adaptation during exercise
14. Nutritional management of inborn errors of metabolism

Reference books:

1. Essentials of food and nutrition M Swaminathan Vol. II, Applied aspects (1974), Ganesh Pub, Madras
2. Human biochemistry – James Orten and Otto Neuhaus, 10th ed , CV Mosby co London
3. Human nutrition and dietetics-Davidson and Passmore

Section II: Food Technology: [24L + 6T]

1. Concepts of food analysis; Rules and regulations of food analysis
2. Monitoring food quality: Hazard Analysis and Critical Control Point, Good manufacturing practices, current good manufacturing practices; Standard operating procedures, good laboratory practices
3. Biochemistry of food spoilage, principles of food preservations , methods of food preservation
4. Proteins from unconventional sources- OCP, SCP etc
5. Starch production, manufacture of natural and synthetic sweeteners and syrups
6. Enzymes in food analysis, alcohol, amino acids, glucose
7. Enzymes in food processing, meat tenderization and fruit juice technology
8. Food additives, starches, sugars, syrups and sweeteners, flavoring agents, colors Food preservatives. Role and mode of action of salts, chelating agents, stabilizers and thickeners; Humectants/polyhydric alcohol, anti-caking agent, firming agent, flour bleaching and maturing agents, antioxidants, nutritional and non-nutritional

sweeteners;

9. Food Laws: FSSAI, AGMARK, BIS, FPO, Weights and Measures Act ,CODEX
10. Genetically modified foods

Reference books:

1. Enzymes and food processing- GG Birch, N Blackbrough (1981)
2. Nutrition and food processing- MG Miller , G Tobin, AVI publishing Co, Creem Holm (1980)
3. Introduction to food sciences and technology –GF Stewart and MA Amerine (1973) Academic Press

CBOP-5, BCH-414 : Practical, Any One Subject

BCH-414 (A): Principles Of Downstream Techniques In Bioprocess **OR**

BCH-414 (B): Clinical Biochemistry and Research Methodology

BCH-414 (A): Industrial Biochemistry [96L + 24T]

1. Ethanol production using bio wastes /raw material [Free cells/ immobilized cells]
2. Microbial production of glutamic acid/citric acid
3. Biotransformation (Enzymatic/Immobilized enzyme)
4. Production of wine from grapes.
5. Extraction, isolation, partial purification (if necessary), calculation of percentage yield and performing a confirmatory test for the following:(Any one)
    1. Carbohydrates:
    a. Cellulose
    b. Glycogen from Liver
    c. Pectin from apples/bananas/oranges
6. Lipids:
    a. Extraction and analysis of lipid.
7. Pigments (Separation of the following pigments on TLC slides):
    a. Oleoresin Extraction
    b. Carotenes from carrots
    c. Chlorophylls from spinach
8. Isolation and Estimation of
    a. Oxalates from spinach/ *Aloe vera*
    b. Lycopene from tomatoes.
9. Demonstration of Bioreactor
10. Isolation and purification of Protein (determination of % yield and purity)
11. Essential oil extraction

CBOP-5, BCH-414(B): Clinical Biochemistry and Research Methodology

Section-I, Clinical Biochemistry(Any 10) [48L + 12T]

1. Estimation of Lipoproteins
2. Estimation of serum amylase
3. Estimation of bilirubin
4. Estimation of blood urea and uric acid
5. Blood sugar determination by Folin-Wu method
6. Estimation of creatine phosphokinase
7. Normal and abnormal constituents of urine
8. Determination of blood cholesterol
9. Determination of glucose by glucose oxidase method
10. Estimation of glycosylated hemoglobin
11. Estimation of LDH and its isozymes
12. Estimation of alkaline and acid phosphatase from serum
13. Estimation of total protein and albumin from serum
14. Determination of SGPT and SGOT

Reference Books:

1. Practical Biochemistry- David Plummer 3rd edition (2015).
2. Practical Biochemistry – J. Jayaraman (2011).
3. Biochemical methods – Sadasivam and Manickam 3rd edition (2007).
4. Biochemistry –Practical Approach – Kieth Wilson and J. Walker 5th edition (2006).
5. Introductory Practical Biochemistry- Randhir Singh and Sawhney (1999).
6. Laboratory handbook on Biochemistry, S Shanmugam, 2010, PHI Pvt Ltd, New Delhi

(2010).

Section-II, Research Methodology [48L + 12T]

1. Preparation of Research Proposal for submitted tothe funding agencies. (Submit it as report)
2. Review of Research work being carried out at any five National/ International Research Centers or Institutes/Research institute visit report
3. Use of Excel for calculation and Graph
   a) Measurement of Central Tendency (Mean, Median, Mode)
   b) Measurement of Dispersion/variability(Mean Deviation, Standard Deviation, Co efficient of variation)
   c) Line Graph, Bar graph. Pie chart
5. Tool plagiarism detection
4. Research Paper analysis
   a) Analysis of data (including graph, table, figure, Method/technique/instrument) (Using MS word of Similar software Brief Report 1 page)
   b) Presentation of Research Paper (15 minute power point presentation)

CCPP-4, BCH-415: (Project) [96L + 24T]

GUIDELINE TO CARRY OUT PROJECTWORK

1. The main purpose of introduction Project Work at MSc Part II is to make the studentsfamiliar with Research Methodology i.e. reference work, experimental work, statisticalanalysis of experimental data, interpretation of results obtained, writing of project workand compilation of bibliography in proper order. This will not only help train the inquisitive minds of the students, but also inspire them to take up research- oriented higher studies and career.

2. **Duration of Project work: -**

Development on the nature of the research problem and the infrastructure available in the respective Biochemistry Departments or Research Institutes or Industries, the duration of Project Work in recommended as follows:-

a. 06 Months (**Equivalent to 96L + 24T**): - The project work will commence immediately after the conclusion of Semester II of M. Sc Part – I.
b. Each student shall complete a small research project during his/ her academic year of M. Sc Part- II. However, the initial reference work can be started in M.Sc Part- I and summer vacation.

4. **Nature of Research Project:-**

The following will be considered as the Research Project.

   a. Experimental based involving laboratory analytical work, or
   b. Industrial training based provided that the candidate has undergone actual hands on training in instrumental analytical techniques.

5. **Schedule for Submission of project Work:-**

a. Experiment work or Industrial training must be completed by October 31.
b. The duration of Diwali Vacation and the part of Sem IV up to December 31 shall be utilized for finalizing the written contents of the project work.
c. The final copy of the project work (3 Copies) will have to submit to the respective HOD by January end of Sem IV.
6. The project containing about 20-30 pages (A4 size paper with normal margins). Should be divided into the following parts: -
   a. Certification of completion of Project Work from the HOD.
   b. Acknowledgement.
   c. Introduction
   d. Review of Related Literature

e. Aims and Objectives
f. Signification of research problems selected
g. Plan of work
h. Material and Methods
i. Results
j. Discussion
k. Bibliography

7. The project should be submitted at the time of University Practical Examination, as the same will be assessed internally.

GUIDELINE FOR THE ASSESMENT OF PROJECT WORK

1. Each student will complete the project (3 copies) and get all the copies certified by the guiding teacher and the Head of Dept.(HOD) by January of Sem IV.
3. One copy of the certified project will be submitted to the HOD; One will be submitted to the guide while the other copy will be retained by the students for his/ her personal record.
4. After the certification of the project, the HOD will invite a PG – Recognized Teacher of Biochemistry Dept of any other College/ Institute/ Research centre for the assessment of **Research Project.**
5. The candidate is required to present the Research Project to the invited examiner followed by Viva- Voce examination based on the project work by the examiner.
6. The following Marking Scheme shall be considered while assessing the project work Particular of Marks Allotment
    a) Project Dissertation (Contents Submitted in the bound form).
    b) Presentation of Project Work before Examiner.
    c) Viva- voce Exam based in Project work.

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Faculty of Science and Technology

Choice Based Credit System (CBCS)

M. Sc. (Physics)

From Academic Year 2019-2020

Structure of Syllabus

SAVITRIBAI PHULE PUNE UNIVERSITY

GANESHKHIND, PUNE-411007

Proposed Structure of M. Sc. (Physics) Syllabus (C. B. C. S.)

1. Title of the Course: M. Sc. Physics

2. Preamble:

The curriculum for the M. Sc. (Physics) programme is designed to cater to the requirement of Choice Based Credit System following the University Grants Commission (UGC) guidelines. In the proposed structure, due consideration is given to Core and Elective Courses (Discipline specific - Physics), along with Ability Enhancement (Compulsory and Skill based) Courses. Furthermore, continuous assessment is an integral part of the CBCS, which will facilitate systematic and thorough learning towards better understanding of the subject. The systematic and planned curricula divided into two years (comprised of four semesters) shall motivate the student for pursuing higher studies in Physics and inculcate enough skills for becoming an entrepreneur.

Objectives:

- To foster scientific attitude, provide in-depth knowledge of scientific and technological concepts of Physics.
- To enrich knowledge through problem solving, minor/major projects, seminars, tutorials, review of research articles/papers, participation in scientific events, study visits, etc.
- To familiarize with recent scientific and technological developments.
- To create foundation for research and development in Physics.
- To help students to learn various experimental and computational tools thereby developing analytical abilities to address real world problems.
- To train students in skills related to research, education, industry and market.
- To help students to build-up a progressive and successful career in Physics.

3. Introduction: Semester Credit System

4. Eligibility: As per the rules and regulations published by SPPU, Pune.

5. Examination: As per the BOOKLET prepared by SPPU, Pune

A. Pattern of Examination

B. Standard of Passing

C. ATKT Rules

D. Award of Class

E. External Students

F. Setting of Question paper / Pattern of Question paper

G. Verification / Revaluation

Index

Title	Page no.
Course Structure	4
Nomenclature and name of the Elective papers in Semester III and Semester IV.	5
Detailed syllabi of Core Compulsory Theory Papers (CCTP), Core Compulsory Practical Papers (CCPP), Choice Based Optional Papers (CBOP).	6

Structure of M. Sc. Physics (Choice Based Credit System)

(Revised)

To be implemented from the Academic Year 2019-20

Subject Name	Year	Semester	Course Type	Course Code	Course Name	Credit
Physics	1	I	Core Compulsory Theory Paper	PHCT-111	Mathematical Methods in Physics	4
				PHCT-112	Classical Mechanics	4
				PHCT-113	Quantum Mechanics	4
			Choice Based Optional Paper	PHOT-114	Electronics	4
			Core Compulsory Practical Paper	PHCP-115	Physics Laboratory – I (Electronics)	4
		II	Core Compulsory Theory Paper	PHCT-121	Electrodynamics	4
				PHCT-122	Solid State Physics	4
				PHCT-123	Statistical Mechanics	4
			Choice Based Optional Paper	PHOT-124	Atoms and Molecules	4
			Core Compulsory Practical Paper	PHCP-125	Physics Laboratory - II	4
	2	III	Core Compulsory Theory Paper	PHCT-231	Physics of Semiconductor Devices	4
				PHCT-232	Laser-Fundamentals and Applications	4
				PHCT-233	Experimental Techniques in Physics - I	4
			Choice Based Optional Paper	PHOP-234	*Elective - I	4
			Core Compulsory Practical Paper	PHCP-235	Physics Laboratory - III	4
		IV	Core Compulsory Theory Paper	PHCT-241	Nuclear Physics	4
				PHCT-242	Materials Science	4
				PHCT-243	Experimental Techniques in Physics - II	4
			Choice Based Optional Paper	PHOP-244	*Elective - II	4
			Core Compulsory Practical Paper	PHCP-245	Project	4

Electives:

Semester 3

Sub-code	Elective-I
PHOP234-I	Medical Physics – I
PHOP234-J	Acoustics – I
PHOP234-K	Energy Studies – I
PHOP234-L	Physics of Thin Films
PHOP234-M	Astronomy and Astrophysics – I
PHOP234-N	Electronics Instrumentation – I
PHOP234-O	Communication Electronics
PHOP234-P	Biomedical Instrumentation – I
PHOP234-Q	Atmospheric Physics – I
PHOP234-R	Nuclear Techniques – I
PHOP234-S	Microcontroller Based Instrumentation System – I

Semester 4

Sub-code	Elective-II
PHOP244-I	Medical Physics – II
PHOP244-J	Acoustics – II
PHOP244-K	Energy Studies – II
PHOP244-L	Physics of Nano Materials
PHOP244-M	Astronomy and Astrophysics – II
PHOP244-N	Electronics Instrumentation – II
PHOP244-O	Microwave Physics and Applications
PHOP244-P	Biomedical Instrumentation – II
PHOP244-Q	Atmospheric Physics – II
PHOP244-R	Nuclear Techniques – II
PHOP244-S	Microcontroller Based Instrumentation System – II

Detailed Syllabi:

Course Code and Title: PHCT-111: Mathematical Methods in Physics

Module 1: Complex Analysis **Credit-1**

Complex number, Complex function (polynomial, Exponential, Trigonometric complex function, Logarithm), Limit and Continuity, differentiation, Analytical function, Cauchy-Riemann condition, Line integrals, Cauchy integral formula, Derivative of analytical functions, Power Series, Taylor's theorem, Laurent's theorem, Calculus of residues, Evaluation of real definite integrals (**References: 1-5)**

Module 2: Vector Space and Matrix Algebra **Credit-1**

Revision on Vector space: Vectors (dependent and independent), Vector space, Hilbert space, Dimension of vector space, Matrix representation, Similarity transformation, Eigen values and Eigen vectors, Inner product, Orthogonality, Introduction only to Gramm-Schmidt orthogonalization procedure, Self adjoint and unitary transformation, Eigen values and Eigen vectors of Hermitian and Unitary transformation, Diagonalization (**References: 6, 7)**

Module 3: Special Functions **Credit-1**

Bessel function, Legendre, Hermite, and Laguerre functions – Generating function, Recurrence relations and their differential equations, Orthogonality properties, Bessel's function of first kind, Spherical, Associated Legendre function, Spherical harmonics. (**References: 4, 5, 7)**

Module 4: Fourier Series and Integral Transforms **Credit-1**

Fourier series: Definition, Dirichlet's Condition, Convergence, Fourier Integral and Fourier transform, convolution theorem, Parseval's identity, Application to the solution of differential equations, Laplace transform and its properties, Fourier transform and Laplace transform of Dirac Delta function. (**References: 3, 4, 7)**

Reference Books:

1. Complex Variables and Application- J. W. Brown, R. V. Churchill - Mc- Graw Hill
2. Complex Variables – Seymour Lipschutz
3. Mathematics for Physical Sciences – Mary Boas, John Wiley and Sons
4. Mathematical methods in Physics- B. D. Gupta
5. Mathematical methods in Physics- Satyaprakash
6. Linear algebra – Seymour Lipschutz, Schaum Outline Series Mc-Graw Hill Edition
7. Mathematical Method for Physicists, Arfken & Weber, 6^{th} Edition, Academic Press, N. Y.

Course Code and Title: PHCT-112: Classical Mechanics

Module 1: Analytical Dynamics (Lagrangian and Hamiltonian Dynamics, Canonical Transformations and Poisson Brackets) Credit-2

Variational principle and its applications to problems like shortest distance, brachistochrone, geodesics etc. Lagrangian and Hamiltonian equations of motion - derivation using Hamilton's principle of least action and their applications to various problems. Hamiltonian for a charged particle. Properties of kinetic energy function. Time-dependence of total energy (theorem on total energy). Symmetry and conservation laws (energy and momentum). Gauge function for Lagrangian. Invariance under Galilean transformation.

Canonical transformations and their applications. Canonical transformations of the free particle Hamiltonian. Liouville's theroem. Area conservation properties of canonical flows. Poisson Brackets. Jacobi-Poisson theorem on Poisson Brackets. Invariance of Poisson brackets under canonical transformations. Dirac's formulation of generalized Hamiltonian.

Module 2: Central Forces and Non-inertial Frames of Reference Credit-1

Lagragian formulation of motion under central forces. Kepler problem. Stability of orbits. Motion of satellites. Rotating frames of reference. Coriolis force, banking of rivers, Foucault's pendulum, and tides.

Module 3 Rigid body dynamics and Small Oscillations Credit-1

Moment of inertia tensor. Euler angles. Euler equation of motion for rigid body motion. Symmetric top. Small oscillations. System of couple oscillators. Normal modes and normal coordinates.

Reference Books:

1. Classical Mechanics by H. Goldstein, C. Poole and J. Safko.
2. Classical Mechanics by N. C. Rana and P. S. Joag.
3. Mechanics by L. D. Landau & E. M. Lifshitz.
4. Classical Mechanics by J. R. Taylor.
5. Classical Mechanics by P. V. Panat
6. Classical Mechanics by Y. R. Waghmare

Course Code and Title: PHCT-113: Quantum Mechanics

Module 1: Revision and General Formalism **Credit-1**

Inadequacy of classical Physics, wave packets and uncertainity relations, Schrodinger wave equation and probability interpretation, Simple one dimensional problems wells, barriers and harmonic oscillator (One dimension)

Postulates of Quantum Mechanics

Representation of states and dynamical variables, observables, self adjoint operators, eigen functions and eigen values, degeneracy, Dirac delta function, Completeness and closure property, Physical interpretation of eigen values, eigen functions and expansion coefficients, eigen values and eigen functions of momentum operator.

Module 2: Representation of States – Dirac Notation **Credit-1**

Hilbert space, Dirac's bra and ket notation, dynamical variables and linear operators, projection operators, unit operator, unitary operator, matrix representation of an operator, change of basis, unitary transformation. Eigen values and eigen functions of simple harmonic oscillator by operator method.

Module 3: Angular Momentum **Credit-1**

Eigen values and eigen functions of L^2 and Lz operators, ladder operators L_+ and L_-, Pauli theory of spins (Pauli's matrices), matrix representation of J in |jm> basis. Addition of angular momenta, Computation of Clebsch-Gordon coefficients in simple cases (J_1=1/2, J_2=1/2)

Module 4: Approximation Methods **Credit-1**

Time-independent Perturbation theory: Non degenerate, Zeeman effect, Time dependent Perturbation theory: Transition amplitude 1st and 2^{nd} order, Fermi's golden rule, Harmonic perturbation, Introduction to WKB approximation, Variational method

Basic principles and applications to particle in box, SHO

Reference Books:

1. A Text-book of Quantum Mechanics by P.M.Mathews and K.Venkatesan.
2. Quantum mechanics by A. Ghatak and S. Lokanathan
3. Quantum Mechanics by L.I. Schiff
4. Modern Quantum mechanics by J. J. Sakurai
5. Quantum Physics by R. Eisberg and R. Resnick
6. Introduction to Quantum Mechanics by by David J. Griffiths
7. Introductory Quantum mechanics by Granier, Springer Publication.
8. Introductory Quantum Mechanics, Li Boff, 4^{th} Edition, Pearson Education Ltd
9. Quntum Mechanics Nouredine Zettili,, A John Wiley and Sons, Ltd., Publication
10. Shankar R. Principles of Quantum Mechanics, II^{nd} Edition (Plenum, 1994)

Course Code and Title: PHCT-114 Electronics

Module 1: Semiconductor Devices and its Applications **Credit-1**

1.1 SCR: Construction, working, Characteristics and applications as half wave and full wave rectifier

1.2 DIAC and TRIAC: Construction, working, characteristics and application as fan regulator

1.3 DC-DC Converter and SMPS: Concept and Applications. (Ref. 1: page nos. 166 to 194 and Ref. 2, 3)

Module 2: Special Function ICs and their Applications **Credit-1**

2.1 Operational Amplifier: Function generator using two OPAMPS with variable controls, Astable and Monostable multivibrators using OPAMPs, Precision rectifiers (Half wave and Full wave), Instrumentation amplifier.

2.2 Timer IC 555: Applications as PAM, PWM, FM and FSK generator.

2.3 Voltage Controlled Oscillator (IC566): Block diagram and working.

2.4 Phase Locked Loop (IC565): Block diagram and working and applications as FM detector, FSK detector, Frequency multiplier and Frequency Translator .(Ref. 4, 5, and 6)

Module 3: Digital Logic Circuits I: Combinational Logic **Credit-1**

Review of Boolean identities and its use to minimize Boolean expressions. Use of Karanaugh Map to design 4-variable logic circuits like BCD to 7-segment decoder, Binary-to-Gray and Gray-to-Binary code converter.

Digital Logic Circuits II: Sequential Logic

4-bit serial, parallel and combinational counter. Study of IC 7490 with applications as MOD counters (01 to 99)Study of IC 7495 and its use as SISO, SIPO, PIPO and PISO.UP-DOWN counters, Ring counter and their applications. (Ref.: 7, 8, and 9)

Module 4: Data Converters **Credit-1**

4.1 Digital to Analog converters: Binary weighted and R-2R ladder type with practical circuit (Using Input switches, Level amplifiers, Control gates and Buffer amplifier)

4.2 Analog to Digital converters: Single slope, Dual slope, Flash (Simultaneous) type, Counter ramp type, Continuous type and Successive approximation type. (Ref.: 7, 8, and 9)

Reference Books:

1. Power Electronics Circuits, Devices and Applications, 3rd Edition by *Muhammad H. Rashid*, Pearsons Publications
2. Electronic Devices and Circuits: An Introduction by *Allen Mottershed.*
3. Solid State Electronic Devices, 6th Edition, by *Ben G. Streetman.*
4. Operational Amplifiers, 5th Edition by *G.B. Clayton.*
5. Linear Integrated Circuits, 4th edition by *Roy Choudhari*
6. Design with OPAMPS and Analog Integrated Circuits by *Sergio Franco*
7. Digital Electronics by *R.P. Jain*
8. Digital Principles and Applications by *Leach and Malvino*
9. Digital Electronics: An Introduction to Theory and Practice by *W.H. Gothmann*

Course Code and Title: PHCP-115 Physics Laboratory-I (Electronics)

Student has to perform any **12 Experiments** **Credits-4**

1. Diode Pump Staircase generator using UJT
2. Foldback Power Supply
3. Crystal Oscillator & Digital Clock
4. Voltage Control Oscillator using IC-566
5. Function generator using IC -8038
6. Optocoupler using OPAMPs and IC MCT-2E
7. Constant current Source using OP-AMP
8. DAC (Digital to Analogue Converter) using R-2R and Binary ladder
9. Active filters using OP-AMP / IC- 8038(L-P, H-P. Notch type)
10. Study of Multiplexer & Demultiplexer
11. Precision rectifier
12. Design, built and test oscillator – LC oscillator
13. 8-bit ADC
14. PLL application using IC565
15. OPAMP : logarithmic amplifier
16. Voltage to Frequency / Frequency to voltage converter using OP-AMP
17. Study of errors in electrical measurement and results due to loading
18. To determine the transition capacitance of a varactor diode and use it as a variablecapacitor.(Pg. 28, Experiments in Electronics, S.V. Subramanian, McMillan India Limited, 1982)
19. Measurement of efficiency of a power amplifier.(IC 810)and study of its frequency response.(Pg. 118, Experiments in Electronics, S.V. Subramanian, McMillan India Limited, 1982)
20. Study of noise performance of an amplifier. (Pg. 449, Art of Electronics, Horowitzand Hill, Cambridge, University Press, Low Price Edition, 1995.)
21. Fourier analysis (Pg. 18, Experiments in Electronics, S.V. Subramanian, McMillan India Limited, 1982)

Reference Books:

1. Signetic Manual.
2. Power supplies: B.S. Sonde.
3. Digital Principles: Malvino (6th Edition, Tata McGraw Hill Publication Co. Ltd. Delhi)
4. Operational Amplifier: G.B. Clayton.
5. OP-AMPS and Linear Integrated Circuits: Ramakant Gaikwad.
6. Data Converters: B.S. Sonde, Tata Mc-Graw Hill Pub. Co. Ltd. (1974).
7. Pulse, Digital and Switching Circuits: Miliman and Taub.
8. Electronic Integrated Circuits & Systems: Franklin, C. Fitchen (Van No strand Reinhold Co.
9. Digital Principles & Applications: Leach and Malvino, (5th Edition, 2002)

Course Code and Title: PHCT-121, Electrodynamics

Module 1: Multipole expansions and time varying fields **Credit-1**

Multipole expansions for a localized charge distribution in free space, linear quadrapole potential and field, static electric and magnetic fields in material media, boundary conditions, Time dependent fields, Faraday's law for stationary and moving media, Maxwell's displacement current, differential and integral forms of Maxwell's equations, Maxwell's equations for moving medium. (Ref: 1- 4, 10)

Module 2: Energy, Force, Momentum relations and Electromagnetic wave equations **Credit-1**

Energy relations in quasi-stationary current systems, Magnetic interaction between two current loops, Energy stored in electric and magnetic fields, Poynting's theorem, General expression for electromagnetic energy, Electromagnetic wave equations, Electromagnetic plane waves in stationary medium, Reflection and refraction of electromagnetic waves at plane boundaries (Oblique incidence), Electromagnetic waves in conducting medium, Skin effect and skin depth. (Ref: 1- 6, 8, 10).

Module 3: Inhomogeneous Wave Equations **Credit-1**

Inhomogeneous wave equations, Lorentz's and Coulomb's gauges, Gauge transformations, Wave equations in terms of electromagnetic potentials, D'Alembertian operator, Hertz potential and its use in computation of radiation fields. Ref: 1- 5, 8, 10

Module 4: Relativistic Mechanics and Covariance **Credit-1**

Experimental basis for special theory of relativity (Michelson – Morley experiment), Lorentz transformations, Relativistic velocity addition, Minkowski's spacetime diagram, Four vector potential, electromagnetic field tensor, Lorentz force on a charged particle (Ref: 1-3, 6, 9, 10).

Reference Books:

1. Introduction to Electrodynamics, (3rd Edition) by David J. Griffith, Publication: Prentice-Hall of India, New Delhi.
2. Introduction to Electrodynamics, by A.Z. Capri & P.V. Panat, Narosa Publishing House.
3. Classical electricity & Magnetism, by Panofsky and Phillips, Addison Wesley.
4. Foundations of Electromagnetic theory by Reitz & Milford, World student series Edition.
5. Classical Electrodynamics, by J.D. Jackson, 3rd Edition John Wiley.
6. Electromagnetic Theory and Electrodynamics, by Satya Prakash, Kedar Nath and Co., Meerut.
7. Special theory of Relativity, by Robert Resnick.
8. Electromagnetics by B.B. Laud, Willey Eastern.
9. Matrices and Tensors in Physics, A. W. Joshi, 3rd Edition, New Age International.
10. Electrodynamics by Kumar Gupta and Singh.

Course Code and Title: PHCT-122 Solid State Physics

Module-1: Crystal Structure of Solids **Credit-1**

Revision of crystal structures, Reciprocal Lattice, Brillion zone, Ewald's spherical construction, structure of atomic form factor, X-Ray diffraction and Neutron diffraction.

Module-2: Electronic Structure of Solids **Credit-1**

Revision of free electron theory, Mathesien value of resistivity, Bloch theorem, KronigPenney Model, nearly free electron model, Fermi sphere, Tight binding approximation, Band structure (in R space) of semiconductor crystal.

Module -3: Magnetism and Superconductivity **Credit-1**

Dia-magnetism, Para-magnetism, (Classical and quantum theory), Ferromagnetism (Weiss theory and quantum theory), Anti-ferromagnetism and Ferrimagnetisms, Superconductivity: Meissner effect, Type I and II superconductor, Josephson Superconductor junction

Module-4: Dielectric Properties of Solids **Credit-1**

Macroscopic and local electric field, Polarizability, Dielectric constant, Clausius–Mossotti relation, Piezoelectricity, Dielectric behavior in $BaTiO_3$

Reference Books:

1. Solid State Physics, N. W. Ashcroft and N. D. Mermin, (CBS Publishing Asia Ltd.).

2. Introduction to Solid State Physics, C. Kittel, (John Wiley and Sons.).

3. Introductory Solid State Physics, H. P. Myers, (Viva Books Pvt. Ltd.)

4. Solid State Physics, H. Ibach and H. Luth, (Springer-Verlag).

5. Fundamentals of Solid State Physics, J. R. Christman, (John Wiley and Sons).

6. Solid State Physics, A. J. Dekkar, (Prentice Hall).

7. Solid State Physics, J. J. Quinn and K-Soo Yi (Springer).

Course Code and Title: PHCT-123 Statistical Mechanics

Module1: Probability theory, Statistical Description of thermodynamic system Credit-1

Brief discussion on probability distributions (F. Reif Chap-1), Thermodynamical laws and basic thermodynamic relations including Maxwell's equations.

Specification of state of a system, Macroscopic and Microscopic states, Phase space, Statistical ensemble, Postulate of equal a priori probability, Probability calculations, Behaviour of density of states, Liouville's theorem (Classical). Distribution of energy between systems in equilibrium, Sharpness of the probability distribution, Equilibrium between interacting systems.

Module 2: Classical Statistical Mechanics Credit-1

Micro-canonical ensemble, Canonical ensemble, Partition function, Applications of canonical ensembles to Paramagnetism, Molecule in an ideal gas, Law of atmosphere. System with specified mean energy, Calculation of mean values and fluctuations in a canonical ensemble in terms of energy, enthalpy and pressure. Connection with thermodynamics and Calculations of thermodynamic quantities, Ideal monoatomic gas.

Gibbs paradox, Equipartition theorem and its applications. i) Mean kinetic energy of a molecule in a gas ii) Brownian motion iii) Harmonic Oscillator iv) Specific heat of solid (Einstein and Debye Specific heat) v) Maxwell velocity distribution, related distributions and mean values

Module 3: Applications of Statistical Mechanics and Quantum Distribution Functions Credit-1

Grand-canonical ensemble, Physical interpretation of Chemical potential (μ) in the equilibrium state. Mean values and fluctuations in grand canonical ensemble. Thermodynamic functions in terms of the Grand partition function. Application: adsorption of gas molecule on surface using grand partition function.

Symmetry of wave functions, Quantum distribution functions, Boltzmann limit of Boson and Fermion gases, Evaluation of the partition function, Partition function for diatomic molecules, Equation of state for an ideal gas, quantum mechanical paramagnetic susceptibility

Module 4: Ideal Bose and Fermi Systems (1 Credit)

Bose-Einstein statistics: Partition function, thermodynamic behavior, Ideal Bose gas: Photon gas -i) Radiation pressure ii) Radiation density iii) Emissivity iv) Equilibrium number of photons in the cavity; Einstein derivation of Planck's law, Specific heat of on gas and Bose Einstein Condensation.

Fermi-Dirac distribution function: Ideal Fermi system. Fermi energy, Mean energy of fermions at absolute zero, Fermi energy as a function of temperature, Electronic specific heat, White – Dwarfs (without derivation)

Reference Books

1. Fundamentals of Statistical and Thermal Physics, - F. Reif, McGraw Hill International Edition (1985).
2. Statistical and Thermal Physics: With Computer Applications- Harvey Gould and Jan Tobochnik (Princeton University Press; 6.1.2010 edition (July 21, 2010).
3. Statistical Physics, Berkeley Physics Course, F. Reif, (Tata McGraw-Hill, 2008).

4. Fundamentals of Statistical Mechanics- B.B. Laud, New Age International Publication (2003).
5. Statistical Mechanics by R.K. Pathria, Bufferworgh Heinemann (2^{nd} Edition).
6. Statistical Mechanics by K. Huang, John Willey and Sons (2^{nd} Edition).
7. Statistical Mechanics by Satya Prakash and Kedar Nath Ram, Nath Publication (2008)
8. Statistical Mechanics by Loknathan and Gambhir

Course Code and Title: PHCT-124 Atoms and Molecules

Module 1: Atoms **Credit-1**

(a) Revision of Atomic models, Revision of Hydrogen atom, Revision of quantum numbers, exclusion principle, electron configuration, Hund's rule

(b) origin of spectral lines, selection rules, One electron spectra, Coupling schemes, two electron spectra, fine structure and hyperfine structure, The Hartree Theory, Results of Hartree theory, X-ray line

(c) Atoms in Electromagnetic field: Zeeman effect- Normal and Anomalous, Paschen- Back effect, Stark effect (weak field)

Module 2: Molecules **Credit-1**

Bonding mechanism in molecules, Molecular orbital methods, Valence band method, Molecular Spectra – Rotational and vibrational spectra for diatomic molecules, Electronics spectra of diatomic molecules, vibration course structure, vibrational analysis of band system, Frank – Condon principle, Dissociation energy and dissociation products, rotational fine structure of electronic vibration transitions, electronic angular momentum in diatomic molecules.

Module 3: Spectroscopic Techniques **Credit-1**

(a) Microwave Spectroscopy: microwave spectrometer, information derived from rotational spectra and analysis of microwave absorption by H2O

(b) Infrared spectroscopy: IR spectrophotometer and instrumentation, sample handling techniques, FTIR spectroscopy and analysis of HCl spectrum, Applications

(c) Raman spectroscopy: Theory of Raman scattering, Rotational Raman spectra, Mutual exclusion, Raman spectrometer, sample handling techniques, Fourier transform Raman spectrometer, Structure determination using IR and Raman spectroscopy (diamond), Applications

Module 4: Resonance spectroscopy **Credit-1**

(a) ESR- Principles of ESR, ESR spectrometer, total Hamiltonian, hyperfine structure.

(b) NMR-Magnetic properties of nucleus, resonance condition, NMR instrumentation, relaxation process, chemical shift, applications of NMR.

Reference Books:

1. Fundamentals of Molecular spectroscopy. Collin N. Banwell and Elaine M. McCASH

2. Molecular structure and Spectroscopy G. Aruldhas

3. Quantum Physics – Robert Eiesberg and Robert Resnik

Course Code and Title: PHCP-125 Physics Laboratory-II (General Lab)

Student has to perform any **12 Experiments** **(Credit-4)**

1. **Photoconductivity:**
a) To plot the current voltage characteristics of a CdS photoresistor at constant irradiance.
b) To measure the photocurrent as a function of irradiance at constant voltage.

2. **Speed of Light** :
To determine the speed of light using transit time of light pulse as a function of a reflecting mirror.

3. **Faraday Effect**: Rotation of The Polarization Plane Φ As A Function of The Magnetic Field and Rotation of The Polarization Plane 2Φ As A Function Of The Magnetic Field

4. **Dielectric constant**:
a) To Measure the charge Q on a plate capacitor as a function of the applied voltage E.
b) To determine the capacitance C as a function of areas A of plates.
c) To determine the capacitance C with different dielectrics between the plates.
d) To determine the capacitance C as a function of the distance d between the plates

5. **Millikan Oil Drop Apparatus:** To measure the rise and fall times of the oil droplets at different voltages having different charges.
a) To determine the radii of droplets. b) To determine the charge '**e**' on the droplets

6. **Michelson's Interferometer:**
To determine the wavelength of He-Ne LASER by using Michelson's Interferometer apparatus.

7. **Specific Heat of Solids**:
To determine the specific heat of copper, lead and glass at three different temperatures.

8. **Electron Spin Resonance**:
To study the Electron Spin Resonance and to determine Lande's g-factor

9. **Frank-Hertz experiment**: To study the discrete energy levels using Frank-Hertz experiment

10. **G.M. counter:** Counting statistics, Characteristics of GM tube and determination of end point energy of β-ray source

11. **G.M. counter:** Determination of dead time of GM tube by Double source method

12. **Skin depth :** Skin depth in Al using electromagnetic radiation

13. **Gouy's Method:** Measurement of magnetic susceptibility of MnSO4

14. **Thermionic emission:** To determine work function of Tungsten filament

15. **Hall effect:** To determine charge concentration, conductivity of Ge-semiconductor

16. **Four Probe method:** Temperature variation and Band gap of Ge-semiconductor

17. Ionic Conductivity of NaCl

18. Fabry-Parot Etalon

19. Zeeman Effect

20. Stefan's constant – Black Body Radiation

21. To study absorption spectra of Iodine molecule and to determine its dissociation Energy using spectrometer

Reference Books:

1. Solid State Laboratory Manual in Physics, Dept. of Physics, University of Pune, (1977).

2. Experimental Physics, Wersnop and Flint.

3. Molecular structure and Spectroscopy, G.Aruldas Prentice-hall of India Pvt. Ltd. New Delhi.

4. Practical Physics, D.R. Behekar, Dr.S. T. Seman, V.M.Gokhale,P.G.Kale (KitabMahal Publication)

5. Introduction to experimental Nuclear Physics, R.M. Singru, Wiley Eastern privateLtd. New Delhi.

Course Code and Title: PHCT-231 Physics of Semiconductor Devices

Module 1: Properties of semiconductor **Credit-1**

Band structure of semiconductors, carrier concentration at thermal equilibrium for intrinsic and doped semiconductors and calculation of Fermi level, Current density equations, carrier transport phenomenon- Mobility, resistivity and Hall effect, Excess carrier generation and recombination, Excess carrier lifetime, basic equation for semiconductor device operation

Module 2: p-n Junction **Credit-1**

Types of semiconductor, direct and indirect band gap semiconductors, Basic device technology, Depletion region and depletion layer capacitance, current voltage characteristics- ideal case- Shockley equation, generation-recombination process, high injection condition, diffusion capacitance, junction breakdown.

Module 3: Junction Transistor and Field Effect Devices **Credit-1**

Formation of transistor, basic current voltage relationship, mathematical derivations current gain factors- injection efficiency, base transport factor and recombination factor, static characteristics common base and common emitter configurations, power transistors-general consideration, Static and dynamic characteristics of switching transistor (second breakdown), unijunction transistor, silicon controlled rectifier, junction field effect transistor and their energy band diagrams.

Module 4: Metal and Metal Insulator semiconductor devices **Credit-1**

Energy band relation at metal semiconductor contacts - ideal condition and surface states, depletion layer, Schottky effects, Current transport processes- thermionic emission theory, Diffusion theory and Thermionic emission-Diffusion theory, general expression for barrier height, Schottky Barrier diode - current voltage measurement, metal semiconductor IMPATT diode, Ideal MIS diode - surface space-charge regions and effect of metal work function.

Reference Books:

1. Physics of Semiconductor Devices – S.M. Sze.
2. An introduction to Semiconductor Devices—Donald A. Neaman (McGraw-Hill 2006).
3. Solid State Electronic Devices – B.G. Streetman and S.K. Banerjee (Pearson Education).
4. Fundamentals of Semiconductor Devices – J. Lindmayer and C.Y. Wrigley.
5. Physics of Semiconductor Devices – Micheal Shur.

Course Code and Title: PHCT-232 Laser Fundamentals and Applications

Module 1 **Credit-1**

Interaction of radiation with matter: Absorption, spontaneous and stimulated emission, population inversion, properties of laser, metastable state, gain, absorption coefficient, Einstein's coefficient, stimulated emission cross section, threshold condition. (Ref. 1, 2)

Module 2 **Credit-1**

Three and four level system and rate equations, pumping mechanisms (electron beam impact, optical, and current injection type), threshold pump power, relative merits and demerits of three and four level system. g-parameters of laser cavity, stability curve, Gaussian beam and their properties (TEM modes 00, 01, 10, 11). Line broadening (homogeneous and non-homogeneous) mechanisms. Measurements of laser power, energy, wavelength, frequency, line width.

(Ref. 1-4, 10)

Module 3 **Credit-1**

Principle, Construction, Energy level diagram and working of following lasers:
Solid state lasers (Ruby laser, and Nd:YAG laser), Semiconductor lasers (homo junction), Gas lasers (He-Ne laser, Nitrogen laser, CO_2 laser, and Excimer lasers), Liquid lasers (Dye laser).
(Ref. 1, 2, 7)

Module 4 **Credit-1**

Industrial applications: Cutting, melting, welding, drilling, surface hardening
Medical applications: Skin therapy, laser eye surgery, laser surgery, tumor ablation
Military applications: Range finders, laser radar, laser gyro
Scientific applications: In spectroscopy, laser deposition, optical fiber communication
` (Ref.1, 2, 7, 8)

Reference Books:

1. Solid State Engineering Vol-I – W. Koechner Springer Verlag (1976).
2. Lasers Fundamentals – W.T. Silfvast.
3. Principles of Lasers – O. Svelto – Plenum, 1982.
4. Laser Parameters – Heard.
5. Laser and Non-Linear Optics – B.B. Laud (2^{nd} Edition).
6. Lasers : Principles, Types and Applications -- K.R. Nambiar.
7. Introduction to Fiber Optics – A.Ghatak, K.Thyagarajan- Cambridge University Press.
8. Principles of Laser And Their Applications – Callen O'Shea, Rhodes.
9. An Introduction to Laser Theory and Application – M. N. Avdhanulu, S. Chand Publications.
10. Experiments with Laser – Sirohi.

Course Code and Title: PHCT-233: Experimental Techniques in Physics-I

Module 1: Signal, Signal Analysis and Sensors **Credit-1**

Signals, Signal analysis (Time and Frequency Domain), Signal to noise ratio. Measurement, result of a measurement, sources of uncertainty and experimental error, Systematic error, random error, Reliability-chi square test, Analysis of repeated measurement, Precision and accuracy, Elementary data fitting.

Sensors: Sensor's characteristics, Classification of sensors, Operation principles of sensors such as electric, thermal, mechanical, pressure, gas and humidity with examples.

Module 2: Vacuum Physics **Credit-1**

Importance and fields applications of vacuum, kinetic theory of gases, impingement rate of molecules on a surface, average velocity of gas and mean free path, gas transport properties (thermal conductivity, viscosity and diffusion), various ranges of vacuum, gas conductance of a vacuum line, gas impedance of a vacuum line, pumping speed, flow of gases through apertures, elbows, tubes etc. for viscous and molecular flow regimes, pump down time, Numerical

Module 3: Vacuum Techniques **Credit-1**

Principles of Pumping concept, Types of Vacuum pumps: Rotary, Molecular drag, Oil diffusion, Cryogenic getter ion, Titanium sublimation, Sputter ion, Orbitron

Module 4: Vacuum Measurement and Low Temperature Techniques **Credit-1**

Vacuum gauges: Mc Leod, Thermocouple (Pirani), Penning gauges. Hot cathode ionization (triod type), Bayard-Alpart. Leak detection in vacuum pump. Low Temperature Techniques: Refrigeration principle (including thermodynamical aspects) and low temperature production techniques (Throttling process).

References:

1. Instrumentation: Devices and Systems, C.S. Rangan, G.R. Sarma and V.S.V. Mani, Tata Mc Graw Hill Publishing Co. Ltd.
2. Vacuum Physics and Techniques, T. A. Delchar, Chapman and Hall.
3. Vacuum Technology, A. Roth, (North Holland, Elsevier Science B.V. 1990).
4. High vacuum techniques, J. Yarwood (Chapman and Hall, London, 1967).
5. Experimental principles and methods below 1 K, O. U. Lounasmaa, (Academic Press, London and, New York, 1974).

Course Code and Title: PHY234 (Elective-I)

PHOP234-I: Medical Physics-I

Module 1: Forces acting on body and Physics of the skeleton **Credit-1**

Statics, Frictional forces, Dynamics, Conservation of Energy in the body, Heat losses from body, Pressure in the body. Physical properties of bone, Mechanics of joints.

Module 2: Electricity within the body **Credit-1**

Nervous system and neuron, Electric properties of Nerve, Electrical potential of nerve, Nernst Equation, Bio potentials EMG, ECG, EEG, EOG, ERG, Magnetic signals from heart and Brain

Module 3: Physics of hearing **Credit-1**

Basic definition of Audibility, Physics of ear, Human Audibility Curve, Sensitivity of ear, Testing of hearing. Deafness and hearing aids, Sound in medicine, Sound pollution, Effects of sound pollution on living body, Methods to minimize sound pollution

Module 4: Physics of vision **Credit-1**

Optics of eye, Diffraction effects of eye, Refractive effect in eye and its correction, Contact Lenses, Color vision and chromatic aberration, Instruments used in Ophthalmology.

Reference Books:

1. Medical Physics by John R. Cameron, J. G. Skofronick, John Wiley and Sons, International Publications
2. Essential of Biophysics by Narayanan, New age Publication
3. Radiation Biophysics by Edward Alphan, prentice Hall Advance Refers
4. T.B. of Biophysics by R.N. Roy, Central Publication
5. Medical Informatics by Smita Mishra and K. C. Mishra, ICFAI University
6. Fundamental of Bioinformatics by S. Harisha
7. Biomedical Engineering by S.N. Sarbadhikari, University Press
8. Principles of Medical Electronics and Biomedical Instrumentation by C. Raja Rao, S. K. Guha, University Press
9. Electronics in Medicine and Biomedical Instrumentation by Nandini Jog

PHOP234-J: Acoustics-I

Module 1: Measurement and Perception of Sound **Credit-1**

Velocity of sound in fluids; Energy density of a plane wave; Acoustic intensity; Acoustic standards and reference conditions; Specific acoustic impedance; Decibel Scales: Intensity level (IL), Sound pressure Level (SPL), Sound Power Level (PWL), Loudness Level (LL)

Module 2: Transmission Phenomenon, Resonators and Filters **Credit-1**

Transmission from one fluid medium to another: Reflection at the surface of a solid, Significance of standing wave ratios; Helmholtz resonator; acoustic, electrical and mechanical analogues; Expansion chamber muffler

Module 3: Speech Hearing and Community Noise Criteria **Credit-1**

Equivalent continuous sound pressure level (L_{Aeq}); Perceived noise level (L_{EPN}) Human voice and hearing mechanism, thresholds of the ear; Audiometry; Haas effect and delay

Module 4: Architectural Acoustics **Credit-1**

Growth and decay of sound in live rooms; Sabine equation; Decay of sound in dead rooms: Eyring approach, Millington and Sette approach; Optimum reverberation time; Methods of measuring reverberation time; Sound absorption coefficients; Room modes; Room acoustics: Sound transmission class, High-loss frame walls, Floor and ceiling systems

Reference Books:

1. Fundamentals of Acoustics, II or Ill Edn., L. E. Kinsler and A. R. Frey, Wiley Eastern, 1982
2. Acoustics, W.W. Seto, Schaum's Outline, 1978
3. Basic Acoustics, D. E. Hall, Oxford University Press
4. Technical Aspects of Sound, Richardson, Prentice Hall: 1962
5. Noise Reduction, L. L. Baranek, MIT Press, 1970
6. Handbook of Sound Engineers (The New Audio Cyclopedia), G. M. Ballou, Academic Press, 1998
7. Design for good Acoustics and Noise Control, J. E. Moore, University Press, 1998
8. Acoustics Sourcebook, S. Parker, McGraw Hill, 1996

PHOP234-K: Energy Studies-I

Module 1: Energy Sources **Credit-1**

Energy, Work and Power, Energy units and inter-conversion, Various types of energy sources, Non Renewable Energy sources (Coal, Oil, Natural gas, Nuclear power, Hydroelectricity, and their potentials), Renewable Energy sources (Solar, Wind, Biomass, Tidal, Ocean wave, Ocean thermal, Geothermal and their potentials)

Energy crisis: Energy consumption and its impact on environment, Climate Change, Global Warming.

Future Energy Option: Sustainable development, Energy for security and security of energy, Transition to carbon free technologies, Carbon credits

Module 2: Solar Radiation and Its Measurements C**redit-1**

Importance of Solar Energy: Nature of solar radiation, Sun as a fusion rector, spectral distribution of terrestrial and extraterrestrial radiation, Estimation of extraterrestrial solar radiation, Radiation on horizontal and titled surfaces.

Nature of Solar Radiations - beam, diffuse, global radiation and their measurement by Pyranomater, Pyrhelimeter, Sunshine recorder (Ref. 8)

Module 3: Basics of Heat transfer **Credit-1**

Heat and Thermodynamics: Basic units, dimensions, Concept of heat, 1st and 2nd law of thermodynamics, Types of heat transfer. Conductive heat transfer: Fourier's law. Stefans-Boltzman relation and IR heat transfer between gray surfaces. Radiative heat transfer: sky radiation, radiation heat transfer coefficient

Convective heat transfer: Natural and forced convection, natural convection between parallel plates, Non-dimensional numbers, conductive heat transfer coefficient, Heat transfer due to wind (Ref. 9)

Module 4: Energy Storage **Credit-1**

Types of energy storage systems: sensible and latent heat storage systems, Electric energy storage systems, Chemical energy storage systems, Heat exchanges, Hydrostorage, solar pond as a energy storage, Green house (Ref. 11)

Reference Books:

1. TEDDY Year Book (Tata Energy Research Institute (TERI) Publication, New Delhi)
2. World Energy Resources, Charles E.Brown (Springer Publication) 2002
3. Energy Policy for India, B.V. Desai (Welley Eastern Publication)
4. Handbooks of Solar Radiation, A. Mani (Allied Publishers) 1980.
5. Solar Energy Fundamentals and Applications, H.P. Garg and Satya Prakash, (Tata McGraw Hill) 1977
6. Treatise on Solar Energy, H.P. Garg, Volume 1, 2, and 3 (John Wiley and Sons) 1982
7. Principles of Solar Engineering, F. Kreith and J.F. Kreider, McGraw Hill, 1978
8. Solar Energy Thermal Processes, J.A. Duffie and W.A. Beckman, (John Wiley & Sons) 1980.

9. Heat and Thermodynamics, M.W. Zemansky (McGraw Hill Publication).

10. Principles of Solar Energy Conversion, A.W. Culp (McGraw Hill Publication).

11. Solar Energy Principles of Thermal Collection and Storage, S.P. Sukhatme, 2nd Edition (Tata McGraw Hill Publication Co. Ltd.) 1976.

12. Solar Energy Utilization, G.D.Rai (Khanna Publishers) 1996.

13. Solar Thermal Engineering, J.A. Duffie (Academic Press).

14. Renewable Energy Sources and Conversion Technology, N.K. Basal, M. Kleeman and S.N. Srinivas, (Tata Energy Reserch Institute, New Delhi) 1996.

PHOP234-L: Physics of Thin Films

Module 1: Introduction to Thin Films **Credit-1**

Overview of vacuum techniques, Comparison of thin and thick films, Theory of growth of thin films: Nucleation, condensation, Capillarity model, Atomistic model, comparison of models, various stages of film growth.

Module 2: Deposition Techniques and Measurement of Thickness **Credit-1**

Physical Vapour Deposition, Chemical Vapour Deposition, Molecular Beam Epitaxy, Sputtering, Spray pyrolysis, Dip coating and Spin coating, photolithography, Electron –beam deposition, Pulsed Laser Ablation. Tolansky technique, Talystep (styles) method, Quartz crystal microbalance, Stress measurement by optical method, Gravimetric method

Module 3: Properties of Thin Films **Credit-1**

Electrical Properties: Source of Resistivity in Metallic conductors, Influence of thickness on the resistivity of thin films, Hall Effect & Magneto-resistance in thin films, Fuch-Sondhemir theory, TCR and its effects. Mechanical properties: Adhesion and its measurement with mechanical and nucleation methods, stress measurement by using optical method. Optical properties: Absorption and transmission.

Module 4: Applications of Thin Films **Credit-1**

Resistors, capacitors, Junction devices (Metal semiconductor junction) Solar cells, ICs, Optical coating, Thin film sensors (gas and humidity), Thin films for information storage, electro acoustics and telecommunication

Reference Books:

1. Hand book of Thin Film Technology: Maissel and Glang, (Mc Graw Hill).
2. Thin Film Phenomena: K. L. Chopra (Mc Graw Hill).
3. Material Science of Thin Films: M. Ohring (Academic Press).
4. Thin Film Process: J. L. Vossen and Kern (Academic Press).
5. Vacuum Technology by A. Roth (2^{nd} Revised Edition) (North Holland).

PHOP234-M: Astronomy and Astrophysics-I

Module 1: Astronomical Scales & Basic Concepts of Positional Astronomy Credit-1

Astronomical Distance, Mass and Time Scales, Brightness, Radiant Flux and Luminosity, Measurement of Astronomical Quantities, Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature, Celestial Sphere Geometry of a Sphere Spherical Triangle, Astronomical Coordinate Systems, Geographical Coordinates Horizon System, Equatorial System Diurnal Motion of the Stars Conversion of Coordinates, Measurement of Time Sidereal Time Apparent Solar Time Mean Solar Time Equation of Time, Calendar

Module 2: Astronomical Techniques and Physical Principles Credit-1

A. Basic Optical Definitions for Astronomy Magnification Light Gathering Power Resolving Power and Diffraction Limit Atmospheric Windows Optical Telescopes Types of Reflecting Telescopes Telescope Mountings Space Telescopes Detectors and Their Use with Telescopes Types of Detectors Detection Limits with Telescopes, Sky charts and their importance

B. Gravitation in Astrophysics Virial Theorem, Newton versus Einstein, Keplar's laws, Systems in Thermodynamic Equilibrium, Theory of Radiative Transfer, Radiation Field Radiative Transfer Equation, Optical Depth; Solution of Radiative Transfer Equation, Local Thermodynamic Equilibrium

Module 3: The Sun and Stellar Structure Credit-1

A. Solar photosphere Solar Atmosphere, Chromosphere, Corona, Solar Activity,Basics of Solar Magneto, hydrodynamics Helioseismology. Solar System: Facts andFigures Origin of the Solar System: The Nebular Model Tidal Forces and Planetary rings.

B. Hydrostatic Equilibrium of a Star, Some Insight into a Star: Virial Theorem Sources of Stellar Energy, Modes of Energy Transport, Simple Stellar Model Polytropic Stellar Model. Stellar Spectra and classification: Atomic Spectra Review, Stellar Spectra, Spectral Types and their Temperature Dependence, Black Body Approximation, H-R Diagram, Luminosity Classification

Module 4: Star Formation, Nucleo-synthesis and Stellar Evolution Credit-1

Basic Composition of Interstellar Medium, Interstellar Gas, Interstellar Dust Formation of Protostar, Jeans Criterion Fragmentation of Collapsing Clouds from Protostar to Pre-Main Sequence Hayashi Line, Cosmic Abundances, Stellar Nucleo-synthesis, Evolution of Stars, Evolution on the Main Sequence, Evolution beyond the Main Sequence, Supernovae. Basic Familiarity with Compact Stars, Equation of State and Degenerate Gas of Fermions, Theory of White Dwarf, Chandrasekhar Limit, Neutron Star, Gravitational Red-shift of Neutron Star, Detection of Neutrons

Reference Books:

1. Structure of the Universe, J.V. Narlikar.
2. Astronomy- Fundamentals and Frontiers, Robert Jastraw, H.Thomson (John Wiley and Sons).
3. Astrophysics by Bowers and Deeming Vols.1 and 2.
4. Cox and Guili: Principles of Stellar Interiors - Vol. I and II.

5. Mihalas: Stellar Atmospheres.
6. C.R. Miczaika and W.M.Sinton: Tools of the Astronomers.
7. Baidyanath Basu: Introduction to Astrophysics.
8. W.A. Hiltner (Ed): Astronomical Techniques.
9. A. Unsold: The New Cosmos (3rd Edition). Springer-Verlag 1983.
10. M. Schwarzschild: Stellar Evolution.
11. S. Chandrasekhar: Stellar Structure.
12. Menzel, Bhatnagar and Sen: Stellar Interiors.
13. J. Greenstein (Ed): Stellar Atmospheres.
14. The Physical Universe, F. Shu (University Science Books).
15. Bowuwer and Clemence: Methods of Celestial Mechanics.

PHOP234-N: Electronic Instrumentation- I

Module 1: General Background and Measurements **Credit-1**

1.1 General configuration and functional description of measuring instruments, few examples of instruments and their functional description. (Ref.1: #2.1 to 2.4). Input output configuration of measuring instruments, methods of correction of unwanted inputs. (Ref.1: #2.5)

1.2 Qualities of measurements (Ref. 9 Ch#1) Static characteristics, Errors in measurement, Types of errors, sources of errors (Ref. 9 Ch#1) Dynamic characteristics: Generalized mathematical model of measurement System, order of instruments: zero, first and second order. Step, ramp and frequency response of first order instruments (Ref.1: # 3.3 pp 94 to 115 & 123 to 131) References: 1, 3, and 9

Module 2: Transducers **Credit-1**

2.1 Electrical transducers, resistive, strain gauge, thermistor, inductive transducers, variable reluctance, LVDT, pressure inductive, capacitive transducers, piezoelectric transducer, photoelectric, magneto resistive sensors. Transducers for displacement, velocity, acceleration.

2.2 Fluid flow, fluid rate and velocity. Various temperature transducers: Acoustic temperature sensor, high temperature measurement using a cooled thermocouple (Ref.1), Humidity sensors, conductivity measurements, PMT, Optical pyrometry (with at least one application of each transducer) References: 9

Module 3: Signal Conditioners and Data Acquisition and Conversion **Credit-1**

3.1 Signal conditioners: Op-amps, instrument amplifier, bridge, phase sensitive detector (References: 9: Chapter 17).

3.2 Data acquisition and conversion D to A and A to D converters, Data loggers, ADC digital transducer (optical transducer) Data acquisition system. ICs available: ADCs, DACs (Ref 9).

Module 4: Indicators, Display System and Recorders **Credit-1**

4.1 Digital display system with LED and LCD. Printers: principle of Laser printers only

4.2 Introduction to microprocessor based instruments, with suitable examples. Stepper motor controller and basic idea of process control (References: 9).

Reference Books:

1. Measurement Systems- Applications and Design.4th Edn E.O. Doeblin.
2. Measurement System – Applications and Design by E.O. Doblin and Manik
3. Instrumentation, Measurement and Systems. Nakra and Chaudhary
4. Electronic Instrumentation and Measurement Techniques by A.D. Helfrick and W. D. Cooper (Pearson)
5. Instrumentation, Devices and Systems. Rangan, Mani and Sarma Prentice Hall Of India.18
6. Process Controlled Instrumentation by C.D. Johnson
7. Elements of Electronic Instrumentation and Measurement. 3rd Edn. Joseph Carr. (Pearson)
8. Sensors and Transducers, Patranabis
9. Electronics Instrumentation, Kalsi (Tata Mcgraw-Hill).

PHOP234-O: Communication Electronics

Module 1: Digital Communication **Credit-1**

Fundamentals of digital communication systems. Characteristics of data transmission system such as Band-Width requirement, speeds SNR, cross talk, echo suppressors, distortion equalizer, Digital codes, Baudot code, binary code, ASCII code (EBCDIC), hollerith code, error detection, constant ratio codes, Redundant codes, parity check codes, Communication system using modern interfacing, interconnection of Data circuit to telephone loops, Network organization.

Module 2: Broadband Communication Systems **Credit-1**

Multiplexing – FDM, TDM, Higher order digital multiplexing, Fiber Optic

Communications – Principles of light transmission in a fiber, effect of Index profile on propagation, Modes of propagation, Number of modes a fiber will support, Single-mode propagation, losses in fibers. Dispersion – effect of dispersion on pulse transmission, types of dispersion, intermodal, material and waveguide, total dispersion and maximum transmission rates, Light sources for fiber optics, An Optical Receiver Circuit, Connectors and Splices – loss mechanism, types of connectors and fiber Splices, Fiber communication systems.

Module 3: Telephone and Facsimile Systems **Credit-1**

Wire telephone, telephone subscriber's loop circuit, transmission bridges, four wire terminating set, Two –wire repeaters, Four wire transmission, Public telephone network, Trunk circuits and Private telephone networks, Cellular and mobile phone systems. Facsimile transmission, reception, Transmission of facsimile telegraph, line transmission and radio transmission.

Module 4: Satellite Communication **Credit-1**

Introduction to radar systems, fundamental radar range equation, basic pulsed radar. Satellite frequencies, orbits (geostatics, equatorial/polar, synchronous) station keeping, satellite attitude, transmission path, path loss, noise considerations, satellite system and scanning methods.

Reference Books:

1. Electronic Communications – Rooddy – Coolen (PHI).
2. Communication Systems – George Kennedy (TMH).
3. Telecommunication Switching Systems and Network – T. Vishwanathan.(PHI).
4. Mobile Cellular Tele Communication System – C.Y. Lee.
5. Communication Electronics – Fresnel.
6. Communication Electronics – Katre.

PHOP234-P: Biomedical Instrumentation-I

Module 1: Fundamentals to Biomedical Instrumentation and Patient Safety **Credit-1**

1.1 Basic medical instrumentation system
1.2 System configuration
1.3 Basic characteristics of measuring system
1.4 Problems faced when measuring a human body
1.5 Essentials of biomedical instrumentation
1.6 Electric shock hazards-Gross shock-Micro current shock
1.7 Precautions to minimize electric shock hazards

Module 2: Electrodes and Physiological Transducers **Credit-1**

2.1 Electrode theory, and Biopotential electrodes.
2.2 Electrodes for ECG, EEG, EMG.
2.3 Introduction to physiological transducers.
2.4 Classification of Transducer.
2.5 Performance characteristic of transducer.
2.6 Displacement, position, motion, and pressure transducers.
2.7 Transducer for Body temperature measurement.
2.8 Biosensors

Module 3: Recording Systems and Signal Analysis **Credit-1**

3.1 Basic recording system.
3.2 General consideration for signal conditioners.
3.3 Preamplifiers, Differential, Instrumentation, Isolation amplifier.
3.4 Source of noise in low level measurement.
3.5 Biomedical signal analysis techniques.
3.6 Fourier Transform, FFT and Wavelet Transform.
3.7 Signal processing techniques.

Module 4: Cardiovascular System and Measurements **Credit-1**

4.1 The Heart.
4.2 The Heart and Cardiovascular system.
4.3 Blood Pressure.
4.4 Heart Sounds.
4.5 Block diagram of electrocardiograph.
4.6 The ECG leads.
4.7 Effect of Artifacts on ECG recording.
4.8 Introduction to Pacemakers, their types and need for pacemakers.
4.9 Pacemaker system and its functioning.

Reference Books:

1. Biomedical Instrumentation and Measurements (Second Edition) by Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Pearson Education.
2. Handbook of Biomedical Instrumentation (Second Edition) by R. S. Khandpur (Tata McGraw Hill).
3. Biomedical Instrumentation and Measurement by Carr and Brown-Pearson.

PHOP234-Q: Atmospheric Physics-I

Module 1: Atmospheric Thermodynamics **Credit-1**

Atmospheric compositions, Equation of state for dry and moist air, Adiabatic process, Virtual temperature, humidity parameters, thermodynamic laws, Potential temperature, Pseudo adiabatic process, Clausius - Clapeyron equation, Thermodynamic diagrams-general considerations, Emagram, Tephigram

Module 2: Hydrostatic Equilibrium **Credit-1**

Hydrostatic equation and geo-potential, Height computation for air sounding, The homogeneous atmosphere, The isothermal atmosphere, The constant lapse rate atmosphere, The dry adiabatic atmosphere, The dry and moist adiabatic lapse rate.

Module 3: Atmospheric Aerosols **Credit-1**

Introduction to Aerosols, Aerosol concentration and size distributions and its characteristics, sources of Aerosols, Transformation of Aerosols, Chemical composition of aerosols, Transport of aerosols, Sink of aerosols, residual time of aerosols, Geographical distribution of aerosols, Atmospheric effect of aerosols.

Module 4: Cloud Physics **Credit-1**

Aerosols as Cloud Condensation Nuclei (CCN), Heterogeneous and homogenous Nucleation process, Curvature and solute effect, Condensation growth of cloud droplet by diffusion, collision and coalescence, Collection efficiency, Freezing nuclei, Mechanism of growth of ice particles in cloud, formation of ice, Rain making experiment, Classification of clouds and hails.

Reference Books:

1. Introduction to Theoretical Meteorology- S.Hess
2. An Introduction to Atmospheric Chemistry – Prof. Peter V.Hobbs
3. Tropical Meteorology Vol- I And II- G.C. Asnani
4. Weather Forecasting – A.A. Ramshastry
5. Cloud Physics-Rogers
6. Cloud Physics-Wallace and Bob
7. Atmosphere, Weather and Climate –K. Siddharth (Kisalaya Publication Pvt.Ltd)
8. Atmospheric Chemistry and Physics - John Seinfeld and S.N.Pandis, Wiley Interscience

PHOP234-R: Nuclear Techniques-I

Module 1: Interaction of radiation with matter **Credit-1**

General description of interaction processes, direct and indirect ionizing radiations, interactions of directly ionizing radiation such as electrons, protons and ions, stopping power, linear energy transfer, range of particles, straggling, interaction of indirectly ionizing radiation such as gamma radiations, attenuation coefficient, energy transfer.

Module 2: Nuclear detectors **Credit-1**

Ionization and transport phenomena in gases, Ionization chamber, Proportional counter, GM counter, general characteristics of organic and inorganic scintillators, scintillation detectors NaI-(Tl), detection efficiency for various types of radiations, scintillators, detection efficiency for various types of radiation, PHYomultiplier gain, semiconductor detectors, surface barrier detector, Si(Li), Gel(Li), HPGedetectors.

Module 3: Pulse processing and related electronics **Credit-1**

Preamplifier, pulse shaping and pulse stretchers networks, delay lines, amplifier, Pulse height analysis and coincidence technique, Discriminators: Single channel analyzer, multichannel analyzer, pulse height spectroscopy, pulse shape discrimination, coincidence and anti- coincidence units.

Module 4: Dosimetry and radiation protection **Credit-1**

Radiation measurements Units: Rontgen, RAD, REM, RBE, BED, Gray, Sievert, kerma, Cema, energy deposit and energy imparted, absorbed dose, main aims of radiation protection, dose equivalent and quality factor, organ dose, effective dose equivalent effects and dose limits, assessment of exposure from natural man-made sources, effects of radiation on human body.

Reference Books:

1. Nuclear Radiation Detectors, S. S. Kappor and V. S. Rmanurthy. (Wiley Eastern Limited, New Delhi,) 1986
2. Introduction to Radiation Protection Dosimetry, J. Sabol and P. S. Weng (World Scientific) 1995
3. Techniques for Nuclear And Particle Physics, W.R. Len (Springer) 1955
4. Nuclear Measurement Techniques, K. Sriram, (Affiliated East-West Press, New Delhi) 1986
5. Fundamentals of Surface and Thin Film Analysis, Leonard C. Feldman and James W. Mayer, (North Holland, New York) 1988
6. Introduction to Nuclear Science And Technology, K. Sriram and Y.R. Waghamare (A.M. Wheeler) 1991
7. Nuclear Radiation Detection, W.J. Price (Mcgraw-Hill, New York) 1964
8. Alphas, Beta and Gamma-Ray Spectroscopy K. Siegbahn, (North Holland, Amsterdam) 1965.
9. Introduction to Experimental Nuclear Physics, R.M. Singru (John Wiley and Sons) 1974.
10. Radioactive Isotopes in Biological Research, Willaim R. Hendee (John Wiley and Sons) 1973.
11. Atomic and Nuclear Physics, Satendra Sharma, Pearson Education, 2008

PHOP234-S: Microcontrollers Based Instrumentation System-I

Preamble: The students are supposed to have studied the following topics at undergraduate and post graduate level:

Analog and Digital Electronics, binary number and other number systems such as bcd, hex with their arithmetic's. Boolean algebra, K map techniques, Basic logic gates, flip-flops such as RS, JK, D flip-flop (bi- stable multivibrators) binary counters using flip-flops, half adder full adder using basic logic gates. Analog to digital converters such as successive approximation ADC, dual slope ADC, binary weighted and R-2R DAC, basic regulated power supply using IC- 723 or three pin regulators, temperature sensors such LM 35, AD 590. Basics of C programing.

Module 1: **Credit-1**

Architecture of 8-bit microprocessors, comparison between microprocessor and microcontroller (8085 and 8051). Introduction to Microcontrollers, Architecture, RISC and CISC processors

8051 Microcontrollers: Architecture and introduction to Instruction set of 8051 Microcontroller. Types of instructions (jumps, loops and call instructions & stack related operations), addressing modes in 8051, Programming 8051 microcontrollers: simple arithmetic and logic programs, codes conversions, look up table handling programs, moving/copy a block of data from one memory location to other etc.

Module 2: **Credit-1**

I/O programming: Four ports of 8051 with their special features (dual role of port 0 and port 2), programs related to setting port(s) as an input/output port(s), I/O ports and bit addressability, timers and interrupts programming in 8051 Timers: Programming 8051 timers, counter programming, 8051 interrupts, interrupts service routine, interrupts vector table, enabling and disabling 8051 interrupts, Interrupt priority in the 8051, programing 8051 timers using interrupts.

Module 3: **Credit-1**

8051 programming using C: Time delay in 8051 C, I/O programing, data conversion ASCII, BCD, binary (Hex) to decimal, accessing code space of 8051, timer and interrupt programming of 8051.

Module 4: **Credit-1**

Interfacing an LCD module, keyboard, ADC (0809) & DAC (0808), a stepper motor, traffic signaling (hardware compatibility and programs using C), data serialization, basics of serial communications, 8051 connections to RS232, 8051 serial port programing using C.

Reference Books:

1. 8051 Microcontroller by Kenneth J. Ayala
2. 8051 Microcontroller and Embedded Systems using Assembly and C by Mazidi, Mazidi and D MacKinlay, 2006 Pearson Education Low Price Edition
3. Microprocessor and Microcontroller by R.Theagarajan, Sci Tech Publication, Chennai
4. Programming Customizing the 8051 Microcontroller by MykePredko, Tata McGraw Hill

Course Code and Title: PHCP 235 Physics Laboratory III

Student has to perform **12 Experiments** **(Credit-4)**

COMPUTER LABORATORY

Expected Background: Course contents of PH-345, C' Programming and Computational Physics (To be covered by the teacher if required).

Objectives: To enable students to use numerical methods in solving problems in Physics and any other areas.

Notes: **1.** The theoretical background relevant to the experiments listed below should be discussed during practical sessions only.

2. Wherever possible, the output should be presented in graphical form also.

Section I: (Any six)

1. Legendre polynomials using the standard recurrence relation. Confirm that the method works well for Legendre functions by comparing with standard tables for special functions. (Use forward recursion.)
2. Bessel functions of the first kind using the standard recurrence relation. Use backward recursion with
   (x)=J_{50} J_{49} 0, (x) = 0.1 X 10^{-30} and the sum rule
   J_0 $\Sigma_{n=1}^{25} J_{2n}$ (x)+ 2 (x) = 1
3. To generate random numbers. Find out the value of 'π' using Monte-Carlo methods. Obtain your result correct up to five decimal positions.
4. Interpolation: Interpolate the value of a function at a point. Use Lagrange interpolation method.
5. Rotation of matrix: Rotate the elements of a n x n matrix in clockwise/ anticlockwise direction and display the matrices (n>=5).
6. Inverse of a matrix: Find the inverse of an xn matrix and display both matrices.
7. Trapezoidal/ Simpson rule: Evaluate a given function f(x) using Trapezoidal/ Simpson rule correct up to given accuracy by successively halving the step size.
8. Graphics: Write a program and display the Miller planes in the cubic lattice. Display the FCC, BCC and simple cubic lattice on the computer screen.

Section II: (Any six)

9. Differential Equation: Find out the motion of a charged particle in a uniform magnetic field. The equation of motion of partType equation here.icle with charge 'q' and mass 'm' in a uniform magnetic field B is given by
   $\frac{d\vec{r}}{dt} = \frac{q}{m} (\vec{v} \times \vec{B})$
   Where r denotes the position vector.
10. Gauss – Elimination method: Circuit analysis using Kirchhoff's Laws. Write the relations for currents through various branches of a Whetstone's bridge. Find the current using Gauss elimination method.
11. Different equation: Write the differential equation for charging /discharging of a capacitor C through a resistance 'R'. Solve this equation using Euler method and display your result in tabular as well as graphical form.
12. Write a program to graphically display eigen functions and probability density curves for particle in one dimensional rigid box.

13. Differential Equation: Write the one – dimentional time independent Schrodinger's equation. Solve it using Runge – Kutta method for three different harmonic Oscillator potential.
14. Fourier Analysis: perform the Fourier analysis (1) Full wave rectifier (2) Square wave
15. Use modified Euler method to solve the differential equation

$$m\frac{d^2z}{dt^2} = mg$$

For the displacement z of a freely falling body as a function of time t, from a given height z $=z_0$ at t=0. Compare with known analytical results. Add a term due to buoyancy of air on the motion of a spherical body (say a rain drop) of radius r (No damping due to viscosity and drag is considered).Thus,

$$m\frac{d^2z}{dt^2} = (m - \frac{4}{3}\pi r^3 \rho)g$$ ρ is

the density of air.

16. Consider the motion of a point mass under the influence of a harmonic restoring force F=kx. Solve m (d^2x/dt^2)=-kx for x as a function of time. The kinetic energy of the mass=$1/2 mv^2 = 1/2\ m$ $(dx/dt)^2$ and potential energy is $1/2$ kx^2.

Such that the total energy E=T+V=constant throughout the motion. Calculate x, T, V, E for various values of t starting with t=0 and time step h=dt, plot x, T, V, E as a function t and find the period of oscillation from the graph using numerical method. Compare with analytical result.

Reference Books:

1. The C Programming Language: B.W. Kernighan and D.M. Ritchie, Prentice Hall of India Pvt. Ltd., (1985).
2. Schuam's Series "Programming in C".
3. Introductory Methods of Numerical Analysis, S.S. Sastry, Prentice Hall of India Pvt. Ltd. (1990)
4. Computational Physics, R.C. Verma, P.K. Ahluwalia and K.C. Sharma, New Age International Publishers (1999)
5. Computational Physics, S.E. Koonin, Benjamin/Cumming Pub .Co .(1986)
6. Computer Method for Engineering, Y. JalurIa, Allyn and Bacon Inc. (1988)
7. An Introduction to Computational Physics, T. Pang, Cambridge University Press (1997)

Course Code and Title: PHCT 241: Nuclear Physics

Module 1: General Properties and Concepts of Nuclei **Credit-1**

Nuclear Mass & Binding Energy, Systematic of Nuclear Binding Energy, Measurement of Charge Radius- Electron Scattering Experiment, Concept of Mass Spectrograph, Nuclear spin, Magnetic Dipole Moments & Electric Quadrupole Moments of Nuclei , Basic theory of deuteron nucleus and problems, Radioactivity, Unit of Radioactivity, Alpha Decay: Velocity of Alpha Particles, Disintegration Energy, Range-Energy Relationship, Geiger-Nuttal Law, Beta Decay: Conditions for Spontaneous Emission of β^-& β^+ Particles, Selection Rules, Origin of Beta Spectrum-Neutrino Hypothesis, Gamma Decay: Decay Scheme of ^{137}Cs &^{60}Co Nuclei, Internal Conversion, Internal Pair Creation.

Module 2: Radiation Detectors and Nuclear Models **Credit-1**

Detectors: NaI (Tl) Scintillation Detector, Si (Li) and Ge (Li) Detectors, High Purity Germanium Detector, Bubble Chamber, Cloud Chamber, Spark Chamber, Nuclear Models: Shell Model- Square Well Potential, Harmonic Oscillator Potential, Spin-Orbit Coupling, Predictions of the Shell Model, Achievements & Failures of shell Model, Fermi Gas Model, Collective Model.

Module 3: Reaction Dynamics, Nuclear Reactors and Accelerators **Credit-1**

Reaction Dynamics: Types of Nuclear Reactions, Conservation Laws in Nuclear Reactions, Q of Nuclear Reaction, Compound Nucleus Hypothesis, Fission and Fusion Reactions, Reactors: Fission Chain Reaction, Four Factor Formula, Multiplication Factor, General Properties and Concepts of Nuclear Reactors, Reactor Materials, Types of Reactors, List of Different Types of Reactors Developed in India, Accelerators: Van de Graff, Microtron, Electron & Proton Synchrotron, Pelletron, Cyclotron, Special Accelerators in world: Light Hydron Collidor (LHC)

Module 4: Nuclear Interactions and Particle Physics **Credit-1**

Nuclear Interactions: Low Energy Neutron-Proton Scattering, Scattering Length, Spin Dependence of n-p Interaction, Proton-Proton and Neutron-Neutron Scattering at Low Energies, Particle Physics: Classification of Elementary Particles, Mass Spectra and Decays of Elementary Particles- Leptons & Hadrons, Quantum Numbers, Conservation Laws, Quarks, Higgs Boson concept

Reference Books:

1. K.S. Krane, Introductory Nuclear Physics, Wiley, India, 1988
2. B.L. Cohen, Concepts of Nuclear Physics, Tata McGraw Hill
3. I. Kaplan, Nuclear Physics, 2nd Edition, Narosa, New Delhi, 1989
4. S.N. Ghoshal, Atomic and Nuclear Physics, S. Chand
5. S.B. Patel Nuclear Physics: An Introduction, New Age International, 1991
6. D.C. Tayal, Nuclear Physics, Himalaya Publishing House
7. R.D. Evans, The Atomic Nucleus, Tata McGraw Hill
8. G.F. Knoll, Radiation Detection and Measurement, 3rd Edition, Wiley India
9. S.S. Kapoor and V.S. Ramamurthy, Nuclear Radiation Detectors, Wiley Eastern Limited
10. R.R. Roy, B.P. Nigam, Nuclear Physics-Theory and Experiment, Wiley Eastern Limited
11. Blatt and Weisskopf, Theoretical Nuclear Physics, New York, Wiley
12. S. Sharma, Atomic and Nuclear Physics, Pearson Education 2008

Course Code and Title: PHCT242: Material Science

Module 1: Properties of Materials and Defects in Solids **1 Credit**

a Mechanical, electrical, magnetic, thermal and optical properties (in brief – 2L only)

b Point defects - Vacancies, interstitials, non-stoichiometry, substitution, Schottky and Frenkel defects with proofs

c Line defects - Edge and screw dislocations, properties of dislocations – force on dislocation, energy of dislocation, pinned dislocation (These properties with derivation), dislocation density, interaction between dislocations, motion of a dislocation (cross-slip and climb), dislocation generator (Frank Read source)

d Surface defects – grain boundaries with explanation of high angle, low angle, tilt and twist boundaries, stacking fault

e Volume defect- twin boundary

Module 2: Solid Solutions and Diffusion in Solids **Credit-1**

a Solid solubility with few examples, Types of solid solutions – Substitutional and Interstitial, Factors governing solid solubility (Hume - Rothery rule), Atomic size and size factor in solid solutions, Vegard's law, Explanation of strain in solid solutions

b Mechanism of Diffusion, Fick's first and second laws of diffusion, solution to Fick's second law (without proof, introduction of error function), Factors governing diffusion, Experimental determination of D, Applications of diffusion: Corrosion resistance of duralumin, Carburization of steel, Decarburization of steel, Doping of semiconductors

Module 3: Metallurgical Thermodynamics **Credit-1**

Revision of laws of thermodynamics, Auxiliary thermodynamic functions, measurement of changes in enthalpy and entropy, Richard's rule, Trouton's rule, Phase equilibrium in a one-component system, Chemical reaction equilibrium, Thermodynamic properties of solutions (mixing processes – Rault's law, activity coefficient; regular solution behavior – Henry's law), Gibb's phase rule: proof, explanation and application to single component (H_2O) and binary phase diagram

Module 4: Phase diagrams **Credit-1**

Thermodynamic origin of phase diagrams, Lever rule, Type I (Cu-Ni) phase diagram, Type II (explanation only) phase diagram, Type III (Pb-Sn) phase diagram, Maxima and minima in two-phase regions, Miscibility gaps, Limited mutual solid solubility, Topology of binary phase diagrams (Explanation in short of eutectic, peritectic, Monotectic, eutectoid, peritectoid, syntactic reaction, extension rule), Experimental determination of phase diagrams

Reference books:

1. Elements of Materials Science and Engineering (5^{th} Edition) - Lawrence H. Van Vlack, Addison - Wesley Publishing Co.

2. Materials Science and Engineering - V. Raghvan

3. Physical Metallurgy (PartI) R.W.Cahn and P.Hassen, North Holland Physics Publishing, New York

4. Introduction to Materials Science for Engineers (6^{th} Edition) - J.F.Shaekelford and M.K.Murlidhara - Pearson Education

5. Materials Science – Kodgire and Kodgire

Course code and title: PHCT243 Experimental Techniques in Physics II

Module 1: Radiation Sources, Detectors and Sensors **Credit-1**

Sources of Electromagnetic Radiations: Different types of radiations (γ-rays, X- rays, UV-VIS, IR, microwaves and nuclear) and their sources Detectors: γ-rays, X-rays, UV-VIS, IR, microwaves and nuclear detectors Sensors: Sensor's characteristics, Classification of sensors, Operation principles of sensors such as electric, dielectric, acoustic, thermal, optical, mechanical, pressure, IR, UV, gas and humidity with examples

Module 2: Structural Characterization and Thermal Analysis **Credit-1**

X-ray Diffraction – Production of X-rays, Types (continuous and characteristics), Bragg's diffraction condition, principle, instrumentation (with filters) and working, Techniques used for XRD – Laue's method, Rotating crystal method, Powder (Debye- Scherrer) method, Derivation of Scherrer formula for size determination Neutron Diffraction: Principle, Instrumentation and Working Thermal analysis: Principle, Instrumentation and Working: Thermo-gravimetric (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC); Graphical analysis affecting various factors. Numericals

Module 3: Morphological and Magnetic Characterization **Credit-1**

Optical Microscopy: Principle, Instrumentation and Working of optical microscope Electron Microscopy: Principle, Instrumentation and Working of Scanning Electron Microscope (SEM), Field Emission Scanning Electron Microscope (FESEM) – Advantages over SEM, Transmission Electron Microscope (TEM), Selected Area Electron Diffraction (SAED) Probe Microscopy: Principle, Instrumentation and Working of Scanning Tunneling Microscope (STM) and Atomic Force Microscope (AFM) Magnetic Characterization: Principle, Instrumentation and Working of Vibrating Sample Magnetometer (VSM), Analysis of Hysteresis loop**,** SQUID Technique:Principle, Instrumentation and Working. Numerical

Module 4: Spectroscopic Analysis **Credit-1**

Spectroscopic characterization (principle, instrumentation and working): Infra-Red (IR), Fourier Transform Infra-Red (FTIR), Ultraviolet-Visible (UV-VIS), Diffused Reflectance Spectroscopy (DRS), X-ray Absorption (XPS), Electron Spin Resonance (ESR), Nuclear Magnetic Resonance (NMR). Numerical

Reference Books:

1. Nuclear Radiation Detectors, S.S. Kapoor, V. S. Ramamurthy, (Wiley-Eastern Limited, Bombay)
2. Instrumentation: Devices and Systems, C.S. Rangan, G.R. Sarma and V.S.V. Mani, Tata Mc Graw Hill Publishing Co. Ltd.
3. Instrumental Methods of Chemical Analysis, G. Chatwal and S. Anand, Himalaya Publishing House
4. Instrumental Methods of Analysis by H.H. Willard, L.L. Merritt, J.A. Dean, CBS Publishers
5. Characterization of Materials, John B. Wachtman & Zwi. H. Kalman, Pub. Butterworth Heinemann (1992)
6. Elements of X-ray diffraction, Bernard Dennis Cullity, Stuart R. Stock, (Printice Hall, 2001 - Science - 664 pages)

Course Code and Title: PHOP244 (Elective-II)

PHOP244-I: Medical Physics II

Module 1: Nuclear Medicine **Credit-1**

Radioactivity, Sources of Radioactivity, Nuclear medicine imaging device rectilinear scanner, Positron emission tomography, Magnetic resonance imaging (MRI), Laser in medicine.

Module 2: Radiation physics **Credit-1**

Ionizing Radiation, Interaction of radiation with matter, Dosimetry, Radiation isotopes, Biological effects of radiation, Radiation protection in therapy

Module 3: X-ray in medicine **Credit-1**

Discovery and Production of X-ray, Basic components of X ray machine, Making of X-ray image, Fluoroscopy, Computer tomography (CT Scan), X-ray in diagnosis, X-ray in therapy, Hazards of X-ray

Module 4: Biomaterials and new trends in Medical Physics **Credit-1**

Biomaterials – Introduction, Bio-ceramics, Bio-polymer, Bio-steel, Bio-chip, Blood as a Biomaterial, Introduction to Bio- Nanomaterial, Telemedicine, New trends in Medical Informatics Embedded system in Hospital

Reference Books:

1. Medical Physics by John R. Cameron, J. G. Skofronick, John Wiley and Sons, Int. Publication

2. Essential of Biophysics by Narayanan, New Age Publication

3. Radiation Biophysics by Edward Alphan, Prentice Hall

4. T.B. of Biophysics by R.N. Roy, Central Publication

5. Biophysics by Mohan Arora, Himalaya Publication House, Mumbai (2004).

6. Ophthalmology by A.K. Khurana, New Age Publication

7. Introduction to Biomedical Engineering by Enderle, Elsevier Publication

8. Websites of the related topics

PHOP244-J: Acoustics II

Module1: Acoustic transducers **Credit-1**

Loudspeakers: Direct-radiator loudspeaker: equivalent circuit and efficiency; effect of voice-coil parameters on acoustic output; loudspeaker cabinet; Horn loudspeaker: wave equation for horns, pressure response of loudspeakers; woofers, squawkers, tweeters; Crossover networks

Module2: Acoustic transducers **Credit-1**

Microphones: Carbon, Condenser, Moving-coil electrodynamics and Velocity-ribbon microphones; polar response characteristics; Electroacoustic Reciprocity Theorem; reciprocity calibration of microphones

Module3: Sound recording and reproducing systems **Credit-1**

Monophonic and Stereophonic sound systems; Compact disc audio; Audio file formats; Dynamic range, Volume compressors, expanders and limiters; Graphic equalizer; Dolby noise reduction

Module4: Technical acoustics and music **Credit-1**

Active noise control; Ultrasonic transducers: principle and applications; Anechoic chamber; Bioacoustics: animal sounds – synthesis and analysis; Music: pitch and timbre; Characteristics of musical notes: Vibrato, Tremolo, Portamento; Musical Instruments Digital Interface (MIDI)

Reference Books:

1. Fundamentals of Acoustics, II or III Edn., L.E. Kinsler and A. R. Frey, Wiley Eastern, 1982
2. Acoustics, W.W. Seto, Schaum's Outline, 1978
3. Basic Acoustics, D.E. Hall, Oxford University Press
4. Technical Aspects of Sound, Richardson, Prentice Hall, 1962
5. Noise Reduction, L.L. Baranek, M.LT. Press, 1970
6. Handbook of Sound Engineers (The New Audio Cyclopedia), G.M. Ballou, Academic Press, 1998
7. Design for good Acoustics and Noise Control, J.E. Moore, University Press, 1998
8. Acoustics Sourcebook, S. Parker, McGraw Hill, 1996
9. Introduction to Acoustics, Robert D. Finch, Pearson, 2005

PHOP244-K: Energy Studies II

Module 1: Solar Photovoltaics (SPV) **Credit-1**

Solar photovoltaic (SPV) Conversion: Basic principles, Types of solar cell materials, Fabrication of solar photovoltaic cells, solar cell parameters and characteristics, Modules.
Block diagram of general SPV conversion system and their characteristics, Different configurations, Application (such as street light, water pumps, Radio/TV, Small capacity power generation) Solar photovoltaic (SPV) Systems Designing: Load estimation, selection of inverters, battery sizing, and array sizing. Ref. no. 2, 15.

Module 2: Photo-thermal Applications of Solar Energy **Credit-1**

Selective coatings: Ideal characteristics of selective coating for various applications, Types of selective coatings, materials and techniques for selective coatings, Effect of selective coating on the efficiency of solar collectors. Solar Thermal Devices and Systems: Different types of collectors, Flat plate collector (Basic principle, construction, Energy balance equation of steady state, Testing, Methods to reduce losses), Solar cookers, Domestic hot water system, Solar dryers, solar pond, Solar still, Solar furnace, Solar refrigeration, Solar concentrators, systems based on use of solar concentrators. Ref. no. 2, 6.

Module 3: Hydrogen Energy **Credit-1**

Hydrogen Fuel: Importance of Hydrogen as a future fuel, Sources of Hydrogen, Fuel of vehicles.
Hydrogen production: Production of Hydrogen by various methods, Direct electrolysis of water, Direct thermal decomposition of water, Biological and biochemical methods of hydrogen production.
Hydrogen storage: Gaseous, Cryogenic and Metal hydride. Utilization of hydrogen: Fuel cell – Principle, construction and applications. Ref. no. 2, 11, 12.

Module 4: Wind and Bio Energy **Credit-1**

Wind Energy: Introduction, Basic principle of wind energy conversion, Extraction of maximum power from wind and its dependence on various parameters. Wind Mills: Types of wind mills, Vertical axis and Horizontal axis wind mills their performance, Merits and Demerits, Limitations of wind energy conversions.
Bio Energy: Biomass, Generation and utilization, Property of biomass, Agriculture crop and Forestry residues used as fields. Physical, Chemical and biological conversion of biomass into useful form of energy. Gasification, Biomass gasifiers and types.
Biogas: Introduction, Generation of biogas, Aerobic and anaerobic bioconversion process. Substances used to produce biogas (Cow dung, Human and other agricultural waste, municipal waste etc.), Digesters and their designs, Pyrolysis and gasification, Fermentation process.
Biofuels: Types of biofuels, Production processes, Biofuel applications, Ethanol as a biofuel.
Ref. no. 2, 9, 14**.**

Reference Books:

1. Climatological and Solar Data for India, Seshadri (Sarita Prakashan) 1969
2. Solar Energy Utilization, G.D. Rai, (Khanna Publishers) 1995
3. Energy Technology, S. Rao and B.B. Parulekar (Khanna Publishers) 1995

4. Terrestrial Solar Photovoltaics, Tapan Bhattacharya, (Namsa: Publication House, New Delhi)
5. Solar Cells-operating Principles, Technology and System Applications, Martin A. Green (Prentice Inc. USA).
6. Solar Thermal Engineering, J.A. Duffie (Academic Press)
7. Renewable Energy Sources and Conversion Technology, N.K. Bansal, M. Kleeman and S.N. Sreinivas (Tata Energy Research Institute, New Delhi) 1996
8. Fundamentals of Solar Cells, F.A. Faherenbruch and R.H. Bube (Academic Press)
9. Biomass Energy Systems, Venkata Ramala and S.N. Srinivas (Tata Energy Research Institute, New Delhi, New Delhi) 1996
10. Thin Film Solar Cells, K.L. Chopra and S.R. Das (Plenum Press) 1983
11. Solar Hydrogen Energy Systems, T. Ohta (Pergamon Press) 1979
12. Hydrogen Technology for Energy D.A. Maths (Noyes Data Corp.)1976
13. Handbook Batteries and Fuel Cell, Linden (McGraw Hill)1984
14. Wind energy Conversion Systems, L.L. Freris (Prentice Hall)1990
15. Solar Photovoltaics, C.S. Solanki

PHOP244-L: Physics of Nanomaterials

Module 1: Introductory Concept for Nanomaterials **Credit-1**

1.1 Introduction to nano-sized materials and structures
1.2 Effect of Reduction of Dimension, Quantum size effect
1.3 Surface Effect and Interface Effect
1.4 Nucleation and Growth Phenomenon
1.5 Growth Kinematics

Module 2: Synthesis Methods of the Nanomaterials **Credit-1**

2.1 High energy ball milling
2.2 Physical Vapour Deposition
2.3 Chemical Bath Deposition
2.4 Sol gel Method
2.5 Hydrothermal method
2.6 Chemical bath deposition
2.7 Metal Reduction Method
2.8 Biological Method

Module 3: Properties of Nanomaterials **Credit-1**

3.1 Mechanical Properties
3.2 Thermal Properties
3.3 Electrical Properties
3.4 Optical Properties
3.5 Magnetic Properties

Module 4: Special Nanomaterials and Applications **Credit-1**

4.1 Fullerene
4.2 Graphene
4.3 Carbon nanotubes and their types
4.4 Aerogel
4.5 Nano-composites
4.6 Biomedical Application
4.7 Optoelectronic Application
4.8 Mechanical Applications

Reference Books:

1. Nanotechnology: Principal and Practices; by Sulbha Kulkarni; Capital Publication
2. Nanostructures and Nanomaterials: Synthesis, Properties and Application; by Guozhong Cao; Imperical College Press, London
3. Nanomaterials: Synthesis, Properties and Application; by A. S. Edstein and R.C. Commorta; Institute of Physics publishing Bristol and Philadelphia
4. Introduction to Nanotechnology: by C. P. Poole, Jr. Frank J. Owens: Willey student Edition

PHOP244-M: Astronomy and Astrophysics II

Module 1: The Milky Way **Credit-1**

Basic Structure and Properties of the Milky Way, Nature of Rotation of the Milky Way, Differential Rotation of the Galaxy and Oort Constant, Rotation Curve of the Galaxy and the Dark Matter, Nature of the Spiral Arms, Stars and Star Clusters of the Milky Way, Properties of and Around the Galactic Nucleus

Module 2: Galaxies **Credit-1**

Galaxy Morphology, Hubble's Classification of Galaxies, Elliptical Galaxies, The Intrinsic Shapes of Ellipticals, de Vaucouleurs Law, Stars and Gas, Spiral and Lenticular Galaxies, Bulges, Disks, Galactic Halo, The Milky Way Galaxy Gas and Dust in the Galaxy, Spiral Arms, Active Galaxies 'Activities' of Active Galaxies, How 'Active' are the Active Galaxies?, Classification of the Active Galaxies, Some Emission Mechanisms Related to the Study of Active Galaxies, Behaviour of Active Galaxies, Quasars and Radio Galaxies Seyferts, BL Lac Objects and Optically Violent Variables, The Nature of the Central Engine, Unified Model of the Various Active Galaxies

Module 3: Astronomical Techniques **Credit-1**

A. Electro-magnetic spectrum. Radio Window, Radio telescopes, Interferometry, Basic parameters of an antenna, Various types of antennas. Infrared, Ultraviolet and X-ray telescopes, Solar telescopes

B. Detectors for optical and infrared regions. Application of CCD's to stellar imaging, photometry and spectroscopy, Observing technique with a photometer, Correction for atmospheric extinction. Transformation to a standard photometric system. Astronomical spectroscopy. Spectral classification. Simple design of astronomical spectrograph. Radial velocity measurements.

C. Radio Astronomical Techniques: Design and construction of a simple radio telescope, Receiver systems and their calibration. Design and construction of a simple radio interferometer, MST Radar for Ionospheric studies, LB and VLBI Systems. Aperture Synthesis.

Module 4: Large Scale Structures and the Expanding Universe: **Credit-1**

Cosmic Distance Ladder. An Example from Terrestrial Physics Distance Measurement using Cepheid Variables Hubble's Law, Distance-Velocity Relation, Clusters of Galaxies, The Virial Theorem and Dark Matter, Friedman Equation and its Solutions, Cosmology, Cosmological models, Early Universe and Nucleo synthesis, Cosmic Background Radiation, Evolving vs. Steady State Universe

Reference Books:

1. K.D. Abhyankar: Astrophysics: Stars and Galaxies
2. R. Bowers and T. Deeming: Astrophysics (John and Barlett. Boston)
3. L.H. Aller: Astrophysics
4. Hynek: Astrophysics
5. E. Ambartzumian: Theoretical Astrophysics
6. Introduction to Cosmology, J. V. Narlikar, (Cambridge University Press)
7. Quasars and Active Galactic Nuclei, A. K. Kembhavi and J. V. Narlikar, (Cambridge University Press)
8. K.D. Abhyankar: Astrophysics - Stars and Galaxies. Tata McGraw Hill Publication

9. M. Sandage and J. Kristian: (Ed.) Galaxies and the Universe. University of Chicago Press
10. C.R. Kitchin: Astrophysical Techniques.
11. Gordon Walker: Astronomical Observations - an Optical Perspective (Cambridge University Press)
12. Henden and Kaitchuck: Astronomical Photometry
13. W.A. Hiltner (Ed): Astronomical Techniques
14. Kraus-‘‘Antennas”, McGraw Hill, 1950

PHOP244-N: Electronic Instrumentation II

Module 1:

1.1 Introduction to Process Control: **Credit-1**

Introduction, Control systems, Process control block diagram, Control system Evaluation
Control system Objective Stability, Regulation, Transient Regulation, Evaluation Criteria, Damped response, Cyclic response, Sensor time response, Process Control Drawing and symbols with their meaning. References: 1, 2

1.2 Discrete Process Control:

Introduction, definitions of discrete state process control characteristics of the systems, relay, controllers and ladder diagrams, PLC's, Interfacing with LAN, SCADA systems. References: 1

Module 2: Controller Principles **Credit-1**

Introduction, Process Characteristics Process Load, Transient, Process Lag, Control System Parameters, Error, Variable Range, Control Parameter Range, Control Lag, Dead Time, Cycling, Controller Modes, Reverse And Direct Action, Discontinuous Controller Modes Two Position Neutral Zone (Examples) Applications, multi position controller floating control mode(eliminate single speed and multiple speed) Continuous controller modes Proportional Control Mode Integral, Control Mode, Derivative Control Mode, Composite Control , PI Control, PD Control Mode, Three Mode Controller (PID). References: 1

Module 3: Controllers **Credit-1**

3.1Analog Controllers:

Electronic controller with design considerations: Proportional (P), Integral (I), Derivatives (D) PI, PD and PID

3.2 Digital Control: Introduction two position controls and multivariable alarms. References: 1

Module 4: **Credit-1**

4.1: Introduction to Modelling and Simulation:

Mathematical model, equivalent circuit model, Empirical Model, methodology, concept and need of simulation and its applications. References: 2

4.2: Introduction to MATLAB/ Sci. Lab programming:

All chapters are taken from "MATLAB: An Introduction and Applications", by Amos Gilat, Wiley Students Edition. References: 3

References Books:

1. Process Control Instrumentation Technology, Curtis D. Johnson, 7th Edition, Prentice Hall India Pvt. Ltd.
2. Computer based Industrial Controls K. Kant PHI publications.
3. MATLAB: An Introduction and Applications by Amos Gilat, Wiley Students Edition

PHOP244-O: Microwave Physics and Applications

Prerequisite: Electron Motion in electric field, Magnetic field and electromagnetic field, Electric and Magnetic wave equation.

Module 1: Passive Elements **Credit-1**

Introduction to microwave its application: transmission line theory, their equations and Solutions, reflection coefficient, standing wave ratio (SWR), admittance resonant lines.

Module 2: Impedance matching, Wave guides and wave guide components **Credit-1**

Impedance matching, single stub and double stub, rectangular wave guides, circular wave guides, TE & TM modes of propagation Q – of cavity resonator, use of Smith chart. Attenuators, filters, junctions, Tee's – magic Tee, (hybrid T), directional couplers, hybrid rings (Rat – Race), wave guide corners, bends.

Module 3: Active Elements **Credit-1**

Microwave generation problems and principles, Reflex Klystron, two cavity Klystron, operation as amplifiers and oscillators, bunching process, Applegate diagram, Magnetron traveling wave tube amplifier, BWA Semiconductor devices, Microwave transistor: Cut-off frequency, power gain, maximum available gain, frequency limitation. Johnson four equations, Gun diode, Tunnel diode, MOSFET, PIN diode, read diode, parametric amplifiers.

Module 4: Microwave other devices and measurements **Credit-1**

Ferrite isolators, Bolometers, TR and ATR switches, Microwave measurements: Impedance, power, frequency attenuation, dielectric constant Q measurements.

Reference Books:

1. Introduction to Microwave Theory and Measurements: Lance PUB Mcgraw Hill
2. Foundations of Microwave Engineering: Collins PUB Mcgraw Hill
3. Microwave Semiconductor Devices and Their Circuit Applications: Watson PUB Mcgraw Hill
4. Microwave Devices And Circuits: Liao, PHL
5. Physics of Semiconductor Devices: S.M. Sze, Willey Eastern Ltd.
6. Microwave Electronics: V.Kulkarni, 1 Up Publication
7. Microwave Application: Sisodia, Raghuvanshi
8. Microwave Principles: Rich, Addion Wesley

PHOP244-P: Biomedical Instrumentation II

Module 1: The Computer in Biomedical Instrumentation **Credit-1**

1.1 The digital computer-computer hardware-Computer Software.
1.2 Microprocessors –Types of Microprocessors
1.3 Microprocessors in Biomedical instrumentation
1.4 Microcontrollers in Biomedical instrumentation
1.5 Examples of Microcontroller Based system (data acquisition)
1.6 Interfacing the computer with medical instrumentation and other equipment.
1.7 Biomedical computer applications.

Module 2: Biomedical Recorders **Credit-1**

2.1 Introduction to nervous system,
2.2 Neuromuscular transmission, muscle potentials, receptors, Neurotransmitters
2.3 Electroencephalograph (EEG), Block diagram, Computerized Analysis of EEG
2.2 Electromyography (EMG)
2.3 Pulse Oximetry

Module 3: Ultrasonic Imaging Systems **Credit-1**

3.1 Diagnostic ultrasound
3.2 Physics of ultrasonic waves
3.3 Characteristics impedance, wavelength and frequency, velocity of Propagation
3.4 Absorption of ultrasonic energy beam width, resolution
3.5 Generation and detection of ultrasound
3.6 Basic pulse echo apparatus
3.7 Diagnostic scanning mode A-mode, B-mode

Module 4: Respiratory system, measurements and basic of radiology **Credit-1**

4.1 The Physiology of the respiratory system
4.2 Tests and instrumentation of the mechanics of breathing
4.3 Respiratory Therapy Equipment
4.4 Heart lung machine
4.5 Basic definition in radiology
4.6 Generations and detection of ionizing radiation
4.7 Instrumentation for diagnostic x-rays.
4.8 Instrumentation for the medical use of radio isotopes

Reference Books:

1. Biomedical Instrumentation and Measurements (Second Edition) By Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer Pearson Education
2. Handbook of Biomedical Instrumentation (Second Edition) by R.S. Khandpur (Tata McGraw Hill)
3. Biomedical Instrumentation and Measurement by Carr and Brown-Pearson

PHOP244-Q: Atmospheric Physics II

Module 1: Upper Atmosphere **Credit-1**

Thermal structure of Troposphere, Stratosphere and Mesosphere, Ionosphere, D,E, F regions, Radio wave propagation through Ionospheric circulation and warming, Pressure and density measurements from moving Rockets, Meteors in the mesospheres

Module 2: Atmospheric Ozone **Credit-1**

Temporal and spatial variation of ozone Umkehr effect, stratospheric ozone, ozone flux from stratosphere to the troposphere, tropopsheric ozone, Chapman mechanism, ozone depletion on ozone Hole

Module 3: Solar and Terrestrial Radiations **Credit-1**

Nature of radiations, scattering (Rayleigh and Mie), Black body radiations, Radiative transfer, Nature of solar radiations, Terrestrial radiation, optical depth, radiative equilibrium in stratosphere, short wave radiation, long wave radiation

Module 4: Atmospheric Electricity **Credit-1**

Elementary principle of electricity, electric field, electrostatic potential, charge separation in clouds, origin and distribution of ions, rate of ion pair production by cosmic rays as a function of height, conductivity, The lightning discharge

Reference Books:

1. Introduction to Theoretical Meteorology-S. Hess
2. An Introduction to Atmospheric Chemistry – By Prof. Peter V. Hobbs
3. Tropical Meteorology Vol- I And II-G.C. Asnani
4. Weather Forecasting – A.A. Ramshastry
5. Cloud Physics-Rogers
6. Cloud Physics-Wallace And Bob
7. Atmosphere, Weather and Climate –K. Siddharth (Kisalaya Publication Pvt.Ltd)
8. An Introduction to Atmospheric Physics: By Robert G. Fleagle and J.A. Businger, Academic Press.
9. Atmospheric Chemistry and Physics By John Seinfeld And S.N. Pandis, Wiley Interscience
10. The Upper Atmosphere, Meteorology and Physics By Richard Craig, Academic Press

PHOP244-R: Nuclear Techniques II

Module 1: Basic parameters of radioactive disintegration process **Credit-1**

Law of radioactive disintegration, units of activity, basic concepts of half-life, mean life time of nuclei. Measurement of lifetime of nuclear excited states using techniques such as conversion line shift recoil distance, delayed coincidence, activity measurement and other methods. Measurement of Beta-Beta and Beta-gamma coincidence

Module2: Generation and detection of neutrons **Credit-1**

Neutron sources, neutron detectors, measurement of cross-sections for nuclear reaction, thermal and fast reactors, production of radioisotopes. Reactor operation, thermal neutrons, neutron scattering and applications.

Module3: Nuclear reaction analysis **Credit-1**

Elemental analysis by neutron activation technique, proton induced X-ray emission technique, Rutherford backscattering, Resonance nuclear reaction, ERDA, channelling, ion scattering and other such methods.

Module 4: Radioisotopes and its Applications **Credit-1**

Radioisotopes, Radioactive waste disposal applications of radioisotopes (industrial, agricultural) dating of archaeological and other ancient object, Medical uses of radioisotopes and electron beams, radiotherapy, Carbon-14 and potassium-argon dating

Reference Books*:*

1. Nuclear Radiation Detectors, S.S. Kapoor and V. S. Ramamurthy (Wiley Eastern Limited, New Delhi) 1986
2. Introduction to Radiation Protection Dosimetry, J. Sabol and P.S. Weng (World Scientific) 1995.
3. Techniques for Nuclear and Particle Physics, W.R. Leo (Springer) 1995
4. Nuclear Measurement Techniques, K. Sriram, (Affiliated East-West Press, New Delhi) 1986
5. Fundamentals of Surface and Thin Analysis, Leonard C. Feldman and James W. Mayer, (North Holland, New York), 1988.
6. Introduction to Nuclear Science And Technology, K. Sriram and Y.R. Waghamare, (A. M. Wheeler) 1991
7. Nuclear Radiation Detection, W. J. Price, (Mcgraw-Hill, New York) 1964
8. Alpha, Beta A Gamma-Ray Spectroscopy, K. Siegbahn (North Holland, Amsterdm) 1965
9. Introduction to Experimental Nuclear Physics, R.M. Singru (John Wiley and Sons) 1974
10. Radioactive Isotopes in Biological Research, William R. Hendee, (John Wiley and Sons) 1973
11. Atomic and Nuclear Physics, Satendra Sharma, Pearson Education, 2008

PHOP244-S: Microcontrollers Based Instrumentation System-II

Module 1: **Credit-1**

Introduction to Embedded Systems, types of arduino modules (list only), Arduino Uno Microcontroller**,** Introduction to architecture of AT 328, block diagram, types, programing arduino UNO, Detailed Pin Mapping, Boot loaders and Boot loading process for Microcontroller, brief introduction to serial communication, UART, USART

Module 2: Basic Electronic Concepts of Embedded Designing, Signal Conditioning Circuits: Credit-1

Input signal conditioning: Designing a bridge amplifier module using an instrumentation amplifier (three Op Amps configuration) for PT-100 temperature sensor (RTD) and strain gauge bridge, (student is expected to select/choose design for bridge excitation voltage and output in the range of 0 – 5 volts for a given range of measurand (quantity to be measured) i. e. temperature and force/ pressure), current to voltage converter (0 – 5 volts output for 4 – 20 mA input) for a 4 – 20mA current loop, interfacing an ADC module H X- 711

Output signal conditioning: designing a driver module for dc motor (5 volts) for rotating in clock and counter clockwise direction, driver module for dc motor speed control or led intensity control using pwm (using transistor darlington configuration or mosfet), relay driver module, seven segment display (two digit) driver module , interfacing a DAC module mcp 4725 interfacing RTC module.

Module 3: **Credit-1**

Interfacing modules to Arduino uno: interfacing a single key (push to ON/OFF), light dependent resistor (intensity, on/off output control) , LED & LCD module, IR photo diode, temperature(on/off temperature control), moisture and humidity, multiple analog input (humidity, temperature, moisture) , Ultrasonic (level/ distance, on/off control), (all above interfaces are analog input and digital output (single input -single output & on/off type output control) speed sensor (photo, fork type), hall effect sensor, (digital input digital output) , stepper motor, servomotor, dc motor, power MOSFET module, Relay Module (or other compatible module(s)) and multiple output (on/off type)

(Student is expected to write a program(s) using arduino IDE for all above interfaces)

Module 4: **Credit-1**

DC motor speed control using potentiometer(pot) and DC motor using voltage control or power control (PWM technique), Designing a car reverse alarm system with ultrasonic sensor and speaker output. (sound level and frequency of output audio signal will go on increasing as the car approaches near to the obstacle, analog input and analog output). Designing a poly house environmental controller system for monitoring and controlling humidity, moisture and temperature. (analog input and digital output (on/off control)), coffee vending machine: customer can choose one of three options 1] black coffee, 2] black coffee with sugar and 3] coffee with sugar and cream. Three push button will initiate the process of choosing one of three above options. Hot coffee will be served if there is empty coffee cup at the outlet tap. Once chosen the option customer cannot change the option and also to ensure that coffee will not be served twice in the same amount.

Reference Books:

1. Beginning Arduino Programming by Brian Evans
2. Beginning Arduino by Michael McRoberts
3. Arduino Project Handbook: 25 Practical Projects to Get You Started by Mark Geddes
4. Arduino Projects for Dummies by Brock Craft

Savitribai Phule Pune University

(Formerly University of Pune)

Three Year B.Sc. Degree Program in Physics

(Faculty of Science & Technology)

T.Y.B.Sc. (Physics)

Choice Based Credit System

To be implemented from Academic Year 2021-2022

Savitribai Phule Pune University, Pune

Revised syllabus for T.Y.B.Sc. (Physics) (CBCS Pattern-2021-22)

To be implemented from Academic Year 2021-22

Salient Features of Revised Syllabi in Physics

As far as possible to promote:

1) Physics Education through Master Texts:
It helps in understanding the theoretical and mathematical development of the subject and to create interest in the subject.

2) Physics Education through Experimentation:
It helps in general to improve scientific attitude. So emphasis is given on the development of experimental skills, data analysis, calculations, and also on the limitations of the experimental method and data and, results obtained.

3) Physics Education through Problem Solving: It helps in understanding the concepts of physics. It underline the strength of equations, formulae, graphs, mathematical tools to tackle the problems. So accordingly, we have introduced compulsory problem part in the question paper.

4) Physics Education through History and Philosophy:
It helps in understanding the conceptual development of the subject and thereby increase the interest in the subject. A topic on this is introduced in the Physics Course.

5) Physics Education through Awareness of Misconceptions:
It improves the scientific awareness among the students. A discussion on different subjects are encouraged.

6) Physics Education through Proto-research:
It creates interest in the subject and improves technological aspect. Accordingly, mini projects, hands-on activities, projects, models and demonstrations etc. is included in the syllabi.

7) Physics Education through Qualitative Overview:
It creates interest in the subject to continue to work in the field of science in general and physics in particular. Accordingly future directions and frontiers of the subject are included in the syllabi.

8) **Structure of Question paper:**
Existing structure shall continue.

9) **ATKT Rules:**
Existing rules shall apply.

10) **Structure of the Course:**

Semester	Course Type	Course Code	Course Name	Credit
V	Discipline Specific Elective Course	PHY-351	Mathematical Methods in Physics-II	2
		PHY-352	Electrodynamics	2
		PHY-353	Classical Mechanics	2
		PHY-354	Atomic and Molecular Physics	2
		PHY-355	Computational Physics	2
		PHY-356: Elective-I (Select any One)		2
		PHY-356(**A**)	Astronomy and Astrophysics-I	
		PHY-356(**B**)	Elements of Materials Science	
		PHY-356(**C**)	Biophysics	
		PHY-356(**D**)	Renewable Energy Sources-I	
		PHY-356(**E**)	Applied Optics	
		PHY-356(**F**)	C# programming	
		PHY-356(**G**)	Acoustics-I	
		PHY-357	Physics Laboratory-3A	2
		PHY-358	Physics Laboratory-3B	2
		PHY-359	Project-I	2
	Skill Enhancement Course	**PHY-3510: Skill Enhancement Course-I (Select any One)**		2
		PHY-3510(**H**)	Python Programming	
		PHY-3510(**I**)	Energy studies	
		PHY-3510(**J**)	Introduction to Arduino	
		PHY-3510(**K**)	Sensors and Transducer	
		PHY- 3511: Skill Enhancement Course-II (Select any One)		2
		PHY-3511(**L**)	Physics Workshop Skill	
		PHY-3511(**M**)	Biomedical Instrumentation	
		PHY-3511(**N**)	Non-destructive Testing Techniques	
		PHY- 3511(**O**)	Acoustics Applications	
VI	Discipline Specific Elective Course	PHY-361	Solid State Physics	2
		PHY-362	Quantum Mechanics	2
		PHY-363	Thermodynamics and Statistical Physics	2
		PHY-364	Nuclear Physics	2
		PHY-365	**(A)** Electronics-II **OR**	2

			(B) Advanced Electronics	
		PHY-366: Elective-II (Select any One)		2
		PHY-366(**P**)	Medical Electronics	
		PHY-366(**Q**)	Physics of Nanomaterials	
		PHY-366(**R**)	Microcontrollers	
		PHY-366(**S**)	Lasers	
		PHY-366(**T**)	Astronomy and Astrophysics-II	
		PHY-366(**U**)	Renewable Energy Sources-II	
		PHY-366(**V**)	Acoustics-II	
		PHY-367	Physics Laboratory-4A	2
		PHY-368	Physics Laboratory-4B	2
		PHY-369	Project-II	2
	Skill Enhancement Course	**PHY-3610: Skill Enhancement Course-III (Select any One)**		2
		PHY-3610(**W**)	Scientific Data Analysis using Python	
		PHY-3610(**X**)	Solar PV System: Installation, Repairing and Maintenance	
		PHY-3610(**Y**)	Applications of Internet of things (IOT)	
		PHY-3610(**Z**)	Calibration Techniques	
		PHY- 3611: Skill Enhancement Course-IV (Select any One)		2
		PHY- 3611(**AA**)	Microcontrollers	
		PHY- 3611(**AB**)	Instrumentation for Agriculture	
		PHY- 3611(**AC**)	Radiation Physics	
		PHY- 3611(**AD**)	Photography	

Semester-V

T.Y.B.Sc. (Physics) (Sem-V)
PHY-351: Mathematical Methods in Physics-II

Lectures: 36 **(Credits-02)**

1: Curvilinear Co-ordinates (10L)

Review of Cartesian, spherical and cylindrical co-ordinate, transformation equation, General Curvilinear co-ordinate system: Co-ordinate surface, co-ordinate lines, length, surfaces and volume elements in curvilinear co-ordinate system.

Orthogonal curvilinear co-ordinate system, expressions for gradient, divergence, Laplacian, and curl, special case for gradient, divergence and curl in Cartesian, spherical polar and cylindrical co-ordinate system, Problems.

2: The Special Theory of Relativity (10L)

Introduction, Newtonian relativity, Galilean transformation equation, Michelson-Morley experiment, Postulates of special theory of relativity, Lorentz transformations, Kinematic effects of Lorentz transformation, Length contraction, Proper time, Problems.

3: Partial Differential Equations (8L)

Introduction to Partial differential equations (PDE), General methods for solving second order PDE, Method of separation of variables in Cartesian, Spherical polar and cylindrical co-ordinate system (two dimensional Laplace's equation, one dimensional Wave equation), Singular points ($x = x_0$), Solution of differential equation-Statement of Fuch's theorem, Frobenius method of series solution.

4: Special Functions (8L)

Introduction, generating function for Legendre Polynomials: $P_n(x)$, Properties of Legendre Polynomials, Generating function for Hermite Polynomials: $H_n(x)$, Properties of Hermite Polynomials, Bessel function of first kind: $J_n(x)$, Properties of Bessel function of first kind, Problems.

Reference books:

1. Mathematical methods for physicists, Arfken and Weber, Acadmic press Newyork, 7th Edition.
2. Mathematical physics, Rajput, Pragati prakashan-1997.
3. Mathematical methods in the physical sciences – Marry L. Boas, John Willy & Sons publication, 3rd Edition-2005.
4. Introduction to special relativity, Robert Resnick, John Wiley & Sons, Inc.-1968.
5. Mathematical physics, B. D. Gupta, Vikas publishing house Pvt. Ltd., 4th edition-2010.
6. Mathematical physics, H. K. Dass, Dr. Rama Varma, S. Chand & Company Pvt. Ltd.,7th Edition-2014
7. The Special Theory of Relativity: A Mathematical Approach-Farook Rahaman, Springer Publication -2014.

T.Y.B.Sc. (Physics) (Sem-V)
PHY-352: Electrodynamics

Lectures: 36 **(Credits-02)**

1: Electrostatics **(12 L)**

- **a.** Revision of Coulomb's law, Gauss law, Electric field, Electrostatic Potential.
- **b.** Potential energy of system of charges.
- **c.** Statement of Poisson's and Laplace's equation, Boundary Value problems in electrostatics-**S**olution of Laplace equation in Cartesian system, Boundary conditions.
- **d.** Polarization **P**, Electric displacement **D**, Electric susceptibility and dielectric constant, bound volume and surface charge densities.
- **e.** Electric field at an exterior and interior point of dielectric.

2: Magnetostatics **(12 L)**

- a. Concepts of magnetic induction, magnetic flux and magnetic field.
- b. Magnetic induction due to straight current carrying conductor, magnetization of matter, relationship between **B, H** and **M.**
- c. Boundary conditions at the interface of two magnetic media (Normal and tangential components).
- d. Biot-Savart's law, Ampere's force law, Magnetic force between two current carrying loops, Ampere's circuital law.
- e. Equation of continuity, Magnetic vector potential **A,** Magnetic susceptibility and permeability.

3: Electrodynamics **(12 L)**

- **a.** Concept of electromagnetic induction, Faradays law of induction, Lenz's law, displacement current, generalization of Amperes' law.
- **b.** Maxwell's equations (Differential and Integral form) and their physical significance.
- **c.** Polarization, reflection & refraction of electromagnetic waves through media.
- **d.** Wave equation and plane waves in free space.
- **e.** Poynting theorem & Poynting vector.

Reference Books:

1. Introduction to Electrodynamics; D. J. Griffith; Cambridge India; Fourth edition (2020)
2. Classical Electrodynamics; J. D. Jackson; Wiley; Third edition (2007)
3. Introduction to Electrodynamics; A. Z. Capri, Panat P. V.; Alpha science international ltd; Illustrated edition(2002)
4. Foundations of electromagnetic theory; Reitz, Milford and Christy; Pearson education India; Fourth edition (2010)
5. Electrodynamics; Gupta, Kumar, Singh; Pragati Prakashan; Ninteenth edition (2011)
6. Electromagnetic field and waves; Paul-Lorrain, D. R. Corson; W.H. Freeman & co. Ltd; Second edition (1970)
7. Electricity and magnetism; Murugeshan; S. Chand; (2020)
8. Electromagnetic theory and electrodynamics; Satya Prakash; Kedar Nath Ram Nath; (2020)

T.Y.B.Sc. (Physics) (Sem-V)
PHY-353: Classical Mechanics

Lectures: 36 **(Credits-02)**

1: Motion of Particles **(8L)**

a. Charged Particles: Motion of a charged particle in constant electric, magnetic and electromagnetic field,
b. System of particles: Concept of Centre of mass, Conservation of linear momentum, angular momentum, energy of system of particles.(statements only)
c. Problems

2: Central force Field **(8L)**

a. Central force Field: Definition and Properties of central force field. Reduction of two body problem to an equivalent one body problem
b. Motion in central force field,
c. Kepler's laws of planetary motion and their proof
d. Artificial satellite and its orbit
e. Problems.

3: Scattering of particles **(10L)**

a. Elastic and inelastic scattering: Definition and properties,
b. Elastic scattering - Laboratory and center of mass system.
c. Scattering: Scattering angles in laboratory and center of mass system.
d. Differential cross-section, impact Parameter, total cross-section in brief.
e. Problems

4: Langrangian and Hamiltonian formulation **(10L)**

a. Limitations of Newton's Law of Motion,
b. Constraints and Their Classification, Example of Constrains, degrees of freedom, generalized coordinate, configuration space,
c. Principle of Virtual work done,
d. D'Almeberts Principle of virtual work,
e. Langrangian equation from D' Alembert's principle, cyclic coordinates,
f. Phase space, Hamiltonian's equations
g. Problems

Reference books:

1. **Classical Mechanics**, J.C. Upadhyaya, Himalaya publishing Houses, 2nd Edition of 2005.
2. **Introduction to Classical Mechanics,** R. G. Takawale, P. S. Puranik, Tata McGraw Hill publishing Company Ltd., New Delhi.
3. **Classical Mechanics,** NC Rana and PS Joag, Tata McGraw Hill Education Private Limited, New Delhi, 1991.
4. **Classical Mechanics** by P.V.Panat.
5. **Classical Mechanics,** Herbert Goldstein, Narosa Publishing House.

T.Y.B.Sc. (Physics) (Sem-V)
PHY-354: Atomic and Molecular Physics

Lectures: 36 **(Credits-02)**

1: Atomic structure **(6 L)**

1. Revision of various atomic models
2. Vector atom model (Concepts of space quantization and electron spin)
3. Pauli Exclusion Principle and electron configuration, Quantum states, Spectral notations of quantum states.
4. Problems

2: One and Two Valence electron systems **(12 L)**

1. Spin-Orbit Interaction (Single valence electron atom), Energy levels of Na-atom, Selection rules, Spectra of sodium atom, Sodium doublet.
2. Spectral terms of two electron atoms, terms for equivalent electrons, LS and JJ-coupling schemes.
3. Singlet-Triplet separations for interaction energy of LS coupling, Lande's interval rule, Spectra of Helium atom.
4. Problems

3: Zeeman Effect **(4 L)**

1. Zeeman Effect
2. Experimental arrangement
3. Normal and anomalous Zeeman Effect
4. Stark effect (Qualitative discussion)
5. Applications of Zeeman effects
6. Problems

4: Molecular spectroscopy **(8 L)**

1. Introduction of molecular spectra and its types
2. Rotational energy levels, Rotational spectra of rigid diatomic molecule
3. Vibrational energy levels
4. Rotational and Vibrational spectra
5. Electronic spectra of molecules
6. Applications of UV-Vis spectroscopy
7. Problems

5: Raman spectroscopy **(6 L)**

1. History of Raman effect, Molecular polarizability
2. Classical theory and Quantum theory of Raman Effect
3. Characteristics Raman Lines and Applications of Raman spectroscopy
4. Problems

Reference books:

1) R. Murugeshan, Er. K. Sivaprasath, Modern Physics, S. Chand, 2014, Revised edition
2) Robert Eiseberg, Robert Resnik, Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Wiley, 2016, 2nd edition
3) G. Aruldhas, Molecular structure and Spectroscopy, PHI, 2015, 2nd edition
4) Colin Banwell, Elaine McCash, Fundamentals of Molecular Spectroscopy, TMH, 4th ed
5) Arthur Baiser, Concepts of Modern Physics , McGraw Hill International, 4th edition
6) White H. E, Introduction to Atomic spectra, McGraw Hill International

T.Y.B.Sc. (Physics) (Sem-V)
PHY-355: Computational Physics

Lectures: 36 **(Credits-02)**

1: Concepts of Programming and Introduction to C-programming: (14 L)

a) Definition and Properties of algorithms, Algorithm development, Flow charts- symbols and simple flowcharts.
b) Introduction and Structure of C-program, 'C' Character set, key words, Constants and variables, Variable names, Data types, qualifiers and their declarations, Symbolic Constants.
c) Input/output functions: scanf( ), printf( ), getchar(), putchar(), gets(), puts().
d) Operators and Expressions: Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators, Conditional Operator.
e) Control statements: if, if else, while, do while, for loop, nested control structures (nested if, nested loops), break, continue, switch- case statement, goto statement.
f) Use of Library functions: e.g. mathematical, trigonometric, graphics.

2: Arrays, Pointers and user defined function in C-Language (8 L)

a) Arrays: 1-D, 2-D: Arranging numbers in descending and ascending order, Sum of matrices, multiplication of matrices.
b) Concept of pointers with suitable illustrative examples.
c) User defined functions: Definitions and declaration of function, function prototype, passing arguments (Call by value, Call by reference). Simple illustrative examples.

3: Graphics in C-Language: (3 L)

Concepts of graphics in C, Some simple graphic commands- Point, Line, Circle, Arc, Ellipse, Bar with suitable illustrative examples.

4: Computational Physics: (11 L)

Numerical Methods to solve the Physics Problems

a) **Iterative methods:** Bisection method and Newton-Raphson Method– Algorithm, Flowchart and writing C- program for finding the roots of the equation, problems
b) **Integration:** Trapezoidal rule, Simpson's $1/3^{rd}$ rule – Algorithm, Flowchart and C-program, problems

Reference Books:

1. Programming in C- (Schaum's series), Gottfreid, TMH
2. Programming in C- Balgurusami, Prentice Hall publications
3. Let us C- Yashwant Kanetkar, BPB publications
4. Programming with C- K.R. Venugopal, S. R. Prasad, TMH.
5. Introductory methods of numerical analysis-S. Sastry, Prentice Hall
6. Computer oriented numerical methods – V. Rajaraman.

PHY-356: Elective-I

T.Y.B.Sc. (Physics) (Sem-V)
PHY-356 Elective-I (A): Astronomy and Astrophysics-I

Lectures: 36 **(Credits-02)**

1: Fundamentals of Astronomy: **(10 L)**

Introduction: Components of the Universe; Stars, Planets, Asteroids, Meteors, Comets, Galaxies. Solar System: Age, Origin Basic measurements: Planetary orbits, distances, physical size, mass, density, temperature, rotation period determination, Co-ordinate system, Celestial hemisphere,

2: Astronomical Instruments: **(8 L)**

Optical telescopes, mounts, light gathering power, magnification, Resolution. Spectroscopes, CCD camera, photometer, filters Radio telescopes, Interferometry (only introduction)

3: Star Systems and basic observations: **(10 L)**

Stars life cycle, Stellar processes (Nuclear). Neutron stars, black holes, Chandrasekhar limit. Spectral classification of stars, O, B, A, F, G, K, M. Star Systems: Binaries / Cepheids / RR Lyrae, Observation of Sun: Eclipses, Moon, planets, meteor showers, transits, occultations.

4: Galaxies, Dark Matter and Dark Energy **(8 L)**

A) Galaxies, types, their formation, Hubble's tuning fork diagram, Open and Globular clusters, Dark Matter / Energy (evidence for both), Cosmology: Theories: BBT, Steady State, Oscillating Universe Theory.

B) Observational Astronomy: Concept of time, Magnitudes: apparent and absolute, introduction to Constellations, Star dial.

Reference books:

1. Astronomy structure of the Universe. A.E. Roy and D. Clarke, Adam Hilger Pub.
2. Source Book of Space Sciences, Samuel Galsstone; D.Van Nostrand Co. Inc
3. Astrophysics - Stars and Galaxies, K.D. Abhyankar, Tata McGraw Hill Pub.
4. Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Pub.
5. Structure of the Universe, J.V. Narlikar
6. Astrophysics, Baidyanath Basu.
7. Astrophysical Techniques, third Edition, C. R. Kitchin
8. Fundamentals of Astronomy, Michael Seed
9. Telescopes and techniques, C. R. Kitchin (Springer)

List of experiments: (Any 2)

1. Study of Binocular, refracting and reflecting telescopes and their mounts.
2. To determine the diameter of the Moon.
3. Measurement of Solar Constant.
4. Observation of emission, continuous and absorption spectra. (Mercury, sodium or iodine spectra could be obtained.)
5. Study of Construction and working of CCD.
6. Study of Solar Eclipse and Lunar Eclipse.

T.Y.B.Sc. (Physics) (Sem-V)

PHY-356 Elective-I (B): Elements of Material Science

Lectures: 36 **(Credits-02)**

1: Defects in Solids **(7 L)**

1. Material Properties – Mechanical, Electrical, and thermal
2. Impurities in solids.
3. Solid solutions in metals.
4. Rules of solid solubility.
5. Imperfection in crystals.
6. Defects in solids point, line, surface, and volume.
7. Atomic diffusions definition, mechanism, Fick's laws.

2: Single Phase Metals **(6 L)**

1. Single phase alloys
2. Deformation
3. Elastic Deformation and Plastic Deformation
4. Mechanism of plastic Deformation by slip
5. Critical resolved shear stress (CRSS)
6. Plastic deformation in poly crystalline materials

3: Ceramic Materials **(10 L)**

1. Ceramic Phases, Classification of ceramic materials
2. Ceramic crystals (AX)
3. Mechanical behavior of ceramics
4. Electromagnetic behavior of ceramics –
   a) Electric properties dielectrics, semiconductors, piezoelectric
   b) Magnetic Properties Magnetic Ceramics, hard and soft ferrites

4: Phase Diagrams **(9 L)**

1. Basic terms System, Surrounding, Component, Coordinates, Phase, Equilibrium.
2. Phase Diagram definition, importance, and objective
3. Lever rule
4. Gibb's phase rule
5. Phase diagram of a) Sugar water b) NaCl water
6. Types of phase diagrams with construction
   a) Type I Lens type CuNi phase diagram
   b) Type II Only introduction
   c) Type III Eutectic type PbSn phase diagram
7. Isothermal cuts

5: Introduction to smart materials **(4 L)**

1. Definition of smart materials
2. Types and structure of smart materials,
3. Properties of smart materials
4. Applications of smart materials.

Reference books :

1. Elements of Materials Science and Engineering I. H. Vanvlach (4^{th} Edition)
2. Materials Science and Engineering - V. Raghavan

List of experiments : (Any 2)

1. To determine the dipole moment of a given liquid
2. To determine magnetic susceptibility of $FeCl_3$
3. To determine the specific heat of graphite
4. Determination of the yield point and the breaking point of an elastic material
5. Ionic conductivity of NaCl/ NaI
6. Grain size and grain boundary measurement using optical microscope.

T.Y.B.Sc. (Physics) (Sem-V)
PHY-356 Elective-I (C): Biophysics

Lectures: 36 **(Credits-02)**

1: Introduction of Biophysics **(13L)**

1.1 History of Biophysics, Concept of Biophysics and Physical properties applied to biology- Surface tension, Viscosity, adsorption, diffusion, osmosis, Definition for Biostatistics and Biometry

1.2 Cell: Animal and plant cell, types of cell, Functional aspects of cell membrane, cytoplasm, nucleus, mitochondria and chloroplast

1.3 Protein structure (Primary and Secondary), amino acid structure, Genetic code- symmetry, DNA structure

1.4 Photosynthesis process:- electron transport, Gibbs's free energy, Redox couple, Redox potential, Oxidation and reduction, Examples of redox potential in biological system.

2: Bio-potentials **(9L)**

2.1 Bioelectric signals: structure of neuron, resting potential, action Potential, Nernst equation

2.2 Bioelectrodes- Half-cell potential, polarizable and non-polarizable electrodes, Microelectrode- metal and glass electrodes

2.2 Study of Cardiovascular system, Compound action potential of human body-ECG (Electrocardiography), Electrodes for ECG

3: Bio-instruments **(6L)**

3.1 Basic principle, Construction and working of colorimeter, spectrophotometer, PH meter and Centrifuge measurement.

3.2 Electron Microscope: SEM, TEM.

4: Radiation Biophysics **(8L)**

4.1 Definition, Units of Radioactivity and radiation doses, Types of radiation (Ionizing and non- ionizing), radioimmunoassays.

4.2 Applications: PET (Positron Emission Tomography), NMR (Nuclear Magnetic Resonance), MRI (Magnetic Resonance Imaging Techniques), Ultrasonography, CT (Computed Tomography) Scan.

Reference books:

1. Introduction to Biophysics - by P. Narayanan.New Age P.
2. Medical Instrumentation - by Khandpur, TMH
3. Laboratory Manuals of Biophysics Instruments - by P.B. Vidyasagar
4. Biophysics -by Vatsala Piramal, Dominant Publisher and Distributors, New Delhi-110002
5. Textbook of Biophysics - by R.N. Roy
6. Photosynthesis - by Hall and Rao.
7. Introduction to Biomedical Equipment Technology (Fourth Edition) by-Joseph J.Carr
8. Text Book of Bio-medical Electronics-by S.S. Agrawal

List of Experiments : (Any 2)

1. Recording and analysis of ECG signals
2. Verification of Beer's and Lambert's Law
3. Absorption spectrum of Blood/Chlorophyll.
4. pH value of Amino acids.
5. Bimolecular model building using standard kits.
6. Separation of components of Milk/Chlorophyll using centrifuge machine.

T.Y.B.Sc. (Physics) (Sem-V)
PHY-356 Elective-I (D): Renewable Energy Sources-I

Lectures: 36 **(Credits-02)**

1: An Introduction to Energy Sources: **(10L)**

1. Energy: Definition, Classifications of energy sources
2. Conventional and non-conventional energy sources.
3. Sun: The source of energy (Structure, Characteristics and Composition)
4. Solar Constant
5. Electromagnetic Energy Spectrum.
6. Solar radiations outside earth atmosphere.
7. Solar radiation at the earth surface.
8. Problems.

Ref.1- page no. 1 to 11 and 15 to 37
Ref.3- 3.1, 3.2, 3.3, 3.4, 3.5

2: Photothermal Applications: **(10L)**

1. Photothermal devices: Solar Insolation, Selective Coating, Glass Cover, Heat Conductor and Heat Insulation.
2. Solar water heating systems: Types, construction and working of Liquid Flat Plate Collector (FPC) and Evacuated Tube Collector (ETC)
3. Energy Balance Equation (without thermal Analysis).
4. Concentrating collectors: Flat plate collector with plane reflector, Cylindrical parabolic, Compound parabolic, Collector with fixed circular concentrators and moving receiver, paraboloid concentrator.
5. Comparative study between flat plate collector and solar concentrators.
6. Solar distillation, Solar dryer, Solar cooker (box type)

Ref. 1: 3.3, 3.3(A), 3.5, 3.7, 3.8, 5.2, 5.8, 5.11.
Ref. 2: 2.2.6

3: Photovoltaic systems: **(10L)**

1. Introduction to Photovoltaic effect and Photovoltaic Conversion.
2. Basic photovoltaic system for power generation
3. Basics of Solar Cell, PV modules, Arrays,
4. Solar Cell: I-V characteristics, Power output and conversion efficiency.
5. Factors affecting on photovoltaic efficiency. (Change in amount of input light, solar cell area, Change in angle, Change in operating Temperature etc.)
6. Types of solar cells: p-n junction solar cell, p-i-n diode solar cell, cadmium sulphide solar cell, Gallium arsenide solar cell, Indium phosphide solar cell, nano-crystalline solar cell.
7. Application of solar photovoltaic systems.

Ref.3 -15.1, 15.3, 15.4, 15.5, 15.7, 15.8, 15.10.
Ref.8 – 3.6.1, 3.6.2, 3.6.3, 3.6.4, 3.6.5

4: Energy Storage: **(06L)**

1. Importance and Needs of Energy storage in Conventional and Nonconventional Energy Systems.
2. Various forms of Energy Storage
3. Electrical Energy: Super capacitors
4. Electrochemical Energy: Battery
5. Chemical Energy: Hydrogen Production and storage

Ref.4 - Ref.5 - Ref.6 - Ref.7 -

Reference books:

1. Non-conventional Energy sources, G. D. RAI (4th edition), Khanna Publishers, Delhi.
2. Solar Energy, S.P. Sukhatme (second edition), Tata Mc. Graw Hill Ltd, New Delhi.
3. Solar Energy Utilizations**,** G. D. RAI (5th edition), Khanna Publishers, Delhi.
4. Energy Storage: Fundamentals, Materials and Applications, by Huggins R. A., Springer
5. Chemical and Electrochemical Energy System by R. Narayan and B. Viswanathan, University Press.
6. Battery Systems Engineering by C. D. Rahn and C. Wang, Wiley Pub.
7. Electrochemical Energy Storage for Renewable sources and grid balancing by P. T. Moseley and J. Garche, Elsevier Science.
8. Solar Photovoltaic Technology and Systems by C S Solanki

List of Experiments: (Any 2)

1. To calculate the thermal efficiency of liquid flat plate collector.
2. To study the box type solar cooker.
3. To determine an instantaneous thermal efficiency of parabolic collector.
4. To calculate an efficiency and fill factor of PN junction solar cell.
5. To study I-V characteristic of various types of solar cells.

T.Y.B.Sc. (Physics) (Sem-V)
PHY-356 Elective-I (E): Applied Optics

Lectures: 36 **(Credits-02)**

1: Fermat's Principle and Matrix Methods in Paraxial Optics: (9L)

1.1 Introduction to Fermat's Principle and its Applications.
1.2 Laws of Reflection and Refraction from Fermat's Principle.
1.3 Ray paths in an Inhomogeneous Medium.
1.4 Introduction to Matrix methods in Paraxial Optics.
1.5 The matrix method, Unit planes and Nodal planes.
1.6 A System of two thin lenses.
1.7 Problems.

2: Multiple-Beam Interferometry and Diffraction: (9L)

2.1 Introduction to Multiple-Beam Interferometry.
2.2 Michelson Interferometer
2.3 The Fabry-Perot Etalon.
2.4 The Fabry-Perot Interferometer.
2.5 Introduction and revision of diffraction.
2.6 Two slit and N-Slit Fraunhofer diffraction pattern.
2.7 Fresnel half period zones, the zone plate and Fresnel Diffraction.
2.8 Problems.

3: Polarization and Holography: (9L)

3.1 Introduction and Revision of Polarization.
3.2 Malus law, Double refraction,
3.3 Phase retarded plate, Quarter wave plate and half wave plate
3.4 Optical activity and Polarimeter
3.5 Introduction and Theory of Holography.
3.6 Importance of coherence and Principle of holography.
3.7 Characteristics, recording and reconstruction of Holography
3.8 Applications of Holography.
3.9 Problems.

4: Fibre Optics: (9L)

4.1 Introduction to Fibre Optics.
4.2 The Optical Fibre: Principle and Structure.
4.3 Fibre Optics: Numerical aperture and Acceptance angle, Pulse dispersion and Calculation of pulse dispersion.
4.4 Types of Optical Fibres: Concept of Mode, Multimode and Single mode fibre.
4.5 Attenuation in optical fibers, single mode and multimode fibers.
4.6 Fibre Optic communication system: Fiber optical telecommunication system.
4.7 Advantages of Fibre Optics.
4.8 Applications of Fibre Optics.
4.9 Problems.

Reference Books:

(1) Ghatak Ajoy, Optics 3rd Edition, The McGraw Hill companies.
(2) N. Subrahmanyam, A textbook of Optics, S. Chand publications.
(3) Optical Fiber and Fiber Optic communication System, S.K Sarkar S. Chand.
(4) Practical Optics, Naftaly Menn, Academic press (2004)
(5) M. Born and E. Wolf, Principles of Optics, Cambridge University Press
(6) F. A. Jenkins, H.E White, Fundamental of Optics, McGraw companies

List of Experiments : (Any 2)

(1) Determination of the numerical aperture of the given optical fibre.
(2) Determination of the optical power loss in attenuators.
(3) Fabry Perot Etalon
(4) To study the nature of polarization of laser light using photo cell and quarter wave plate.
(5)To determine the Brewster's angle for glass using a polarized monochromatic light source.

T.Y.B.Sc. (Physics) (Sem-V)
PHY-356 Elective-I (F): C# Programming

Lectures: 36 **(Credits-02)**

1: MS.NET Framework Introduction **(8L)**

• The .NET Framework - an Overview • Framework Components • Framework Versions • Types of Applications which can be developed using MS.NET • MS.NET Base Class Library • MS.NET Namespaces • The Common Language Runtime (CLR), Common Type System (CTS) • Common Language Specification (CLS) . Installing Required Software – SQL Server and Management studio

2: C # Language Syntax **(8L)**

• Datatypes • Global, Stack and Heap Memory • Common Type System • Reference Type and Value Type • Datatypes and Variables Declaration • Implicit and Explicit Casting • Checked and Unchecked Blocks – Overflow Checks • Casting between other datatypes • Boxing and Unboxing • Enum and Constant • Operators • Control Statements • Working with Arrays • Working with Methods • Pass by value and by reference and out parameters• Writing, testing and execution of program to understand general syntax and functions available in C#.

3: Database Programming Using ADO.NET **(8L)**

• Prerequisite - Knowledge of SQL Queries • Introduction and Evolution of ADO.NET • Understanding the Role of Managed Provider and ADO.NET Objects • connecting to Database and Connection Pooling • Performing Insert, Update and Delete Operations • Fetching Data from database - Executing Select Statements • How to implement Login facility with database

4: Interactive methods **(6L)**

Preparing flowchart, algorithm for interactive methods, Bisection Methods, Newton Rapson Method, Numerical integration by Trapezoidal rule, Simpson 1/3rd rule.

5: Hands on training: **(6L)**

Hands on training to execute numerical problems for interactive methods, Bisection Methods, Newton Rapson Method, Numerical integration by Trapezoidal rule, Simpson 1/3rd rule.

Reference Books:

1. C# 8.0 Pocket Reference: Instant Help for C# 8.0 Programmers
2. Programming in C# by E Balagurusamy
3. Beginning C# Object-Oriented Programming (English, Paperback, Clark Dan)
4. Pro C# 9 with .NET 5: Foundational Principles and Practices in Programming by Troelsen, Andrew, Japikse, Philip

Web References:

1. https://dotnet.microsoft.com/learn/csharp
2. https://docs.microsoft.com/en-us/dotnet/csharp/programming-guide/
3. https://www.pragimtech.com/courses/c-sharp-tutorial-for-beginners/
4. https://www.tutorialspoint.com/csharp/csharp_tutorial.pdf

List of Experiments: (Any 2)

1. Write a program that converts 1 lower case letter ("a" - "z") to its corresponding upper case letter ("A" - "Z"). For example if the user enters "c" then the program will show "C" on the screen.
2. Write a program using a switch statement that takes one value from the user and asks about the type of conversion and then performs a conversion depending on the type of conversion. If user enters:
3. Write a program using conditional operators to determine whether a year entered through the keyboard is a leap year or not.
4. Write a program using a for loop that prints the following output (you need to find a pattern to print letters in this order): A B D H P
5. Write a program using a loop that prints the following output. 1 2 2 3 3 3 4 4 4 4 5 5 5 5 5 6 6 6 6 6 6 . . . nth iteration.

T.Y.B.Sc. (Physics) (Sem-V)
PHY-356 Elective-I (G): Acoustics-I

Lectures: 36 **(Credits-02)**

1: Fundamentals of Sound:

Velocity of sound in fluids; Acoustic standards and reference conditions; Decibel scales: Intensity level (IL), Sound pressure Level (SPL), Sound Power Level (PWL); Problem-solving; Sound fields: Near, far, reverberant, and free. (6L)

2: Speech, Hearing and Community Noise Criteria:

Voice mechanism, acoustic power output of speech; Mechanism of hearing, thresholds of the ear; Equivalent continuous sound pressure level (L_{Aeq}); Perceived noise level (L_{EPN}); Audiometry (6L)

3: Architectural Acoustics and Audio Rooms:

Reverberation time: Concept and measurement, problem-solving relating to reverberation time; Management of sound absorption: porous absorbers, effect of density, thickness, airspace, acoustic tiles, foam board insulation, carpet absorption; Anechoic chamber; Haas effect and delay; Room modes: concept and room mode calculation; Room acoustics: Sound Transmission Class (STC), high-loss acoustic frame walls, acoustic floor, and ceiling systems (10L)

4: Resonators, Filters and Active Noise Control:

Helmholtz resonator; Acoustic, electrical, and mechanical analogues; Expansion chamber muffler, Active noise control: Noise Cancellation, Pros and cons of headphones, earphones, earbuds (8L)

5: Bioacoustics and Music:

Animal sounds: Bird songs, whale sounds - FFT and Wavelet Analysis (introductory) with examples; Pitch and timbre; Characteristics of musical notes: Vibrato, Tremolo, Portamento; Musical Instruments Digital Interface (MIDI) (6L)

Reference Books:

1. Fundamentals of Acoustics, L.E. Kinsler and A. R. Frey, Wiley Eastern
2. Audio and Video Systems, R. G. Gupta, Tata McGraw Hill, 2010
3. Acoustics, W.W. Seto, Schaum's Outline Series, McGraw Hill, 1970
4. Handbook of Sound Engineers, G.M. Ballou, Academic Press
5. Basic Acoustics, D.E. Hall, Oxford University Press
6. Design for good Acoustics and Noise Control, J. E. Moore, Univ. Press
7. Acoustics of Ducts and Mufflers, M. L. Munjal, John Wiley & sons

List of Experiments (Any two):

1. Transmission loss of an expansion chamber muffler.
2. Reverberation time measurement using a storage oscilloscope.
3. Calculation of room modes for a typical room and verification using an online mode calculator
4. Sound mapping using localized SPL measurement.
5. FFT: Square wave, animal sound recording

T.Y.B.Sc. (Physics) (Sem-V)
PHY-357: Physics Laboratory-3A

Lectures: 36 **(Credits-02)**

(General Laboratory, Electromagnetism, Atomic and Molecular Physics, and Optics)

(Any Eight)

GROUP-I: GENERAL PHYSICS (any FOUR)

1. Kater's pendulum
2. Moment of Inertia by Bifilar suspension
3. Young's modulus by Koeing method
4. Surface tension of mercury by ripple method
5. Surface tension liquid by Fergusson method
6. Surface tension of mercury by Quincke's method
7. 'Y' by vibration of wooden scale
8. Young's modulus by Newton's rings
9. Determination of wavelength of light by Michelson's interferometer
10. Study of damped oscillations of physical pendulum and finding log decrement

GROUP-II: ELECTROMAGNETISM (any TWO)

1. Study of forced oscillations by electromagnetically driven simple pendulum
2. Self-Inductance by Anderson's bridge
3. Core losses in transformers
4. Electromagnetic pendulum
5. Self-Inductance by Maxwell's bridge

GROUP-III: ATOMIC AND MOLECULAR PHYSICS AND OPTICS (any TWO)

1. Determination of Rydberg's constant
2. Zeeman Effect
3. Llyod's mirror
4. Determination of Resolving Power of grating
5. Determination of wavelength by Constant deviation spectrometer

Additional Activities (Any ONE)

- Demonstrations: Any 2 demonstrations equivalent to 2 experiments
- Study tour with report equivalent to 2 experiments
- Mini project equivalent to 2 experiments
- Computer aided demonstrations (simulations or animations)
  (Any 2 demonstrations equivalent to 2 experiments)

Note: *Students have to perform* ***ten*** *experiments or* ***one*** *additional activities in addition to* ***eight*** *experiments mentioned above. Total laboratory work with additional activities should be equivalent to* ***ten*** *experiments.*

T.Y.B.Sc. (Physics) (Sem-V)
PHY-358: Physics Laboratory-3B

Lectures: 36 **(Credits-02)**

GROUP-I: EXPERIMENTS USING CRO/INSTRUMENTATION (any TWO)

1. Charging and discharging of capacitor and RC time constant
2. Measurement of g using simple pendulum
3. Velocity of sound
4. Radiation detection
5. IV Characteristics of diode
6. Measuring a value of a capacitor using CRO.
7. Temperature controller using AD590
8. Study of IC 7490 as mod 2, mod 5, mod 7 and mod 10 counter.

GROUP-II: C-PROGRAMMING (any TWO)

1. Factorial of a number by simple and recursive method.
2. To find out the first 100 prime numbers
3. Matrix multiplication
4. Position time data using kinematic equations
5. Finding pressure using Van-der-Waals' equation of state

GROUP-III: COMPUTATIONAL PHYSICS (NUMERICAL BASED) (any TWO)

1. Roots of an algebraic equation (Bisection)
2. Roots of polynomial (Newton Raphson)
3. Numerical Integration by Trapezoidal rule
4. Numerical Integration by Simpson's 1/3 rule

GROUP-IV: PRACTICAL FROM OPTIONAL COURSE (Any TWO)

Additional Activities (Any ONE)

- Demonstrations: Any 2 demonstrations equivalent to 2 experiments
- Study tour with report equivalent to 2 experiments
- Mini project equivalent to 2 experiments
- Computer aided demonstrations (simulations or animations)
  (Any 2 demonstrations equivalent to 2 experiments)

Note: *Students have to perform* ***ten*** *experiments or* ***one*** *additional activities in addition to* ***eight*** *experiments mentioned above. Total laboratory work with additional activities should be equivalent to* ***ten*** *experiments.*

T.Y.B.Sc. (Physics) (Sem-V)
PHY-359: Physics Project-I

Lectures: 36 **(Credits-02)**

Guidelines:

It is expected that,

1. The student does work equivalent to about ten (10) laboratory experiments throughout the semester in the third year.
2. One bears in mind that the project work is a practical course and it is intended to develop a set of skills pertaining to the laboratory work apart from the cognition of students. Therefore, the guides should not permit projects that involve no contribution on part of student.
3. The project must have a clear and strong link with the principles of basic physics and/or their applications.
4. The theme chosen should be such that it promotes better understanding of physics concepts and brings out the creativity in the students.
5. The evaluation of the project work must give due credit to the amount of the project work actually done by a student, skills shown by the student, understanding of the physics concepts involved and the final presentation at the time of viva voce.
6. It is also recommended that a teacher will look after Four (4) projects at one time.
7. Practical examination will be conducted semester wise.
8. The student can perform an Experimental/Theoretical/Computational Project in Physics or interdisciplinary areas under the supervision of one or more guides.
9. The student can learn the basics of the topic chosen for project, to learn how to do literature survey and set up the basic experimental/theoretical and computational techniques needed for the project.
10. The department encourage to students for projects both in experimental and theoretical areas of Physics in collaboration with other institutes and industry.

The Project work shall consist of the following Criterions.

1. Project work is mandatory for all the T. Y .B. Sc. students.
2. All the T. Y. B. Sc. students will be have to complete the Project work prescribed by the Board of Studies in Physics of Savitribai Phule Pune University during the V^{th} Semester.
3. The Project work shall consist of the following Criterions.
    - It is expected that students must finalize the Title of Project, Aim and objective, Significance, Literature survey, Materials required, Method and Application etc.
    - Introduction to foundations of Project Work.
    - Introduction of Project Research Methodology.
    - Study of Data Collection Methods.
    - Project Problem Writing and Presentation Skills.

Evaluation weightage:

- Project-I: Semester End University Examination : 35 Marks
- Internal Examination: 15 Marks

Skill Enhancement Courses

Skill Enhancement Courses (SEC)

a) Selection of Skill enhancement courses

There are two skill enhancement courses (SEC) in 5th semester (PHY-3510 and PHY-3511). For 5th semester, there are four options available. The college has to select any one from the given four options. It is advised that college should not offer elective and skill enhancement course of same theme.

b) Teaching Learning process for Skill Enhancement Courses

Skill base courses are intended to explore the applications of physics knowledge. Learning in skill enhancement courses is largely experience based. The skill enhancement courses may be categorized as knowledge skill or technical skill. For knowledge skill courses one can use the conventional method for teaching along with problem solving, assignments seminars etc. For acquiring the technical skill, the students will get adequate 'hands-on' experience. The teachers may use demonstrations and activity-based learning techniques. On field visits, study tour and mini projects will enrich the learning experience of the students.

c) Assessment methods for skill enhancement courses

Continuous evaluation will be the best method for assessment of skill enhancement courses.

One can use tools like assignments, mini projects or activities, problems, etc and grade the students according to their performance. The internal assessment should have 50 % weightage.

The University examination may be conducted for the remaining 50%.

The University examination question paper should have adequate proportion of objective and subjective question.

d) List of Skill Enhancement Courses:

Semester-Vth	**Semester-Vth**
PHY-3510	**PHY-3511**
PHY-3510(H): Python Programming	PHY-3511(L): Physics Workshop Skill
PHY-3510(I): Energy studies	PHY-3511(M): Biomedical Instrumentation
PHY-3510(J): Introduction to Arduino	PHY-3511(N): Non-destructive Testing Techniques
PHY-3510(K): Sensors and Transducer	PHY-3511(O): Acoustics Applications

T.Y.B.Sc. (Physics) (Sem-V)
PHY-3510 SEC (H): Python Programming

Lectures: 36 **(Credits-02)**

Pre-requisite : Basic mathematics (XII-Science)
Version of python : 3.4
Proposed IDE : Spider, Py Charm or Jupyter

Python Programming:

Python is one of the top ten popular programming languages. Python is a general purpose and high level programming language. You can use Python for developing desktop GUI applications, websites and web applications. Also, Python, as a high level programming language, allows you to focus on core functionality of the application by taking care of common programming tasks. The simple syntax rules of the programming language further makes it easier for you to keep the code base readable and application maintainable. There are also a number of reasons why you should prefer Python to other programming languages.

Advantages of Python Programming

i.) Readable and Maintainable Code
ii.) Multiple Programming Paradigms
iii.) Compatible with Major Platforms and Systems
iv.) Robust Standard Library
v.) Many Open Source Frameworks and Tools
vi.) Simplify Complex Software Development
vii.) Adopt Test Driven Development

Objectives:

i.) To build foundation for understanding Python environment to enhance computational skills.
ii.) Understand variables, input and output functions in python and To Apply computational skill in problem solving approach of Physics
iii.) Get exposure to arithmetic, assignment, relational, logical and Boolean operators.
iv.) Be familiar with Python modules and Libraries

Course outcomes:

After completion of this course student will be able

i.) To write code for complex scientific computational requirement.
ii.) Use Libraries like NumPy for numeric computation
iii.) Use Library SciPy for scientific and technological calculations
iv.) Use Library Matplotlib for plotting of graph and its visualization.
v.) Develop own functions for Physics or mathematics.

Syllabus

a) Python Programming:

Unit No.	Topic	Lectures
1	**Introduction to Python Programming Language**: Introduction to Python Language, • Strengths and Weaknesses, • IDLE, Dynamic Types, • Naming Conventions, • String Values, • String Operations, • String Slices, • String Operators, • Numeric Data Types, • Conversions, • Built In Functions	03
2	**Data Collections and Language Component:** • Introduction, • Control Flow and Syntax, • Indenting, • The if Statement, • Relational Operators, • Logical, • Operators, • True or False, • Bit Wise Operators, • The while Loop, break and continue, • The for Loop, Lists, • Tuples, • Sets, • Dictionaries, • Sorting Dictionaries, • Copying Collections.	05
3	**Functions and Modules :** • Introduction • Defining Your Own Functions Parameters • Function Keyword and Optional Parameters • Passing Collections to a Function • Variable Number of Arguments Scope • Functions Passing Functions to a Function • Mapping Functions in a Dictionary	05

	• Modules • Standard Modules – sys • Standard Modules – math • Standard Modules – time • The dir Function	
5	**Modules and packages in Python :** • NumPy, SciPy • MathPlot etc	**05**

a) Demonstrations :

Sr. No.	Practical Demonstration to Communicate Concepts and Application in Physics, Electronics, Statistics and Mathematics
1	Write python program to use basic math and string operations.
2	Write python program to find roots of quadratic equation, prime numbers etc
3	Write python program to store data in list and perform matrix operation
4	Write python program to do numerical methods
5	Write python program involving tuples, dictionaries in problems related to physics or mathematical concepts
6	Write python program to use random number generator as probability density to show expected value is 0.5 to explain quantum mechanical behaviour of particle in one dimensional well.
7	Write python program to use NumPy library for more complex arithmetic operations
8	Write python program to use complex numbers and complex algebra
9	Write python program to use bitwise operation
10	Write python program to plot graphs using mathplotlib or similar library

Reference books:

- Python Programming: Using Problem Solving Approach. By Reema Thareja.
- Think Python By Allen Downey
- Problem Solving and Python Programming By Balguruswami McGrow Hill
- Let Us Python By Aditya Kanetkar
- Learning with Python By Allen Downey
- Data Analytics By Bharti Motwani

T.Y.B.Sc. (Physics) (Sem-V)
PHY-3510 SEC (I): Energy Studies

Lectures: 36 **(Credits-02)**

Course Objectives:

1. Students understand the comparative aspects, advantages and disadvantages of various sources of energy. They understand the facts and myths regarding the energy sources.
2. Students learn the basic principles involved and technologies developed in the uses of solar energy, biomass energy, wind energy, fuel cells.
3. Students understand the challenges and opportunities in conversion of energy from one form to another, generation of electricity and mechanical work using different energy sources.
4. Students get acquainted with challenges and recent trends in energy storage devices and they learn more about super-capacitors and batteries, electrical vehicles. They can imagine about future road maps in the fields of energy conversion and storage technologies.

Course Outcomes:

1. Students become capable of conducting energy audits and give consultancy in that field.
2. Students can design different types of solar heaters for small domestic as well as large scale community level applications.
3. Students acquire skills to implement solar P-V systems at domestic levels as well as for office premises and educational institutions. Students become able to start their own enterprise in net metering.
4. Students get ideas and hence become self-employed in the field of design , production, commissioning and implementation of bio-mass energy sources , bio-gas plants, gasifiers, wind mills, hybrid systems etc.
5. Students can go for research in the fields of super-capacitors, battery technologies, fuel cells and material synthesis for implementation of these technologies.
6. Students become successful entrepreneurs in the energy field.

Students strive to make the regions where they live and work self-sufficient in generating and fulfilling their own energy needs using different energy solutions.

Unit No.	Topic	Lectures
1	**An Introduction to Energy Sources:** Classification and comparison of energy sources (hydro, thermal, nuclear, solar, wind, biomass, and fossil fuels) considering environmental, safety, economy, production and distribution aspects. Facts and Myths about various sources of energy, thermal, nuclear sources of energy, Hybrid sources. Energy audit. Activity: 1. Energy audit of college campus/public campus/home/building 2. Comparison of energy sources. Visits to energy generation/distribution sites.	6
2	**Solar thermal Applications:** Sun as a source of energy, Solar Constant, Liquid flat plate collector, construction and working, Concentrating collectors, Solar drying, Solar water heating systems. Activity:	6

	1. Study of solar water heaters 2. Study of large scale solar heaters for industrial/cooking/water heating applications. 3. Study of flat plate, parabolic solar concentrators	
3	**Solar Photovoltaic systems Applications:** Photovoltaic principle, Power output and conversion efficiency, Limitation to photovoltaic efficiency, Basic photovoltaic system for power Generation, Application of solar photovoltaic systems, Advantages and disadvantages of Solar PV Systems. Configurations of Solar Photovoltaic Systems: Off-grid, Grid-Tied and Grid-Storage, Net metering and steps in installation of a rooftop solar PV System design. Activity: 1. Efficiency measurement of PV systems using I-V characteristics of Amorphous Si, Mono-crystalline Si, Polycrystalline Si in individual, series and parallel combinations. 2. Effect of intensity of incident light, incident angle and shading on Solar PV Module on Output power. 3. Study of design of solar lanterns, street lights using solar systems 4. Study of Installation and commissioning of roof top solar PV systems **5.** Study of net metering systems	8
5	**Biomass and wind energy:** Bio-mass conversion technologies, Bio-gas generation, Working of biogas plant, Bio-gas from plant wastes, Methods for obtaining energy from biomass, Thermal gasification of biomass, Introduction to wind energy, Classification and description of wind machines, Wind energy, Wind data. Activity 1. Visit to bio gas plant 2. Visit to bio diesel plants 3. Study of modified bio mass plants 4. Design and implementation of domestic/small scale biogas plants. 5. Study of different types of gasifiers 6. Study of wind mill / visit to wind mill	8
	Energy storage devices and electrical Vehicles : Recent trends in batteries, super-capacitors, fuel cells. Applications of storage devices: Electrical Vehicles (EV), Converter, Inverter, Controls & Controllers in EV, Future Trends in Electric Cars. Activity 1. Preparation and testing of fuel cell on Laboratory scale 2. Preparation and testing of super capacitors on Laboratory scale 3. Preparation and testing of paper batteries and other types of batteries on Laboratory scale. 4. Design and implementation of battery-operated toys using green technology	8

Reference books:

1. Non-conventional Energy sources- G. D. RAI (4th edition), Khanna Publishers, Delhi
2. Solar Energy - S. P. Sukhatme (Second Edition), Tata Mc Graw Hill Ltd., New Delhi.
3. Solar Energy Utilisation - G. D. RAI (5th edition), Khanna Publishers, Delhi.

4. Renewable Energy Technology: A practical guides of beginners, Chetan Singh Solanki, PHI Learning Private-Ltd., New Delhi.
5. Solar Photovoltaics: Fundamentals, Technologies and Applications, Chetan Singh Solanki, PHI Learning Private-Ltd., New Delhi

Note :

1. It is expected that students should undertake at least 1 activity from each unit and total 6 activities amounting to 18 lectures time.
2. Out of the total time allotted to each unit, half the time should be utilized for classroom teaching and remaining half for the activity.
3. Students should be encouraged to study this course by using Case–Study approach.

T.Y.B.Sc. (Physics) (Sem-V)
PHY-3510 SEC (J): Introduction to Arduino

Lectures: 36 **(Credits-02)**

Introduction:

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino board designs use a variety of microcontrollers. Boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various circuits. It has USB that is used for loading programs. Microcontrollers can be programmed using C / Python programming languages. This course will focus on creative thinking and on hands-on project development using Arduino Boards.

Objectives:

- To create general awareness and interest in Arduino Boards.
- To provide knowledge of different Arduino boards and various sensors and actuators.
- The course enables student to understand the basics of interfacing with Arduino Boards.
- To familiarize students with Arduino as IDE, programming language & platform and to Program basic Arduino examples.
- To provide knowledge of different Smart System applications.
- Develop skills to design and implement various smart system application.

Course Outcomes: After successful completion of this course, student will be able to

- Students will be able to understand and use various Arduino Boards, and its various components, Input / Output Pins, Input / Output Devices.
- Understand general concepts of Programming Arduino Boards.
- Apply the knowledge gain to design applications using Arduino in different domains.
- To analyze and evaluate the performance of various Arduino based devices.
- Learn and understand about any new IDE, compiler, and MCU chip in Arduino compatible boards or similar types.

Instructions: This course consists of two parts

- Part I: Theory and Part II: Practical / Project.
- Out of which 1 Credit is for Theory and 1 credit is for Practical work.
- Part II has two sub parts:
- Part II(A) : Practical / Demonstration & Part II(B) : Project. The A or B parts are optional, students can opt any one for 1 credit

Part I: Theory

Unit	Topics	Lectures
I : Introduction to Microcontrollers	• Introduction to Embedded Systems, Block Diagram, Single Board Computers (SBC) and System on Chip (SoC), Single Board Microcontroller (SBM), microprocessor vs microcontrollers, Basic system with microcontroller such as Arduino (SBM), Raspberry Pi (SoC) etc.	04

II : Introduction to Arduino and Arduino Programming	• **Arduino Basics:** What is Arduino, Advantages of Arduino, Arduino Types, Arduino Components, Arduino Uno Architecture • **Arduino Hardware:** Types of Arduino boards, Various components on Arduino Board, Various sensors and actuators: Overview of Sensors working, Analog and Digital Sensors	**06**
III : Introduction to Programming for Arduino	• **Arduino Software:** Integrated Simulation Environment (IDE), Setup the IDE, Arduino Libraries, What is Sketch, Writing Arduino Sketches, Serial Monitor, **Introduction to programming:** Fuctions, Variables & Basic Structure of Arduino (C++) Code, Basics Programs (Hello Word, Blinking of LED), Loading program through USB and Test performance of the System, Integration of Sensors and Actuators with Arduino	08

Part II (A): Arduino Programming (Practical / Demonstration) : Any 6 [18 L]

Simple Practical using Arduino Uno Board (Software + Hardware): Choose any-3 Practical from group-1 and any-3 practical from group-2. (Total = 6 practical)

Sr No	List of Practical's
	Group 1 : Any-3
1	Demonstration of Arduino Uno Board, Its Various Components, Pins
2	Installation Arduino Software (IDE) on computer, Introduction to Sketch, Loading of Program from computer, Simple programs: Hello Word, Blinking of LED on Arduino board etc.
3	Interfacing external LED (ON & OFF); Fading of LED
4	Analog Read Serial: 1. Read a potentiometer, print its state out to the Arduino Serial Monitor. 2. Read an analog input and prints the voltage to the Serial Monitor.
5	Digital Read Serial: Interfacing a switch, Read a switch, print the state out to the Arduino Serial Monitor.
6	Digital: Interfacing push Button: Use a push button to control an LED or Buzzer
7	Digital : State Change Detection: Count the number of button pushes.
8	Analog In Out Serial: Read an analog input pin, map the result, and then use that data to dim or brighten an LED.
	Group 2 : Any 3
9	Knock: Detect knocks with a piezo element.
10	Interfacing of Ultrasonic Sensor, Detect objects with an ultrasonic range finder.
11	Interfacing of Proximity Sensor

12	Interfacing of Temperature & Humidity Sensor : To interface DHT11 sensor for recording temperature and humidity readings with Arduino.
13	Interfacing LCD display with Arduino
14	Interfacing of Relay Switch and Servo Motor with Arduino
15	Interfacing Bluetooth Module to Arduino
16	Interfacing of Motion (PIR Sensor) or Light Sensor using (LDR & LED) or Gas Sensor (MQ-2) with Arduino

OR

Part II (B): Arduino Programming (Practical / Demonstration)

Project : any-1 Simple Projects Using Arduino Uno Board [18 L]

Sr No	List of Simple Projects
1	Line Following Robot with Arduino
2	Obstacle Avoiding Robot with Arduino
3	Weather Station using Arduino
4	Home Automation using Arduino
5	Android Based Air quality Monitor
6	Intelligent automatic irrigation system

References:

1. www.arduino.cc
2. https://www.arduino.cc/en/Tutorial/BuiltInExamples
3. https://create.arduino.cc/projecthub

T.Y.B.Sc. (Physics) (Sem-V)

PHY-3510 SEC (K): Smart Sensors and Transducer Technology

Lectures: 36 **(Credits-02)**

Course Objectives:

- To make students familiar with the constructions and working principle of different types of sensors and transducers.
- To make students aware about the measuring instruments and the methods of measurement and the use of different transducers.

Course Outcomes: At the end of the course, a student will be able to:

- Use concepts in common methods for converting a physical parameter into an electrical quantity
- Classify and explain with examples of transducers, including those for measurement of temperature, strain, motion, position and light
- Choose proper sensor comparing different standards and guidelines to make sensitive measurements of physical parameters like pressure, flow, acceleration, etc
- Predict correctly the expected performance of various sensors
- Locate different type of sensors used in real life applications and paraphrase their importance
- Set up testing strategies to evaluate performance characteristics of different types of sensors and transducers and develop professional skills in acquiring and applying the knowledge outside the classroom through design of a real-life instrumentation system.

Syllabus: **[18 L]**

1) **Mechanical and Electromechanical sensor:**
   Definition, principle of sensing & transduction, classification. Resistive (potentiometric type): Forms, material, resolution, accuracy, sensitivity. Strain gauge: Theory, type, materials, design consideration, sensitivity, gauge factor, variation with temperature, adhesive, rosettes. LVDT: Construction, material, output input relationship, I/O curve, discussion.
2) **Capacitive sensors:**
   Variable distance-parallel plate type, variable area- parallel plate, serrated plate/teeth type and cylindrical type, variable dielectric constant type, calculation of sensitivity. Stretched diaphragm type: microphone, response characteristics..
3) **Thermal sensors**:
   Material expansion type: solid, liquid, gas & vapor Resistance change type: RTD materials, tip sensitive & stem sensitive type. Thermo emf sensor: types, thermoelectric power, general consideration, Junction semiconductor type IC and PTAT type.
4) **Magnetic sensors:** Sensor based on Villari effect for assessment of force, torque, proximity, Wiedemann effect for yoke coil sensors, Thomson effect, Hall effect, and Hall drive, performance characteristics. Radiation sensors: LDR.

Activity: Any-6 **[18 L]**

Based on chapter I

1) Linear displacement measurement using potentiometric sensor.

2) Displacement/pressure measurement using strain gauge sensor.
3) Linear displacement measurement using LVDT.

Based on chapter II

1) Capacitive type transducer measure small displacement/force varying plate area/distance of plate/dielectric constant.
2) Displacement/pressure measurement using microphone.
3) Liquid pressure measurement using pressure sensor

Based on chapter III

1) Measurement of temperature using RTD .
2) Measurement of temperature using Thermocouple transducer.
3) Silicon diode as temperature sensor

Based on chapter IV

1) Magnetic sensor/Hall effect/proximity sensor based measurement magnetic susceptibility magnetisation
2) LDR based measurement light intensity etc.

Reference books:

1) R Sensor & transducers, D. Patranabis, 2nd edition, PHI
2) Instrument transducers, H.K.P. Neubert, Oxford University press.
3) Measurement systems: application & design, E.A.Doebelin, Mc Graw Hill
4) Sensor & transducers, D. Patranabis, 2nd edition, PHI
5) Instrument transducers, H.K.P. Neubert, Oxford University press.
6) Measurement systems: application & design, E.A.Doebelin, Mc Graw Hill

T.Y.B.Sc. (Physics) (Sem-V)

PHY-3511 SEC (L): Physics Workshop Skill

Lectures: 36 **(Credits-02)**

Objectives:

This course is to get exposure with various aspects of instruments and their usage through hands-on mode.

Course outcomes:-

After completion of this course students will able to handle and test various instruments.

Syllabus:

Unit-1. Basic of Measurement: 4L

- Accuracy, precision, sensitivity, resolution, range etc.
- Errors in measurements and loading effects.
- Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter.

Multimeter:

- Block diagram and working of a digital multimeter.
- Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance.
- Specifications of a multimeter and their significance.

Unit-2. Electronic Voltmeter: 4L

- Principles of voltmeter, Construction (block diagram only).
- Specifications of an electronic Voltmeter and their significance.
- AC Milli Voltmeter: Type of AC Milli Voltmeters
- Block diagram ac Milli Voltmeter,
- Specifications and their significance.

Unit-3. Cathode Ray Oscilloscope: 5L

- Block diagram of basic CRO.
- Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only-no mathematical treatment),
- Brief discussion on screen phosphor, visual persistence & chemical composition.
- Time base operation, synchronization. Front panel controls.
- Specifications of a CRO and their significance.
- Use of CRO for the measurement of voltage (dc and ac frequency, time period.
- Special featuresof dual trace oscilloscope.
- Introduction to digital oscilloscope, Block diagram and principle and working.

Unit-4. Signal Generators and Analysis Instruments: 2L

- Block diagram, explanation and specificationsof low frequency signal generators.
- Pulse generator, and function generator.

- Brief idea for testing, specifications. Distortion factor meter, wave analysis.

Unit-5. Impedance Bridges and Q-Meters: 3L

- Block diagram of bridge.
- Working principles of basic (balancing type) RLC bridge.
- Specifications of RLC bridge. Block diagram & working principles of a Q- Meter.
- Digital LCR bridges.

Activity: (Complete any activity of 18 L) (18 L)

1. Use of Digital multimeter.(3L)
2. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance. (3L)
3. To observe the limitations of a multimeter for measuring high frequency voltage and currents. (3L)
4. Measurement of voltage, frequency, time period and phase angle using CRO. (3L)
5. Measurement of rise, fall and delay times using a CRO. (3L)
6. To measure Q of a coil and its dependence on frequency, using a Q- meter. (3L)
7. Measurement of distortion of a RF signal generator using distortion factor meter. (3L)
8. Measurement of R, L and C using a LCR bridge/ universal bridge. (3L)

Reference Books:

1) A text book in Electrical Technology - B L Theraja - S Chand and Co.
2) Performance and design of AC machines - M G Say ELBS Edn.
3) Digital Circuits and systems, Venugopal, 2011, Tata Mc Graw Hill. Logic circuit design, Shimon P. Vingron, 2012, Springer.
4) Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3, 2012, Tata Mc-Graw Hill
5) Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

T.Y.B.Sc. (Physics) (Sem-V)

PHY-3511 SEC (M): Biomedical Instruments

Lectures: 36 **(Credits-02)**

Objectives

- Introduction to various bio-signals and their origin
- Understanding of electrode theory
- Use of transducers in biomedical instrumentation
- Patient safety while using biomedical instrumentation
- Instruments handling and analysis of the recorded data

Course Outcomes

- Students will acquire basic knowledge of biomedical instrumentation.
- Students can handle and operate different equipment's like ECG, Oxymeter, and Glucometer.
- Students will be able to record the different health parameters using it.
- Student will also able to analyze and interpret the recorded data.

Syllabus:

Unit-I: Physiological transducers **(7L)**

- Introduction to physiological transducers
- Classification of Transducer
- Performance characteristic of transducer.
- Displacement, position and motion transducer.
- Pressure transducer for blood pressure measurement
- Transducer for Body temperature measurement
- Biosensors

Unit-II: Bioelectric signals and cardiovascular system: **(7L)**

- Basics of signal measuring system
- Basic and essentials of biomedical instrumentation system.
- Heart and Cardiovascular system
- Resting and action potential, propagation of action potential, Passive and active conduction.
- Electro-conduction system of heart
- Blood Pressure measurement
- Heart Sounds, Phonocardiography
- Pulse oximetry

Unit-III: Electrocardiography: **(4L)**

- Introduction and Principle
- Interpretation of Electrocardiogram
- Block diagram of electrocardiograph, ECG machine maintenance and trouble shooting
- The ECG leads
- Effect of artifacts on ECG recording

- Types of ECG recorders

Activities: (Any 6: 3 Lecture hours each) (18L)

1. Study of ECG machine(Voltage gain , chart speed etc) and EEG placement of electrodes
2. ECG recording and analysis (Calculation of heart rate, measurement of peak amplitude and period of waves)
3. Study of anolog sphygmomanometer and digital BP monitor – Measurement of SBP, DBP and pulse rate
4. Measurement of pulse parameter using pulse oxymetry /pulse measuring instrument
5. Use of biosensor (sugar level measurement / skin resistance).
6. To study Infrared sensor/ temperature gun and measuring values
7. Study of BMI/ body composition monitor and measurement of physiological parameters (BMI, % Body fat,
8. First aid for heart patient – study and practice
9. Study of Spirometer and practice for increasing lung capacity
10. Visit to established hospital

Reference Books:

1. Biomedical Instrumentation and Measurements (Second edition) - Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer Pearson education.
2. Handbook of Biomedical Instrumentation (Second Edition) - R. S. Khandpur (Tata McGraw Hill).
3. Biomedical Instrumentation and Measurement by Carr and Brown-Pearson.
4. Biomedical instruments and measurements (Second edition) - R. Ananda Natarajan Eastern economy edition
5. A textbook of Biomedical engineering edited - R.M. Kenedi, blackie (Glasgow & London)
6. Medical instrumentation: Application and design (Third edition)- John G. Webster, Willey India Education

Required Equipment with Probable cost:

1. Electro Cardiogram- ECG machine- analog- Rs. 30000/-
2. SPO_2 meter- Analog- Rs. 3000/-
3. Fat Meter- Digital- Rs. 4000/-
4. Sphygmomanometer – Digital and analog: Rs. 3000/- each
5. Glucometer- Digital: Rs.2000 each.

T.Y.B.Sc. (Physics) (Sem-V)

PHY-3511 SEC (N): Nondestructive Testing Techniques

Lectures: 36 **(Credits-02)**

Objective:

- To study and understand the various non-destructive testing (NDT) methods, and their industrial and scientific applications.

Outcomes:

- After completion of this course the students will be able to use NDT methods for defects and characterization of industrial components.

Unit No.	Topics	Lectures
I	Definition and objectives of NDT, introduction to materials testing, purpose of testing and properties of materials, classification of material testing, destructive testing and its examples only, Definition, Characteristics detected, principle, advantages, limitation and applications of various methods like Visual inspection, liquid penetrant testing, magnetic particle testing, thermography testing, eddy current testing, ultrasonic testing, acoustic emission testing, radiography testing,	6
II	What are the discontinuities, Types of discontinuities in materials? Processing the discontinuity, service induced discontinuity, factors for selection of NDT method in different cases of discontinuity, brief description of equipment used in visual testing method, Principles of liquid penetrant method, stages of liquid penetrant process, liquid penetrant process flow chart, chemical and solvent cleaning methods of surface preparation, how to apply and removal of excess penetrant?, application of developer, and observation of defects, penetrant, their types and properties, role of developer, their types, Magnetic particle testing method, procedure of Magnetic particle testing methods, portable magnetization equipment and stationary magnetization equipment, dry and wet particle inspection techniques and stages involved in it and its applications	6
III	Thermography testing, basics of infrared theory, range characteristics, wavelength, frequency, emission, convection, conduction, reflection, transmission, emissivity of infrared, basic principles of thermography testing, elements of infrared detection system, thermography testing active and passive approach, basics of eddy current testing, working principles of eddy current testing, stages in eddy current testing, factors influencing in eddy current testing, Ultrasonic testing and its methods (transmission and pulse echo method), Acoustic emission testing, factors influencing acoustic wave propagation and data acquisition, instrumentation of acoustic emission testing, Radiography testing, principle, various stages in testing, gamma ray radiography testing, SWSI and DWSI techniques in X ray testing, Fluoroscopy testing arrangement and working principle, Computed tomography in NDT	6

Activity: Any-6 demonstration activities from the followings (each activity will be equivalent to 3-hrs)

1. Video demonstration of any two NDT techniques
2. Study of different X ray photograph and MRI scan photographs in medicine
3. Study of NDT by acoustic method
4. Surface visual study of defects of various objects provided
5. Study of surface defects by liquid penetration method
6. Study of surface defects by liquid leak method
7. Study of surface defects by liquid spray method
8. Study of surface defects by using UV light and fluorescent liquid method
9. Visit to any industry and observing NDT method live (equivalent to two demonstrations)
10. Audio visual expert lecture of industrialist who is using NDT method for quality control.

Reference Books:

1. Non- destructive testing of materials, Dr V. Jaykumar, Dr. K. Elangovan, Lakshmi Publications, Tamilnadu, India.
2. Practical non-destructive testings, Baldev Raj, T. Jaykumar, M. Thavasimuthu, Narosa Publications
3. Basics of non-destructive testings, Lari and Kumar, S.K. Kataria& Sons publications
4. Non-destructive testing techniques, Ravi Prakash, New Age International Private Limited
5. Non-destructive test and evaluation of materials, J. Prasad, C.G.K. Nair, McGraw Hill Education

T.Y.B.Sc. (Physics) (Sem-V)
PHY-3511 SEC (O): Acoustics Applications

Lectures: 36 **(Credits-02)**

Objective:

To study and understand about sound physics, properties and their applications.

Outcomes:

After completion of this course the students will be able to use sound detection and characterization of sounds.

Syllabus:

Unit-1. Environmental Acoustics (3 L)

1.1 Environmental Noise: sonic boom, aircraft flyover, foot-fall noise, slammed door

1.2 Weighted sound levels: Sound level meters, A-weighted & C-weighted sound level, Phon, Sone,

1.3 Noise rating: Community noise: Highway noise, Aircraft noise

1.4 Noise induced hearing loss: Chronic, Trauma.

1.5 Mufflers: Automobile, Silencers, Transmission loss,

Unit-2. Sound Reinforcement Systems (5 L)

2.1 Microphones- Types, selection criteria, Professional grade, sensitivity, FM microphones

2.2 Loudspeakers- Direct Radiator type, Horn- Folded and Flared horn, Woofer, Squawker, Tweeter, Loudspeaker Cabinets- Enclosed cabinet, Open Cabinet, Bass Reflex Cabinet,

2.3 Amplifiers: Public Address systems, Gain and Bandwidth

2.4 Headphones- Noise cancellation features

2.5 Acoustic Delays

2.6 Synthesizers, Graphic equalizers, mixers

2.8 Basics of Audio Signal Processing

2.9 Monophonic and Stereophonic Systems

Unit-3. Musical Acoustics **(**4 L)

3.1 Pitch, timbre, rhythm, intensity, loudness, consonance, dissonance, Bass, Treble, Harmonics and Overtones

3.2 Standing waves, interference, beats, harmony, melody

3.3 Octave: Musical Scales

3.4 Types of Musial Instruments: String - violin, guitar, Wind - Brass, Reed instruments, organ, Percussion - Drums, Tabla

3.5 MIDI - Musical Instruments Digital Interface

3.6 Audio file formats: MP 3 and MP 4 systems

Unit-4. Room Acoustics (2 L)

4.1 Growth and decay of sound in live rooms

4.2 Sabine Equation, Reverberation time measurement methods

4.3 Room modes, Sound absorption materials

4.2 Speech Intelligibility: Articulation Test, Articulation Score

Unit-5. Acoustics in Medicine & Ultrasound (2 L)

5.1 Audiometry and Hearing loss

5.2 Ultrasonography
5.3 Ultrasonic Transducers
5.4 Ultrasonic cleaning, Non Destructive Testing (NDT)

Unit-6. Underwater Acoustics (2 L)

6.1 Speed of sound in sea water, Transmission loss
6.2 Sonar: Active and Passive Sonar

Activities: Any-6 **[18L]**

1. Frequency response of loudspeaker
2. Polar characteristics of a microphone
3. Study of Graphic Equalizer
4. Estimation and measurement of reverberation time
5. Expansion chamber mufflers Transmission Loss (TL)
6. Online calculators for Room Modes

Reference Books:

8. Fundamentals of Acoustics, L.E. Kinsler and A. R. Frey, Wiley Eastern
9. Audio and Video Systems, R. G. Gupta, Tata McGraw Hill, 2010
10. Acoustics, W.W. Seto, Schaum's Outline
11. Handbook of Sound Engineers, G.M. Ballou, Academic Press
12. Basic Acoustics, D.E. Hall, Oxford University Press
13. Design for good Acoustics and Noise Control, J.E. Moore, University Press

Semester-VI

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-361: Solid State Physics

Lectures: 36 **(Credits-02)**

1: The Crystalline Structures **(10 L)**

Lattice, Basis, Translational Vectors, Primitive Unit Cell, Symmetry Operations, Different types of lattices: 2D and 3D (Bravais lattices) Miller indices, Inter Planer Distances, SC, BCC and FCC structures, Packing Fraction, Crystal structures NaCl, diamond, CsCl, ZnS, HCP, Concept of Reciprocal Lattice and its properties, Problems

2: X ray Diffraction and Experimental Methods **(9 L)**

Bragg's Diffraction, Bragg's Law, Experimental X-ray diffraction Methods: The Laue Method, Bragg's Spectrometer, The Powder Crystal Method, Analysis of cubic structure by Powder Method, Ewald's Construction, Bragg's Diffraction condition in direct and reciprocal lattice, Problems

3: Free Electron and Band Theory of Metals **(9L)**

Assumptions of Classical and Somerfield Free Electron model, Energy levels and Density of States (One and Three Dimensions), Nearly free electron model, Fermi energy, Fermi level, Hall Effect, Mobility, Hall Angle

Band Theory of Solids: Origin of energy gap, Energy bands in Solids, Distinction between metal, semiconductor and insulator, Problems

4: Magnetism **(8L)**

Diamagnetism, Langevin theory of Diamagnetism, Paramagnetism, Langevin theory of Paramagnetism, Ferromagnetism, Antiferromagnetism, Ferromagnetic Domains, Hysteresis, Curie temperature, Neel temperature, **Superconductivity**, Problems

Reference books:

1. Solid State Physics S.O.Pillai, 6th Edition, New Age International (P) Ltd, Publisher, (2010).
2. Solid State Physics – Kakani S.L. and Hemrajani C, 4th Edition, S. Chand Publication (2005).
3. Fundamentals of Solid State Physics – B.S.Saxena, R.C.Gupta and P.N.Saxena, Pragati Prakashan, Meerut , Uttar Pradesh
4. Introduction to Solid State Physics- Charles Kittel, John Wiley and Sons, 7th Edition.
5. Solid State Physics- A.J.Dekker, Macmillan India Ltd, (1998).
6. Solid State Physics- R.K. Puri, V.K. Babbar, S. Chand Publication.
7. Elementary Solid State Physics Principles and Applications, M Ali Omar, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.(2006)
8. Problems and Solution in Solid State Physics-S.O. Pillai, New Age International (P) Ltd.
9. Solid State Physics, P.K. Palanisamy, Scitech Publications(India) Pvt Ltd, Chennei, 1st Edition (2004)
10. Solid State Physics: Essential Concepts, David W. Snoke, 2nd Edition, Cambridge University Press

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-362: Quantum Mechanics

Lectures: 36 **(Credits-02)**

1: Origin of Quantum Mechanics (08 L)

1. Historical Background: Black body radiation, photoelectric effects.
2. Matter waves - De Broglie hypothesis. Davisson and Germer experiment.
3. Wave particle duality
4. Concept of wave function, wave packet, phase velocity, group velocity and relation between them
5. Heisenberg's uncertainty principle with Electron diffraction experiment, different forms of uncertainty.
6. Different fields of applications of quantum mechanics
7. Problems

2: The Schrodinger equation (10 L)

1. Physical interpretation of wave function
2. Schrodinger time dependent equation.
3. Schrodinger time independent equation.(Steady state equation).
4. Requirements of wave function.
5. Probability current density, equation of continuity, and its physical significance.
6. An operator in Quantum mechanics, Eigen function and Eigen values.
7. Expectation value, Ehrenfest's theorem (Only statements)
8. Problems

3: Applications of Schrodinger Steady state equation (14 L)

1. Free particle.
2. Step potential.
3. Potential barrier. (Qualitative discussion). Barrier penetration and tunnelling effect.
4. Particle in infinitely deep potential well (one - dimension).
5. Schrodinger's equation in spherical polar co-ordinate system.
6. Rigid rotator (free axis).
7. Problems

4: Operators in Quantum Mechanics (4 L)

1. Hermitian operator.
2. Position, Momentum operator, angular momentum operator, and total energy operator (Hamiltonian).
3. Commutator brackets- Simultaneous Eigen functions.
4. Commutator Algebra
5. Commutator bracket using position, momentum and angular momentum operator
6. Concept of parity according to quantum mechanics, parity operator and its Eigen values.
7. Problems

Reference books:

1. Eisberg, Robert M., and Robert Resnick. *Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles*. Wiley, 1985. ISBN: 9780471873730.
2. Liboff, Richard L. *Introductory Quantum Mechanics*. Addison Wesley, 2002. ISBN: 9780805387148.
3. Griffiths, David J. *Introduction to Quantum Mechanics*. Upper Saddle River, Pearson Prentice Hall, 2005. ISBN: 9780131118928
4. Feynman, Richard P., Robert B. Leighton, and Matthew L. Sands. *The Feynman Lectures on Physics*. Addison Wesley, 1989. ISBN: 9780201500646.
5. P M Mathews and K Venkatesan, *A Textbook of Quantum Mechanics*, Tata McGraw Hill publication, *ISBN*. : 9780070146174
6. N. Zettili, *Quantum Mechanics- Concepts and applications*, Wiley publication, *ISBN*: 978-0-470-02679-3
7. Ajoy Ghatak, S. Lokanathan, *Quantum Mechanics: Theory and Applications*, Springer Publication, *ISBN* 978-1-4020-2130-5
8. G Aruldhas, *Quantum Mechanics*, Phi Learning Private Ltd., *ISBN* : 97881203363
9. Shankar, Ramamurti. *Principles of Quantum Mechanics*. Springer, 2008. ISBN: 9780306447907.
10. Gupta, Kumar & Sharma, *Quantum Mechanics*, Jai Prakash Nath Publications.

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-363: Thermodynamics and Statistical Physics

Lectures: 36 **(Credits-02)**

1: **Transport phenomenon and Maxwell's relations:** **(9L)**

Mean free path, Transport phenomenon, Viscosity, Thermal conductivity and diffusion.
Thermodynamic functions: Internal Energy, Enthalpy, Helmholtz function, Gibb's function,
Derivation of Maxwell Relations, Specific heat and latent heat equations, Joule Thomson effect (Throttling Process), Problems

2: Elementary Concepts of Statistics: **(9L)**

Probability, distribution functions, Random Walk and Binomial distribution, Simple random walk problem, Calculation of mean values, Probability distribution for large-scale N, Gaussian probability distributions, Problems

3: Statistical Distribution of System of Particles and Ensembles: **(12L)**

Specification of state of system, Statistical ensembles, Basic Postulates, Probability calculations, Behaviors of density of states, Thermal, Mechanical and general interactions
Micro canonical Ensemble (Isolated System), Canonical ensembles, simple application of canonical ensemble, Molecules in Ideal gas, Calculation of mean values in canonical ensemble.
Problems.

4: **Introduction to Quantum Statistics**: **(6L)**

Quantum distribution function, Maxwell-Boltzmann's statistics, Bose-Einstein Statistics, Fermi-Dirac Statistics, Comparison of the distributions. Problems.

Reference books:

1) Lokanathan, R.S. Gambhir, Statistical and Thermal physics
2) F. Reif, Fundamentals of statistical and thermal physics
3) A. Beiser, Perspectives of modern physics
4) B.B. Laud, Fundamental of Statistical Mechanics
5) R.B. Singh, A primer of Statistical Mechanics
6) Gupta, Kumar, Statistical Mechanics

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-364: Nuclear Physics

Lectures: 36 **(Credits-02)**

1: Nuclear Structure, Properties and Radioactivity: (12 L)

Basic Concept of Nucleus:

- Composition, charge, size, density of nucleus(Revision)
- Nuclear Angular momentum,
- Nuclear magnetic dipole moment
- Electric quadrupole moment, Parity & symmetry,
- Mass defect and Binding energy, packing fraction,
- Classification of nuclei,
- Stability of nuclei (N Vs Z Curve) and problems.

Radioactivity:

- Radioactivity disintegration (concept of natural and artificial radioactivity, Properties of α, β, γ-rays, Laws of radioactive decay, half-life, mean life, Specific activity and its units (Revision)
- Successive disintegration and equilibriums and radioisotopes.
- Radiocarbon dating
- Application of radioactivity (Agricultural, Medical, Industrial, Archaeological).
- Problems

Ref.(1) Ch.(2,3), Ref.(3) Ch.(3, 6)

2: Particle Accelerator and Radiation Detectors: (06 L)

Particle Accelerators:

- Introduction and Classification
- Linear Accelerator (electron/proton LINAC)
- Cyclic Accelerator (Cyclotron)
- Particle Accelerators In India (Discussion only)

Ref.(1) Ch.(12)

Nuclear Detector:

- Classification of Nuclear Detectors
- Gas filled Detectors (G. M. counter)
- Solid state detectors (scintillation counter)
- Problems:

Ref.(2) Ch.(4), Ref.(3) Ch.(7, 15)

3: Nuclear forces and Nuclear Models: (09 L)

Nuclear Forces:

- Classification of Nuclear Forces
- Meson theory of nuclear forces,
- Properties Of nuclear forces, properties of deuteron system,

- Elementary particles,
- Quarks model for elementary particles
- Shell Model: Assumptions, Evidences, and Spin and Parity limitations.
- Liquid drop model: Assumptions
- Semi-empirical B.E. formula
- Problems:

Ref.(1) Ch.(9, 17, 18), Ref.(3) Ch.(18)

4: Nuclear Reactions and Reactor Theory: (09 L)

Introduction to Nuclear reactions:

- Nuclear Reaction, Conservation laws (Revision)
- The Q-value equation, Exothermic and Endothermic reaction
- Compound nucleus
- Threshold energy
- Nuclear cross-section
- Nuclear fission , nuclear fusion stellar energy, chain reaction and critical mass,
- Nuclear reactor and its basic components, homogeneous and heterogeneous reactors, power reactor, fast breeders
- Nuclear Reactors In India (Discussion only)
- Problems.

Ref.(1) Ch.(14, 15), Ref.(3) Ch.(11, 13, 14)

Reference books:

1. Dr. S. N. Ghoshal, Nuclear Physics, Revised Edition, S. Chand Publication, 2014
2. D. C. Tayal, Nuclear Physics, Revised Enlarged Edition, Himalaya Publishing House.
3. K.S. Krane, Introductory Nuclear Physics, Wiley, India, 1988
4. B. L. Cohen, Concepts of Nuclear Physics, Tata McGraw Hill
5. I. Kaplan, Nuclear Physics, 2nd Edition, Narosa, New Delhi, 1989
6. S.B. Patel, Nuclear Physics: An Introduction, New Age International, 1991

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-365 (A): Electronics-II

Lectures: 36 **(Credits-02)**

1: Semiconductor Devices: **(9L)**

a. LED and Photodiode, Optocoupler. (Working Principles) Problems. Ref. 1.
b. BJT: Transistor amplifier classifications - Class A, B, C and AB (working only), Differential amplifier (transistorized), Problems. Ref. 1.
c. Field Effect Transistor: JFET (Introduction, classification, principle, working and IV characteristics) MOSFETs (DE-MOSFET and E only MOSFET). Problems. Ref. 1

2: Applications of Semiconductor Devices: **(9L)**

a. Three Pin Regulators: Block diagram of 3-pin IC regulator, study of IC-78XX, 79XX. Dual Power Supply using IC-78XX, 79XX. Ref. 1
b. Switching Regulators (SMPS): Introduction, Block diagram, Advantages and Disadvantages. Ref. 4
c. Modulation and Demodulation : Concept of Carrier Wave, Need of Modulation and Demodulation, Methods of Modulation like AM, FM, PM (Concepts Only),
d. Concept of Modulation Index, Upper and Lower Side Band Frequencies in AM. Problems, Ref.3

3: Integrated Circuits: **(9L)**

a. Integrated Circuits: Introduction, Scale of Integration, Advantages and drawbacks of IC Ref.4
b. OP-AMP Applications as Integrator, Differentiator, Comparator. Ref. 1
c. Timer IC-555: Block diagram, Astable, monostable multivibrator (working and design). Problems, Ref. 1

4: Combinational and Sequential Circuits: **(9L)**

a. Combinational Circuits: Introduction to SOP and POS equation. Concept of Standard SOP and POS equation. Concept of K-map and their use in reduction of Boolean expressions, design of half adder, full adder, half subtract, Study of binary to gray and gray to binary code conversion. Problems. Ref. 2
b. Sequential Circuits: RS flip flop using NAND/NOR, clocked RS, D, JK and T-flip flops. Application of flip flops in Sequential Circuits as Counters and Registers. Asynchronous and Synchronous Counters. (3-bit Counter), Shift Registers and their types of operation -SISO, SIPO, PISO, PIPO (Concepts only). Ref. 2

Reference books:

1. Malvino, Electronic Principles (6th Ed.), Tata McGraw Hill, New Delhi
2. R. P. Jain, Modern Digital Electronics (3rd Ed.), Tata McGraw Hill, New Delhi
3. B. L. Theraja, Basic Electronics - Solid State, S. Chand and Company, New Delhi
4. K. R. Botkar, Integrated Circuits, Khanna Publishers, Delhi

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-365 (B): Advanced Electronics

Lectures: 36 **(Credits-02)**

(Important Note: This course is designed for the student who has offered Electronics as one of the subjects at S.Y.B.Sc. level**)**

1: Sensors: **(9L)**

Introduction to Sensors: Revision of temperature measurement and Pressure Measurement.

Motion sensors: Types of motions, Accelerometers' principles, Types of accelerometers, applications.

Optical sensors:

Photo detectors, Photo detector characteristics, photoconductive detectors, photo voltaic detectors, Photodiode detectors, photo emissive detectors.

Pyrometry: Thermal radiation, Broadband pyrometers, Narrowband pyrometers.

Optical sources: Conventional light sources, Laser light sources and principles.

Applications: Label inspection, Turbidity, Ranging.

2: Analog Signal Conditioning: **(11L)**

Introduction to analog and digital signals: Analog Multiplexer and De-Multiplexer using Ic-4051, Ideal & Practical characteristics of Low Pass, High Pass, band pass and band reject filters. 2nd order active low pass and high pass filter using op-amp. Instrumentation amplifier using 3-OP-AMP, Application of Instrumentation Amplifier as thermocouple signal conditioning. Interpretation of integrator and differentiator as low pass and high pass filters respectively.

3: Digital signal conditioning: **(10L)**

Digital Multiplexer and De-Multiplexer using NAND gate, Priority encoder using Ic-74148, Decoders: 2 to 4 decoder and 3 to 8 Decoder.

Signal Converters:

DAC: R-2R ladder type DAC, Binary weighted DAC.

ADC: Single slope ADC, Successive Approximation ADC, Flash ADC.

Data Acquisition System using 3-channels

4: Introduction to Process Control: **(6L)**

Block diagram of Process control, Process control using ON-OFF controller, Op-amp and temperature sensor, Process control using Proportional Control Logic, Definition of Process LAG, and Problems.

Reference books:

1. C.D. Johnson, Process Control Instrumentation Technology, Pearson Education, 8th edition.
2. Krishna Kant, Computer Based Industrial Control, Eastern Economic Edition
3. Rangan, Mani, Sharma, Instrument of Device System
4. B. C. Nakra, K. K. Chaudhari, Instrument measurement and analysis

PHY-356: Elective-II

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-366 Elective-II (P): Medical Electronics

Lectures: 36 **(Credits-02)**

1: Introduction: **(9L)**

1. 1 Terminology of medical instrumentation,
1.2 Physiological system of body
1.3 Sources of bioelectric signals,
1. 4 Origin of bioelectric signals,
1.5 Analysis of ECG pattern
1.6 Nernst equation
1.7 Various types of bioelectric signals,
1.8 Basic medical instrumentation system,
Problems
Ref: 1

2: Bio potential Electrodes and sensors: **(9L)**

2.1 Electrode-electrolyte interface,
2.2 Polarizable and non-polarizable electrodes,
2.3 Electrodes for ECG, EEG, EMG,
2.4 Resistive sensor
2.5 Capacitive sensor
2.6 Inductive sensor
2.7 Piezoelectric sensor
2.8 Temperature sensor
Problems
Ref: 2

3: Amplifiers and Signal Processing: **(9L)**

3.1 Introduction
3.2 Basic amplifier requirements
3.3 The Differential amplifier
3.4 Common mode rejection
3.5 Instrumentation amplifier
3.6 Isolation amplifier
3.7 Pateint safety
3.8 Cardiac monitor
Problems
Ref: 2

4: Measurements of Pressure and Volume Flow of Blood: **(9L)**

4.1 Direct measurements of blood pressure,
4.2 Indirect measurements of BP.
4.3 Heart sounds,

4.4 Phonocardiography,

5.4 Ultrasonic blood flow meter

5.5 Laser Doppler blood flow meter

Ref: 1

Reference books :

1. Handbook of Biomedical Instrumentation, R.S. Khandpur
2. Medical Instrumentation application design, John G Webster, Houghon Mifflin Co.
3. Clinical Biophysics, P. Narayanan
4. Introduction to biomedical equipment technology J. Carr and John M. Brown
5. Introduction to Biomedical Electronics, Joseph DfuBovy, Mc Graw Hill.

List of Experiments: (Any Two)

1. Measurement of BP using Mercury sphygmomanometer and digital BP monitor
2. Study of ECG machine. Gain, chart speed arrangements and positioning electrodes
3. Recording of ECG and its analysis.
4. Absorbance using calorimeter/ Absorption spectra using Spectrophotometer.
5. Pulse oximetry. Measurement of SpO2
6. Use of thermal scanner/Thermal gun
7. Study of glucometer as a sensor and measurement of BSL

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-366 Elective-II (Q): Physics of Nanomaterials

Lectures: 36 **(Credits-02)**

1: Introduction to nanomaterials: **(10 L)**

- Introduction to Nano-sized materials and Structures
- Significance of Nano-size
- Properties of Nanomaterials: Mechanical, Electrical, Thermal and Optical properties
- Classification of nanostructured materials

2: Methods for Synthesis of Nanomaterials: **(08 L)**

- Bottom-up and Top-down approaches
- Classification of Synthesis Techniques: Vapour phase and Liquid phase approach.
- Synthesis Methods: Thermal Evaporation, Sputter deposition, Colloidal method, Sol-gel Method, Chemical Vapour deposition and Electrochemical Deposition.

3: Characterization techniques: **(08 L)**

- Over view of structural characterization of nanomaterials by XRD
- Microstructural characterization and elemental analysis of nanomaterials using Scanning electron microscopy (SEM)and Energy Dispersive Spectroscopy (EDS)
- Structural characterization of nanomaterials using Transmission electron microscopy (TEM)
- Optical characterization of nanomaterials using UV- visible spectroscopy

4: Special nanomaterials: **(04 L)**

- Carbon nanotubes, their types and properties
- Quantum dots and their properties

5: Applications: **(06L)**

- Nanomaterials for application in Nano-electronics, Cosmetics, Medical, Biosensors Automobiles, Space, Sports, Cloth industry etc.
- Nanomaterials for environmental pollution monitoring and reduction etc.
- Nanomaterials for energy generation and storage

Reference books :

1. Nanotechnology: Principles and Practices by Sulbha Kulkarni, Capital Publishing Co. New Delhi.
2. Introduction to nanotechnology, by C. P. Poole Jr. and F. J. Ownes, Willey Publications.
3. Origin and development of nanotechnology by P. K. Sharma, Vista International publishing house.
4. Nanostructure and nanomaterials synthesis, Properties and applications, by G. Cao, Imperials College Press, London.
5. The chemistry of nanomaterials: Synthesis, properties and applications, C. N. R. Rao, A. Muller, A. K. Cheetham (Eds) Wiley VCH Verlag Gmbh& Co, Weinheim, 2004.

List of experiments: (Any Two)

1. Synthesis of metallic nanoparticles by wet chemical method.
2. Synthesis of Metal Oxide Nanoparticle using different techniques.
3. Synthesis of silver nanoparticles from silver nitrate by colloidal solution method.
4. Study of optical absorption of nanoparticles.
5. Determination of crystallite size from X-ray diffraction spectra.

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-366 Elective-II (R): Microcontrollers

Lectures: 36 **(Credits-02)**

1: ARCHITECTURE OF 8051: **[10L]**

1.1 Comparison of Microprocessor and Microcontroller,

1.2 Intel 8051 Microcontroller: Block Diagram and Functions of each block, Pinout details, A and B CPU registers, Program status word (PSW) register, Program Counter, Data Pointer, Stack and Stack Pointer.

1.3 Memory Organization of 8051, Internal RAM, Register Banks, Special function registers, Internal ROM, I/O Ports and their functions, Oscillator and Clock.

2: 8051 ASSEMBLY LANGUAGE PROGRAMMING: **[16L]**

2.1 Introduction to 8051 Assembly programming, 8051 data types and assembler directives, Different Addressing modes, Concept of Unsigned and Signed numbers.

2.2 Instruction Set of 8051 microcontroller: Data Transfer instructions, Arithmetic Instructions, Logic and compare instructions, rotate instructions, Branch (Jump, Call RET) instructions.

2.3 Use of Instruction Set in Assembly Language Programming.

3: 8051 INTERRUPTS, TIMERS/COUNTERS AND SERIAL COMMUNICATION: **[10L]**

3.1 Interrupts and their vector structure, IE register, Interrupt priority in the 8051

3.2 Timers and Counters: Use of Basic Registers in Programming 8051 timers, Timer/ Counter Operation modes. Problems on Timer clock frequency and its Period.

3.3 Basics of Serial Data Communication, Types of Serial Data Communication, Concept of Baud Rate, RS 232 Standards, 8051 connection to RS 232, Functions of SBUF and SCON Registers.

Reference Books:

1. 8051 Microcontroller by Kenneth J. Ayala.
2. 8051 Microcontroller and Embedded Systems using Assembly and C by Mazidi and D Mac Kinlay, 2006 Pearson Education Low Price Edition.
3. 8051 Microcontroller – Hardware, Software and Applications by V Udayashankara, M S Mallikarjunaswamy, McGraw Hill Education (India) Pvt.Ltd, New Delhi.
4. Microprocessor and Microcontroller by R. Theagarajan, Sci Tech Publication, Chennai
5. Programming customizing the 8051 Microcontroller by Myke Predko, Tata McGraw Hill

List of Experiments : (Any Two)

Use Keil / Pinacle software for:

1. Addition of two 16 bit numbers
2. Multiplication of two 8 bit numbers.
3. Write a program to find largest/smallest number of N numbers in given block.
4. Memory block transfer from one location to another.
5. Find one's and two's complement of given number.
6. Subtraction two 8 bit numbers using two's complement method.

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-366 Elective-II (S): Lasers

Lectures: 36 **(Credits-02)**

1: Introduction to Lasers: **(8 L)**

Brief history of Lasers, Interaction of radiation with matter, Energy levels, Population density, Boltzmann distribution, Stimulated Absorption, Spontaneous Emission and Stimulated Emission, Einstein's Coefficients, Einstein's relations.

Characteristics of Laser: Directionality, Mono-chromaticity, Coherence,

2: Laser Action: **(6 L)**

Population inversion, Condition for light amplification, Gain coefficient, Active medium, metastable states.

Pumping schemes: three level and four level

3: Laser Oscillator: **(6 L)**

Optical feedback, round trip gain, critical population inversion, Optical resonator, condition for steady state oscillations, cavity resonance frequencies.

4: Laser Output: **(3 L)**

Line-shape broadening: Lifetime broadening, Collision broadening

5: Types of Lasers: **(7 L)**

Solid State Lasers – Ruby Laser, Diode Laser, Gas Lasers – HeNe Laser, CO_2 Laser

6: Applications of Lasers: **(6 L)**

Industrial: welding, cutting, drilling

Nuclear Science: laser isotope separation, laser fusion,

Medical: eye surgery

Reference books :

1. An introduction to Lasers - Theory and applications, M.N. Avadhanulu, S. Chand and Co. New Delhi
2. Experiments with He-Ne Laser by Sirohi
3. Optical fibre and Laser - Principle and applications, Anuradha De, New Age International Publishers,

List of Experiments: (Any Two)

1. Determination of wavelength of He-Ne Laser by transmission grating
2. Determination of Angle of prism (Pin and drawing paper)
3. Study of Lissajous figures using diode Laser and mirrors
4. Beam divergence of a Diode Laser.
5. Determination of the diameter of a thin wire using a laser.
6. Measurement of wavelength of Laser beam using Michelson Interferometer.
7. To study the interference of light using optical fibers
8. Measurement of the focal length of a given convex lens using a laser.

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-366 Elective-II (T): Astronomy and Astrophysics-II

Lectures: 36 **(Credits-02)**

1: Astronomical Scales: **(10 L)**

Measurement of Astronomical Quantities, Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature, Measurement of Time, Sidereal Time, Apparent Solar Time, Mean Solar Time, Equation of Time, Astronomical Coordinate system (only introduction)

2: The Milky Way and Universe: **(8 L)**

Basic Structure and Properties of the Milky Way, Active Galaxies, Quasars and Radio Galaxies, Hubble's law with equation, its significance, Concept of space time, fate of our universe, Multiverse (only introduction)

3: The Stellar Phenomenon: **(10 L)**

Basic Composition of Interstellar Medium, Sun: Solar Cycle, Activity, Butterfly diagram, Photospheric phenomenon, Stars as distance estimators, Hydrostatic Equilibrium of a Star, Stellar models (only introduction).

4: Non-optical Astronomy: **(8 L)**

Basic parameters of an antenna, various types of antennas. UV, IR, X-ray and Gamma ray Telescopes, Detectors for optical and infrared regions. Orbiting space based telescopes: HST, Chandra.

List of Reference Books:

1. Astronomy structure of the Universe, A. E. Roy and D. Clarke, Adam Hilger Pub.
2. Source Book of Space Sciences, Samuel Galsstone; D.Van Nostrand Co. Inc
3. Astrophysics - Stars and Galaxies, K.D. Abhyankar, Tata McGraw Hill Pub.
4. Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Pub.
5. Structure of the Universe, J.V. Narlikar
6. Astrophysics, Baidyanath Basu.
7. Astrophysical Techniques, third Edition, C. R. Kitchin
8. Fundamentals of Astronomy, Michael Seed
9. Telescopes and techniques, C. R. Kitchin (Springer)

List of experiments: (Any Two)

1. To determine the temperature of an artificial star.
2. To observe the Fraunhofer lines in sunlight and determine the elements present.
3. To obtain the solar image on the screen and trace out the existing sunspots.
4. To locate and observe the various stars, constellation, planets. (At least 2 observation of each)
5. To polar Align an astronomical telescope.
6. To study the solar limb darkening effect.

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-366 Elective-II (U): Renewable Energy Sources-II

Lectures: 36 **(Credits-02)**

1: Bioenergy and Biofuels: **(10L)**

Bioenergy:

1. Introduction to Bioenergy
2. Basic Routs: Biochemical, Thermochemical, Transesterification
3. Biochemical- Biogas generation/methanation
4. Biogas plant: Floating gas holder and fixed dome type biogas plant, construction and working
5. Factors affecting on bio-digestion (list of factors).
6. Thermochemical: Pyrolysis, Gasification, Carbonization
7. Transesterification:
8. Comparative study of floating gas holder and fixed dome type biogas plant.
9. Working of downdraft gasifier.
10. Various methods to obtain energy from biomass.

Biofuel:

1. Introduction to Biofuels
2. Production of Biofuels (Jatropa and Sugar cane bagasse)

Ref 1: 7.1, 7.2, 7.2.1, 7.2.2, 7.4, 7.5, 7.6, 7.7, 7.8, 7.11, 7.23, 7.24.1

Ref 2: 10.3 (page no 374 to 380)

2: Wind Energy **(08L)**

1. Introduction to wind energy.
2. Principles and components of wind energy conversion system.
3. Classification of wind machines: Horizontal axial machine and vertical axial machine.
4. Advantages and disadvantages of wind energy.
5. Wind data

Ref -1: 6.1, 6.2, 6.3, 6.5, 6.7, 6.8

3: Other Energy Sources: **(08L)**

1. Introduction to tidal and geothermal energy.
2. Tidal energy: methods of utilization of tidal energy.
3. Advantages and disadvantages of tidal power generation.
4. Geothermal energy: Geothermal sources and energy conversion.
5. Advantages and disadvantages of geothermal energy.
6. Introduction to Thermocell

Ref -1 (9.3), pages from 510-532),

Ref -1 (8), pages from 443, 470-476, 477) Ref -1 (11), pages from 609-657)

4: Energy Management: **(10L)**

1. Introduction to Energy Management (Definition, Principles etc)
2. Need of Energy Saving and Management
3. Different strategies of Energy Management
4. Role of Energy Managers and Auditors,

5. Energy Audit Measurements and Instruments, and Preparation of Energy Audit Report (in brief).
6. Case studies of Energy Audit & Management (e.g. Industries & Green Buildings, Boilers, Furnaces, Refrigeration and Air conditioning, Cogeneration, Waste Heat recovery, Electric motors, Pumping systems, Fans and blowers, Cooling Towers,
   Industrial/Commercial Lighting system, BEE Star rated equipment) any one.

Ref- 4 to 12 - Use any book for reference

Reference books:

1. Non-conventional Energy Sources, G. D. RAI (4th edition), Khanna Publishers, Delhi.
2. Solar Energy, S.P. Sukhatme (second edition), Tata Mc Graw Hill Ltd, New Delhi.
3. Solar Energy Utilisation**,** G. D. RAI (5th edition), Khanna Publishers, Delhi.
4. Energy Management: W.R.Murphy, G.Mckay (Butterworths).
5. Energy Management Principles: C.B.Smith (Pergamon Press).
6. Efficient Use of Energy: I.G.C.Dryden (Butterworth Scientific)
7. Energy Economics -A.V.Desai (Wieley Eastern)
8. Industrial Energy Conservation: D.A. Reay (Pergammon Press)
9. Energy Management Handbook – W.C. Turner (John Wiley and Sons, A Wiley Inter science publication)
10. Industrial Energy Management and Utilisation –L.C. Witte, P.S. Schmidt, D.R. Brown (Hemisphere Publication, Washington)
11. Hand book of Energy Audit by Sonal Desai (Publisher Tata McGraw Hill.)
12. Energy Management and Conservation Handbook, Frank Kreith and Yogi Goswami, (CRC Press)

List of Experiments: (Any Two)

1. Fuel value of wood/charcoal.
2. Study of sensible heat storage using liquid.
3. Selective and Non-selective coatings – Determination of Selectivity ratio.
4. To do energy audit of home/society/college/industry and prepare a detail audit report.
5. Study and analysis of home Electricity Bill
6. Study of Power consumption of conventional tube light vs LED fitting

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-366 Elective-II (V): Acoustics-II

Lectures: 36 **(Credits-02)**

1: Microphones:

Carbon, Moving Coil and Condenser microphones: construction, equivalent circuit, expression for sensitivity (no derivation), constant pressure frequency response and sensitivity related problem-solving (6L)

2: Loudspeakers:

Direct radiator loudspeaker: construction, equivalent circuit, expression for efficiency (no derivation), acoustic power radiated; problem-solving relating to efficiency and acoustic power; Woofer, tweeter and squawker; Bass-reflex cabinet; Horn Loudspeakers: types, wave equation, cut-off frequency, folded horns, problem-solving relating to exponential horns and cut-off frequency (8L)

3: Sound systems, Recording and Reproduction:

Amplifier power specifications for auditoria: Power required for various applications, expression for power calculation; problem-solving related to power; Audio file formats: Lossy compressed (MP3, WMA), uncompressed (WAV, AIFF, AU); Dynamic range; Volume compressors, expanders, and limiters; Graphic equalizer; Monophonic and Stereophonic sound reproducing systems; Dolby Noise Reduction, Dolby Atmos (12L)

4: Environmental Acoustics:

Community noise criteria: Highway noise, aircraft flyover noise, sonic boom; Weighted sound levels: A-weighted sound level, C-weighting, Phon, Sone, Noise induced hearing loss: Trauma and chronic Hearing aids (6L)

5: Ultrasound: Ultrasound Transducers, Medical Ultrasound, Ultrasonography, Distance Measurement, NDT (4L)

Reference Books:

1. Fundamentals of Acoustics, L.E. Kinsler and A. R. Frey, Wiley Eastern
2. Audio and Video Systems, R. G. Gupta, Tata McGraw Hill, 2010
3. Acoustics, W.W. Seto, Schaum's Outline Series, McGraw Hill 1970
4. Handbook of Sound Engineers, G.M. Ballou, Academic Press
5. Basic Acoustics, D.E. Hall, Oxford University Press
6. Design for good Acoustics and Noise Control, J.E. Moore, Univ. Press
7. Consumer Electronics, S. P. Bali
8. Modern Electronics, A. B. Gupta, Books and Allied (P) Ltd

List of experiments (Any two):

1. Polar response of a microphone
2. Speaker response of a direct radiator loudspeaker
3. Graphic equalizer
4. Acoustic power of direct radiator loudspeaker using hemispherical array
5. Distance measurement using ultrasound transducer

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-367: Physics Laboratory-4A

Lectures: 36 **(Credits-02)**

(General Physics, Thermodynamics and Statistical Physics, Nuclear Physics and Quantum Mechanics)

(Any Eight)

GROUP-I: GENERAL PHYSICS (any FOUR)

1. Surface Tension of Mercury by method of Ripples.
2. Viscosity of Liquid by rotating cylinder method.
3. Coefficient of sound absorption
4. 'Y' by Cornu's Method
5. Hall Effect: To measure the Hall coefficient
6. Energy gap of a semiconductor
7. Study of XRD spectrum of any material.
8. Resistivity by Four probe method
9. Platinum resistance thermometer

GROUP-II: THERMODYNAMICS AND STATISTICAL PHYSICS (any TWO)

1. Determination of pressure coefficient of air by constant volume thermometer.
2. Verification of Stefan's fourth power law by bulb filament
3. Thermal conductivity by Forbes Method.
4. Thermal conductivity of rubber tube.
5. Thermal diffusivity of Brass.
6. Thermal and Electrical conductivity of Cu.

GROUP-III: NUCLEAR PHYSICS AND QUANTUM MECHANICS (any TWO)

1. Characteristics of G.M. tube
2. Inverse square law (γ-rays)
3. e/m by Thomson method
4. Determination of Planck's constant
5. Study of Gaussian distribution by G. M. tube.

Additional Activities (Any ONE)

- Demonstrations: Any 2 demonstrations equivalent to 2 experiments
- Study tour with report equivalent to 2 experiments
- Mini project equivalent to 2 experiments
- Computer aided demonstrations (simulations or animations)
  (Any 2 demonstrations equivalent to 2 experiments)

Note: *Students have to perform* ***ten*** *experiments or* ***one*** *additional activities in addition to* ***eight*** *experiments mentioned above. Total laboratory work with additional activities should be equivalent to* ***ten*** *experiments.*

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-368: Physics Laboratory-4B

Lectures: 36 **(Credits-02)**

(Electronics (Essential) or Advanced Electronics, acoustics and Lasers, Optional Courses)

(Any Eight)

GROUP-I: ELECTRONICS (ESSENTIAL) (any TWO)

(For the students not offering advance electronics in theory courses)

1. Characteristics of JFET
2. Design and built astable multivibrator using IC 555/IC 741
3. Half adder /Full adder
4. Integrator and differentiator using IC 741
5. IC 723 as regulated power supply

GROUP-I: ADVANCED ELECTRONICS (any TWO)

(For the students offering advance electronics in theory courses)

1. Instrumental amplifier using three op-amps
2. Temperature controller using PT 100 / thermocouple /thermistor temperature sensors
3. Object counter (two digit)
4. Schmitt trigger
5. Study of LVDT

GROUP-II: ACOUSTICS AND LASERS (any FOUR)

1. Frequency response of loudspeaker (twitter, woofer, mid-range)
2. Study of interference by Quinck's method
3. Use of Ultrasonic interferometer to measure velocity of sound in liquids
4. Transmission loss using expansion chamber muffler.
5. Study of diffraction using a transmission/reflection grating (metal ruler)
6. Study of the characteristics of a laser beam.
7. Determination of the diameter of a thin wire using a laser beam.
8. 'μ' By total internal reflection of light

GROUP-III: PRACTICAL FROM OPTIONAL COURSE (Any-2)

Additional Activities (Any ONE)

- Demonstrations: Any 2 demonstrations equivalent to 2 experiments
- Study tour with report equivalent to 2 experiments
- Mini project equivalent to 2 experiments
- Computer aided demonstrations (simulations or animations)

  (Any 2 demonstrations equivalent to 2 experiments)

Note: *Students have to perform* ***ten*** *experiments or* ***one*** *additional activities in addition to* ***eight*** *experiments mentioned above. Total laboratory work with additional activities should be equivalent to* ***ten*** *experiments.*

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-369: Physics Project-II

Lectures: 36 **(Credits-02)**

Guidelines:

It is expected that,

1. The student does work equivalent to about 10 laboratory experiments throughout the semesters in the third year.
2. One bears in mind that the project work is a practical course and it is intended to develop a set of skills pertaining to the laboratory work apart from the cognition of students. Therefore, the guides should not permit projects that involve no contribution on part of student.
3. The project must have a clear and strong link with the principles of basic physics and/or their applications.
4. The theme chosen should be such that it promotes better understanding of physics concepts and brings out the creativity in the students.
5. The evaluation of the project work must give due credit to the amount of the project work actually done by a student, skills shown by the student, understanding of the physics concepts involved and the presentation of the final report at the time of viva voce.
6. The viva voce should be conducted at the time of evaluation of project work at least for twenty minutes per student. Extra care must be taken in the evaluation of projects done in a pair or group. Delegation of the work done by individuals must be sought from the students in such cases.
7. Any ready-made material used in the report (such as downloaded pages from the web) must be clearly referred to and acknowledged.
8. It is also recommended that a teacher will look after 4 projects at one time.
9. Any non-adherence to this norm should attract a penalty by way of deduction in the marks awarded to a student. It is recommended that the College will provide consumables/contingencies for every project, to the tune of Rs. 750 /- each. (*If the students paid extra fee other than laboratory fee then college will provide financial assistance for the Project work.)

The Project work shall consist of the following Criterions.

1) Working model (Experimental or Concept based simulation/Demonstration Related to Physics).
2) Understanding of the project.
3) Experimental Details.
4) Data collection and Data Analysis.
5) Innovation.
6) Outcomes/Result.
7) Conclusion.

Note: At the time of project practical examination, the candidate must submit the certified project report by the project in-charge and HOD. A candidate will be allowed to appear for the Project practical examination only if the candidate submits a project completion report duly certified by the project in-charge and Head of the department.

The Project work shall include:

Models based / Demonstrated Applications / Review articles / Simulation on PC on any concept in Physics / Comparative & differentiative study / Improvement in the existing experiment (Design and fabrication concept) / Extension of any regular experiments / Attempt to make experiment open-ended / Thorough survey of existing active components / devices, ICs, methods, means, technologies, generations, applications etc. / any innovative projects using the concept of Physics / Interdisciplinary areas.

Evaluation weightage:

- Semester End University Examination : 35 Marks
- Internal Examination: 15 Marks

Skill Enhancement Courses

Skill Enhancement Courses (SEC)

a) Selection of Skill enhancement courses

There are two skill enhancement courses (SEC) in 6th semester (PHY-3610 and PHY-3611). For 6th semester, there are four options available. The college has to select any one from the given four options. It is advised that college should not offer elective and skill enhancement course of same theme.

b) Teaching Learning process for Skill Enhancement Courses

Skill base courses are intended to explore the applications of physics knowledge. Learning in skill enhancement courses is largely experience based. The skill enhancement courses may be categorized as knowledge skill or technical skill. For knowledge skill courses one can use the conventional method for teaching along with problem solving, assignments seminars etc. For acquiring the technical skill, the students will get adequate 'hands-on' experience. The teachers may use demonstrations and activity-based learning techniques. On field visits, study tour and mini projects will enrich the learning experience of the students.

c) Assessment methods for skill enhancement courses

Continuous evaluation will be the best method for assessment of skill enhancement courses.

One can use tools like assignments, mini projects or activities, problems, etc and grade the students according to their performance. The internal assessment should have 50 % weightage.

The University examination may be conducted for the remaining 50%.

The University examination question paper should have adequate proportion of objective and subjective question.

d) List of Skill Enhancement Courses:

Semester-VIth	**Semester-VIth**
PHY-3610	**PHY-3611**
PHY-3610(W): Scientific Data Analysis using Python	PHY-3611(AA): Microcontrollers
PHY-3610(X): Solar PV System: Installation, Repairing and Maintenance	PHY-3611(AB): Instrumentation for Agriculture
PHY-3610(Y): Applications of Internet of things (IOT)	PHY-3611(AC): Radiation Physics
PHY-3610(Z): Calibration Techniques	PHY-3611(AD): Photography

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-3610 SEC (W): Scientific Data Analysis using Python

Lectures: 36 **(Credits-02)**

Pre-requisite	: Basic knowledge of computer programming (Python/c)
Mode of internal Assessment	: A small project analysing scientific data for visualization
Data sets may include	: Pollution Data, Rain data, Astronomical data, any scientific data Related to Physics or science in general
Sources of Data sets	: MERI, Nashik, AIUCAA Pune, NASA or similar 1. Website for competition: https://www.kaggle.com/ 2. Google dataset: https://datasetsearch.research.google.com/ 3. Data for visualization and dataset resources: https://dev.to/aspittel/my-favorite-data-visualization-and-dataset-resources-35kp Other potentially useful searches: 1. https://bigdata-madesimple.com/70-amazing-and-free-data-sources-for-data-visualization/ 2. https://eduinpro.com/blog/data-sets-for-data-visualization-projects-datascience/

Learn how to analyses data using Python. This course will take you from the basics of Python to exploring many different types of data. You will learn how to prepare data for analysis, perform simple statistical analyses, create meaningful data visualizations, predict future trends from data, and more

Student will learn how to:

- Import data sets, access different elements of data frames.
- Understand the functions available in existing Python modules.
- Understand the utility of functions available in NumPy and Pandas library.
- Clean and prepare data for analysis
- Manipulate pandas Data Frame
- Understand awareness with different types of basic charts and functions in matplotlib library
- Get exposure to visualization techniques from seaborn library
- Build data pipelines

  Data Analysis with Python is delivered through lecture, hands-on labs, and assignments. It includes following parts:
- Data Analysis libraries: will learn to use Pandas Data Frames, Numpy multi-dimensional arrays, and SciPy libraries to work with a various datasets. We will introduce you to pandas, an open-source library, and we will use it to load, manipulate, analyze, and visualize cool datasets. Then we will introduce you to another open-source library, scikit-learn, and we will use some of its machine learning algorithms to build smart models and make cool predictions.

Outcome of the course

- Know basic notions and definitions in data analysis.
- Know standard methods of data analysis and information retrieval.
- Be able to formulate the problem of knowledge extraction as combinations of data filtration, analysis and exploration methods.
- Be able to translate a real-world problem into mathematical terms.

Syllabus:

Unit No.	Topics	Lectures
I	**Data Structures, modules and Importing Datasets** Lists: Creating list, accessing list elements, functions for lists, programming with lists Tuples: Creating Tuples, accessing list elements, functions for Tuples, programming with Tuples Dictionary: Creating Dictionary, accessing list elements, functions for Dictionary, programming with Dictionary. In Built modules : Math module, random Module, Array module, string Module etc	6
II	**Core libraries in Python** NumPy Library for Arrays Pandas Library for Data Processing Basics of data frames, create, adding/ deleting of rows, columns to data frames Import of data, functions of data frames Data Normalization Sets, data extraction using relational, logical operators. Group by functionality, missing values	6
III	**Summarizing the Data Frame and visualization** Matplotlib Library for visualization: Pie chart, violin plot, scatter plot, histogram, bar chart, area plot. Seaborn Library for Visualization: Box plot, point plot, line plot, count plot, bar plot, strip plot, scatter plot and Regression Plot	6

Activity: Hands on data Analysis and Visualization with Pandas [18L]

Note: For Internal assessment students will either do 8 activities related to data analysis and visualization on particular dataset or will carry out small project on analysis or visualization using science (preferably physics) related dataset.

Reference Books:

- Python Programming: Using Problem Solving Approach- Reema Thareja.
- Let us Python - Aditya Kanetkar
- Learning with Pythob - Allen Downey
- Data Analytics - Bharti Motwani

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-3610 SEC (X): Solar PV System: Installation, Repairing and Maintenance

Lectures: 36 **(Credits-02)**

Objectives:

1. In this skill oriented course, student will study basics of solar photovoltaic (PV) cells, modules, and system components.
2. Design and sizing of off-grid PV system for homes, apartments as well as commercial offices.
3. Understanding energy conversion from sunlight to electricity, and working with solar conversion equipment.
4. This Course will hands on experience needed to become self-employed.

Outcomes:

1. Learn basics of light conversion in electricity.
2. Hands on training will motivate to use Solar PV system.
3. Become entrepreneur / self-employed.
4. Analyzed of MSEB electricity bill and design and sizing of off-grid PV system
5. Participants will learn about solar PV module and batteries used in solar PV plant.

Syllabus:

Unit-1: Introduction **(6L)**

The Sun, Earth, and Renewable Energy, Photovoltaic Effect, Working of Solar cell, Types of Solar cell, PV Modules and Arrays, Module Parameters, Sunshine and Shadow, tracking mechanism, Aligning the Array.

Unit-2: Solar Radiations and Measurement **(6L)**

Introduction, Solar Constant, Solar Radiation at the Earth Surface, Need of Solar Radiation Measurement, Instruments For The Measurement of Solar Radiation, Pyrheliometer, Pyranometer, Sunshine Recorder, Sun Meter or Lux Meter

Unit-3: Basics Solar PV Systems **(6L)**

Basics types of PV Systems On grid and off grid, DC to AC Conversion, Building-integrated Photovoltaics, Engineering and Architecture, Balancing of PV system. System Components, Batteries, Charge Controllers, Inverters, Hybrid Systems, System Sizing, Applications of off grid PV System.

Activity: **(18L)**

1. Estimate the value of the Solar Constant.
2. Study of intensity variation on the performance of PV module.
3. Study of series and parallel combination of the PV modules.
4. Measurement of Solar radiation measurement using Sunmeter and Pyranometer.
5. Analysis of MSEB electricity bill.
6. Energy Farm/PV Plant visit report.

Reference books:

1. Solar Energy, S.P. Sukhatme (second edition), Tata Mc.Graw Hill Ltd, New Delhi.
2. Solar Energy Utilisation, G. D. RAI (5th edition), Khanna Publishers,Delhi.
3. Electricity from Sunlight, An Introduction to Photovoltaics, Paul A. Lynn, John Wiley & Sons, Ltd.
4. Solar Electricity, 2nd edition, T. Markvart, John Wiley & Sons, Ltd.
5. Solar Photovoltaic Basics, White Sean, Taylor & Francis Ltd.

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-3610 SEC (Y): Applications of Internet of Things (IOT)

Lectures: 36 **(Credits-02)**

Objectives:

- To introduce the terminology, technology and its applications
- To introduce the concept of M2M (machine to machine) with necessary protocols
- To introduce the C# Language which is used in many IoT devices
- To introduce the Raspberry PI platform, that is widely used in IoT applications
- To introduce the implementation of web based services on IoT devices

Learning Outcomes :

a) IOT concepts
b) IOT Standards
c) Components of IOT System.
d) Relevance of IOT for the future.
e) IOT Applications.
f) IOT for smart cities (Case study Smart city Barcelona)
g) IOT in Indian Scenario
h) Challenges in IOT implementation.

This subject does not have the intention of being a comprehensive course about the technologies involved in IOT. The focus will be more on the possibilities offered by the different technologies, and on the creative thinking techniques to find innovative applications of combinations of such technologies in real-life scenarios. Some presentations will also be scheduled in which people from industry will make presentations about selected topics related to the IoT. The Internet of Things (IoT) is a course about the new paradigm of objects interacting with people, with information systems, and with other objects. The course will focus on creative thinking and on hands-on project development. The duration of the course is 30 hours. Will be a mix of 75 minutes session and 2 hours session. Lab will be for 5 hours.

Future Scope:

It is a system of interrelated computing devices, digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. Internet of Things

What Internet of Things can do?

3. Medical Check-up Health Devices Operational Efficiency Medical Report Health Sector
4. Advanced Kitchen Automatic Parking Remote Home Control Security System Smart Home
5. Wi-Fi Connectivity Traffic Control Security System Advanced Parking System Smart City
6. Advanced Power Supply Manufacturing Bill Payment Planning Industrial Automation
7. Let's Take an Example of Internet of Things

● Renewal Energy Source. ● Automatic wearing suit. ● Next Gen way to fly. ● Speech Recognition. ● Perfect example of AI. ● Advanced GPS.

Syllabus:

Unit-1: Introduction to Internet of Things **[4L]**

Definition and Characteristics of IoT, Physical Design of IoT – IoT Protocols, IoT communication models, IoT Communication APIs IoT enabled Technologies – Wireless Sensor Networks, Cloud Computing, Big data analytics, Communication protocols,

Unit-2: IOT Concepts and introduction **[5L]**

i) Technologies that led to evolution of IOT
ii) IOT and SCADA
iii) IOT and M2M
iv) IOT and Big Data
v) Requirement of international standard (case study)
vi) IOT standards in practice.
vii) Operating platforms /systems

Unit-3: IOT Applications. **[4L]**

i) Lighting as a service (case study)
ii) Intelligent Traffic systems (case study)
iii) Smart Parking (case study)
iv) Smart water management (case study)
vi) IOT in Indian Scenario

Unit-4: Introduction to C# **[5L]**

Language features, commands , functions of C#, Data types, data structures, Control of flow, functions, modules, packaging, file handling, data/time operations, classes, Exception handling.

Activity: Case Studies (Any two) **[18 L]**

i) Lighting as a service (case study)
ii) Intelligent Traffic systems (case study)
iii) Smart Parking (case study)
iv) Smart water management (case study)
v) IoT for smart cities (Case study Smart city Barcelona)

Reference books:

1. Internet of Things – A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547
2. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759
3. The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World Paperback – 26 March 2015 by Michael Miller.

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-3610 SEC (Z): Calibration Techniques

Lectures: 36 **(Credits-02)**

Objective:

- To make students familiar with the constructions and working principle of different types of Instruments
- To make students aware about the measuring instruments and Calibration of Instrument

Course Outcomes: At the end of the course, a student will be able to:

- Calibrate hydraulic, pneumatic and mechanical measuring and control equipment: setting, adjustment, validation or verification of mechanical, pneumatic, hydraulic, measuring and control instruments using reference standards in accordance with predetermined procedures.
- Calibrate electrical and electronic measuring and control equipment: setting, adjustment, validation or verification of electrical, electronic measuring and control instruments using reference standards in accordance with predetermined procedures.
- Carryout maintenance activities on instrumentation and control panel.

Syllabus:

Unit-1: Principles of Calibration [4 L]

1. Introduction and Importance of Calibration
2. Traceability in Calibration
3. Calibration Uncertainty
4. Various Calibration Methods
5. Factors Affect Calibration
6. Instrument Classification and Instrument Identification

Unit-2: Pressure Calibration [6L]

1. Introduction to pressure calibration
2. Pressure unit conversion standards
3. Types of Pressure Gauges
4. Calibration of Pressure Gauges
   a. Accuracy
   b. Pressure Media
   c. Contamination
   d. Height Difference
   e. Leak test of Piping
   f. Adiabatic Effect
   g. Torque Force
   h. Calibration Position
   i. Generating Pressure
   j. Pressurizing the Gauge
   k. Reading the Pressure Value
   l. Number of Calibration Points
   m. Hysteresis (deviation of calibration points)
   n. Number of Calibration cycles
5. Instruments required for calibration:
   a. Pressure comparator
   b. Master Gauge
6. Pressure Calibration with Example

Unit-3: Calibration of Electronic Instruments [4L]

1. Identification of Components
2. Equipment required for calibration
3. Procedure of Calibration
   a. Read operational Specifications
   b. Sequence of events
   c. Identification of common Faults
4. Electronic Calibration with Examples (Oscilloscopes, Multimeters, Function Generators, Signal Generators)

Unit-4: Temperature Calibration [4L]

1. Temperature units and Conversions
2. Temperature Sensors
3. Calibration of temperature sensors
   a. Handling temperature sensor
   b. Preparations
   c. Temperature sources
   d. Reference Temperature Sensor
   e. Immersion Depth
   f. Stabilization
   g. Temperature sensor handle
   h. Calibrated temperature range
   i. Calibration Points
   j. Adjusting/trimming a temperature sensor
4. Examples:

Activity: Any-6 [18L]

Calibration of a dial thermometer

1) RTD calibration check
2) Temperature controller loop
3) Calibration of pressure Transmitters
4) Calibration of pressure switch
5) Level calibration Instrument
6) Liquid head measurement
7) Calibrating a differential pressure level transmitter
8) Calibration of top pan balance
9) Calibration of digital balance
10) Calibration of PH/Conductivity meter
11) Calibration of Volt meter
12) Calibration of Current meter
13) Calibration of Oscilloscopes
14) Calibration of Function Generators

Reference Books :

1) **Calibration:** A Technician's Guide - Mike Cable
2) Measurement and Control Basics -Thomas A. Hughes
3) Measurement and Control of Liquid Level - Chun H. Cho
4) A Practical Book On Calibration Of Analytical Instruments - Dr S Jain ,
5) Calibration Handbook of Measuring Instruments - Alessandro Brunelli

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-3611 SEC (AA): Microcontroller

Lectures: 36 **(Credits-02)**

Objective:

- To make students familiar with the constructions and working principle of microprocessor
- To make students aware about microprocessor

Outcome: After successful completion of this course students are supposed to develop their own applications/ mini/ tiny projects using microcontroller.

Syllabus:

Unit-1. ARCHITECTURE OF 8051: **[05]**

Microprocessor and Microcontrollers a short comparison, Overview of the 8051 family, Block diagram of Microcontroller, Functions of each block, Pin details of 8051, A and B CPU registers, Flags and Program status word (PSW), Program Counter (PC) and Data Pointer register (DPTR), Internal RAM, Stack and Stack Pointer, Special function registers, Memory Organization of 8051, Internal ROM, I/O Ports, Oscillator and Clock

Unit-2. 8051 ASSEMBLY LANGUAGE PROGRAMMING: **[05]**

Introduction to 8051 Assembly programming, Assembling and running an 8051 program, 8051 data types and directives, Jump, loop, and call instructions, 8051 I/O programming, Addressing modes, arithmetic and logical instructions and programs, Signed number concepts and arithmetic operations, Logic and compare instructions, Rotate instructions, BCD, ASCII, and other application programs.

Unit-3. Timers/ Counters and Interrupt programming: **[04]**

Timers of 8051, TMOD and TCON registers, Programming timers 0 and 1 in 8051, counter programming**,** 8051 interrupts, Interrupt priority in the 8051, and Application programs using interrupts.

Unit-4. INTERFACING TECHNIQUES **[04]**

Key/ keyboard (push button) interfacing, interfacing a LCD display, interfacing an ADC and LM35 temperature sensor.

Activity: any-3 **[18L]**

1. Use of Kiel/ Pinnacle/AVR (Atmel processor family) Studio/IDE (Integrated development environment) or any other suitable IDE.
2. Use of IDE/Software the students are supposed to run basic programs of their own. (Arithmetic, logical, Data manipulation, Data transfer/I-O Port related etc.)
3. Single key / Keyboard Interfacing.
4. ADC/DAC Interfacing.
5. Mini Project (Water level controller, Electronic Thermometer etc.)

Reference Books:

1. 8051 Microcontroller by Kenneth J. Ayala.
2. 8051 Microcontroller and Embedded Systems using Assembly and C - Mazidi, Mazidi and D MacKinlay, 2006 Pearson Education Low Price Edition.
3. Microprocessor and Microcontroller by R.

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-3611 SEC (AB): Instrumentation for Agriculture

Lectures: 36 **(Credits-02)**

Objectives:

After completion of this course students can

1. Get knowledge of sensors used in agriculture field
2. Learn continuous and batch process
3. Learn greenhouse automation schemes
4. Learn Instrumentation in Irrigation

Course Outcomes:

After completion of this course student will

1. Able to test soil and water parameters.
2. Able to develop their own juice extract plant.
3. Able to developed their own green house

Syllabus:

Unit-1: Introduction **[02L]**

Necessity of instrumentation and control for agriculture, sensor requirement, remote sensing, bio sensors in agriculture.

Unit-2: Soil Properties & Sensing **[04L]**

Properties of soil: fundamentals definitions and relationship, index properties of soil, permeability & seepage analysis, shear strength, Mohr's circle of stress, active & passive earth pressures, stability & slopes,

Sensors: introduction to sonic anemometers, hygrometers, fine wire thermocouples, open & close path gas analyzers

Unit-3: Instrumentation in Continuous & Batch process **[04L]**

Flow diagram of sugar plant, sensors & instrumentation setup, Flow diagram of fermenter & control (batch process), flow diagram of dairy industry & instrumentation setup for it, Juice extraction control process & instrumentation setup.

Unit-4: Instrumentation in Irrigation **[04L]**

Water distribution and management control, Auto drip and sprinkler irrigation system, upstream & downstream control concept, SCADA for DAM parameters &control.

Unit-5: Greenhouse Parameters & Instrumentation **[04L]**

Greenhouse effect, Concept and construction of greenhouse, merits & demerits, ventilation, cooling & heating, wind speed, temperature & humidity, soil moisture, rain gauge, carbon dioxide enrichment measurement & control, Leaf area length *evapotranspiration*, temperature, wetness & respiration measurement & data logging, electromagnetic radiations photosynthesis.

Activity : any-6 **[18L]**

1) Measurement of water holding capacity of soil.
2) Measurement of soil texture.
3) Measurement of moisture contain in soil.
4) Micronutrients analysis of soil.
5) Measurement of physical properties of soil. (Color, odder, texture etc.)
6) Measurement of Chemical properties of soil (pH, chloride, Oxygen, Sulphur etc. contain in soil)
7) Measurement of Biological properties of soil (Fungi, Bacteria)
8) Air quality measurement.

9) Analysis of Residues in fruits.
10) Visit to green house.
11) Visit to Sugar industry/Juice extract plant/ dairy industry

Reference books:

1. Industrial instrumentation, "Patranabis", TMH.
2. Instrumentation handbook-process control, "B.G. Liptak", Chilton.
3. Process control and instrumentation technology, "C.D. Johnson", PHI
4. Wills B.A., " Mineral Processing Technology", 4th Ed., Pergamon Press
5. Principle of Farm Machinery, R.A Kepner, Roy Bainer;: CBS Publication
6. Agricultural Engineering; Radhey Lal: Saroj Publication
7. Environmental Engineering, Peary. II. S. and others

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-3611 SEC (AC): Radiation Physics

Lectures: 36 **(Credits-02)**

Course Objectives:

1. Students should understand the mechanism of interaction of various types of radiations with matter.
2. Students should get acquainted with principles of Measurement radiation levels, design principles and and actual implementation of variety of radiation detectors.
3. Students should learn about standards regarding safety levels laid down by National and International agencies, methods adapted to maintain safety standards in various places and methods of shielding.
4. Students should study the applications of radiations in various fields.

Course outcomes:

1. Students can use the knowledge in the applications of Radiation Physics in the fields like radio carbon dating, medical diagnostic tools.
2. Students acquire skill in operating different types of radiation detectors to detect and measure radiation levels in different places.
3. Students can work as advisers in maintenance of radiation safety standards and following of strict protocols at various places like Hospitals, Industry, and Laboratories etc.
4. Students become able to employ their skills to develop applications of radio activity in the fields like agriculture, industry, hospitals etc.

Syllabus:

Unit No.	Title and Contents	Lectures
I	**Interaction of Radiation with Matter** Interaction of different types of radiation with matter-Ionizing & Nonionizing radiations, excitation, ionization, radioactive losses-Energy loss by collision, range energy relation, Bethe-Bloch formula collision stopping power, radiation stopping power, Straggling.	3
II	**Radiation Detectors** Characteristic curve of Gas-filled detectors. Ionization chamber, Proportional counter, Gas filled detectors (G. M. counter), Characteristics of organic and inorganic scintillation detectors, Scintillator detector, Semiconductor detector.	3
III	**Radiation units and Measurement of radiation exposure** Units for radiation exposure- Roentgen, Becquerel, Gray, Sievert, RAD, REM, KERMA. Radiation exposure, Absorbed Dose, Equivalent Dose, Effective Dose, Ambient and directional equivalent dose, Relative biological effective dose, Quality factor, Personal dosimeters, Film badge dosimeters, Thermo luminescent dosimeter.	3
IV	**Radiation Sources and Radiation Shielding** Natural & Artificial radioactive sources, Alpha, Beta, Gamma Sources, Basic concept of radiation shielding, linear and mass absorption coefficient, stopping power, materials for shielding of gamma and neutron, shielding interaction cross section.	3

V	**Radiation Protection:** Time, Distance, Shielding, Radiation Protection and Safety rules as per the regulatory guidelines of the Government of India, Safety codes for handling radioactive sources. Monitoring of radiation levels around an open radioactive source, ICRP, NCRP, AERB recommended limit.	3
VI	**Radiation Applications:** Radioactive pharmaceuticals and labelled compounds. Radioactive nuclei used in diagnostic applications. Applications of gamma-rays in sterilization of medical instruments, medication items and preservation of food.	3

Activity: any-6 [18L]

1. Study the different types of radio isotopes and their applications in medical field.
2. Study use of isotopes in radiocarbon dating.
3. Study of working of G. M. Counter.
4. Study of G. M. Counter characteristics – Dead Time and End point energy.
5. Study of commercially available portable, handy radiation detectors.
6. Survey of various places to measure radiation levels
7. Visit to hospitals and other such locations for measuring radiation exposure.
8. Visit to industrial areas to measure radiation exposure levels
9. Study of various shielding materials and their stopping power.
10. Study of dependence of radiation stopping power of materials on physical properties of materials
11. Study of protocols followed by various units to follow safety measures
12. Visit to food industry using preservation techniques using nuclear radiations.
13. Visit to pharmacy industry producing radioactive compounds.
14. Visit to diagnostic centres which employ radiation sources

Reference books:

1. Nuclear and Radiation Physics in Medicine. Tony Key. World Scientific. 2014
2. Introduction to Radiological Physics and Radiation dosimetry. Frank H. Attix. Wiley. 1986
3. Medical Physics by Glasser O, Vol 1, 2, 3 Year Book Publisher Inc Chicago.
4. Radiation Protection and Health Science. Marilyn E. Noz. World Scientific. 2007.
5. Introduction to Radiation Protection. Grupen C. Springer. 2008.
6. Radiation Physics for Medical Physicists. Podgorsak Ervin B. Springer. 2005.
7. Techniques for Nuclear and Particle Physics experiments. Leo. W. R. Springer. 2005.

T.Y.B.Sc. (Physics) (Sem-VI)
PHY-3611 SEC (AD): Photography

Lectures: 36 **(Credits-02)**

Objectives:

- To create general awareness and interest in photography process.
- To make students familiar with the Photographic equipment and handling techniques.
- To help students to learn basic photographic and image processing skills.

Course Outcomes: After successful completion of this course, student will be able to

- Understand the basic principle, structure and handling techniques in digital photography.
- Students will be able to develop and apply photographic skills using digital photography tools including digital editing, saving, sizing, and posting of the images
- Student gets proficient at the technical aspect of photographing with a digital camera.
- Students can identify and apply appropriate business practices specific to the self-employed professional photographer

Syllabus:

Unit No.	Topics	Lectures
I	**Introduction of Photography:** **Introduction:** History & Development of photography, Principles, functions and structure of camera, Indoor and outdoor lighting techniques; Background selection; Flash and its features. Black & White v/s Digital camera (Limitation & advantages) **Types of Camera:** Pinhole camera, Box camera, SLR camera, Studio camera, Digital camera.	6
II	**Camera Control and Exposure:** **Camera Controls:** Need for camera controls. Apertures, Depth of field and depth of focus. Shutters (Ideal, leaf and focal plane shutter). Shutter speed (slow and fast). Auto focus, Manual focus and Image stabilization **Camera lenses & Exposure:** Normal, Wide angle, Telephoto and Zoom range, Incident and reflected light, Exposure triangle, Exposure and equivalent exposures, Brief idea of exposure meter (TTL and Flash meter).	6
III	**Colour Theory & Digital Camera:** **Colour Theory:** Classification and use of colours in photography, Construction of colour enlarger, Colour Head, sources of light and filters used in a colour enlarger **Digital Camera:** Types of Digital Camera and its features, Memory Chip card, Creative shots, Settings in the Digital Camera - Handling methods; White balance, Maintenance of camera. Digital camera sensors and its types.	6

Activity: any-6 (Practical/Demonstration) **[18L]**

Sr No	List of Practical's
1	To study the effect of aperture on depth of field
2	To study and recognize the use of slow and fast shutter speed
3	To study the effect of Exposure for different colour temperatures
4	To identify and determine the focal length of the different types of lenses
5	To study the Image Mixing, Image Cutting and Text Building Effect
6	To study Blurr Effect and Transformation Tools
7	To understand the effect of clip mask, photo filter and stamping Tool
8	To study the effect of natural light, tungsten light and fluorescent light on Photograph.
9	Lighting for still life (Earthen ware, Metal ware, Glass ware, Fruits, Crockery, Jewelry, Flowers, Food etc.)
10	Indoor shooting using three point lighting set up
11	Image processing 1: (Light room techniques 1): Brightness, saturation etc
12	Image processing 2: (Light room techniques 2): Exporting, contact sheet, print
13	Nature photography
14	Wild life photography
15	Night photography
16	Event Photography
17	News photography and preparing a photo story
18	Cover page design for a magazine

Reference books:

1. Basic Photography- M.J. Langford, Focal Press.
2. The basic book of Photography – Fifth edition – by Tom Gri
3. Beginner's guide to photographic lighting: Techniques studio or on Location-Dom Marr
4. Photography its principles & practice: A manual of the photography – Carroll.
5. Photography for the 21st century by Katic Millar
6. Advanced Photography (Vol.-I & Vol.-II) - M.J. Langford, Focal Press.
7. Applied Photographic Optics- Sidney F. Ray; Focal Press
8. The Practical Guide to Photographic Lighting, John Tarrant, Focal Press

SAVITRIBAI PHULE PUNE UNIVERSITY

(*Formerly University of Pune*)

Three Year B. Sc. Degree Course in Statistics
(Faculty of Science and Technology)

T. Y. B. Sc. STATISTICS

CHOICE BASED CREDIT SYSTEM SYLLABUS FOR THIRD YEAR
(To be implemented from Academic Year 2021-22)

Course Structure
T. Y. B. Sc. Statistics

Semester V	Semester VI	Credits	Marks	
			CIA	ESE
ST 351: Distribution Theory – I	ST 361: Distribution Theory – II	2	15	35
ST 352: Theory of Estimation	ST 362: Testing of Hypothesis	2	15	35
ST 353: Design and Analysis of Experiments	ST 363: Sampling Theory	2	15	35
ST 354: Statistical Process and Product Control	ST 364: Introduction to Survival Analysis	2	15	35
ST 355: Operations Research – I	ST 365 (A): Actuarial Statistics OR ST 365 (B): Operations Research – II	2	15	35
ST 356: Regression Analysis	ST 366 (A): Stochastic Processes OR ST 366 (B): Reliability Theory and Applications OR ST 366 (C): Medical Statistics and Clinical Trials	2	15	35
ST 357: Practical Paper – I	ST 367: Practical Paper – IV	2	15	35
ST 358: Practical Paper – II	ST 368: Practical Paper – V	2	15	35
ST 359: Practical Paper – III	ST 369: Project	2	15	35
Skill Enhancement Courses (SEC)				
ST 3510: SEC 1: Turbo C **(Practical Course)**	ST 3610: SEC 3: Introduction to Python **(Practical Course)**	2	15	35
ST 3511: SEC 2: Statistical Computing using R-software **(Practical Course)**	ST 3611: SEC 4: Data Analytics **(Practical Course)**	2	15	35

Equivalence for old courses (from 2014-15) with new courses (w.e.f. from 2021-22) in Statistics:

Semester V	
Papers in Old Syllabus (2014–15 to 2019–20)	Equivalent papers in New Syllabus (2019–20 onwards)
ST331: Distribution Theory	No equivalent paper *
ST 332: Theory of estimation	ST 352: Theory of Estimation
ST 333: Sampling Methods	ST 363: Sampling Theory
ST 334: Design of Experiments	ST 353: Design and Analysis of Experiments
ST 335: C Programming (Turbo C)	ST 3510: SEC 1: Turbo C
ST 336: Introduction to Regression Analysis	ST 356: Regression Analysis

Semester VI	
Papers in Old Syllabus (2014–15 to 2019–20)	Equivalent papers in New Syllabus (2019–20 onwards)
ST 341: Actuarial Statistics	ST 365 (A): Actuarial Statistics
ST 342: Testing of Hypotheses	ST 362: Testing of Hypothesis
ST 343: Statistical Quality Control	ST 354: Statistical Process and Product Control
ST 344: Operations Research	ST 355: Operations Research-I
ST 345 (A): Reliability and Survival Analysis	No equivalent paper *
ST 345 (B): Introduction to Stochastic processes	ST 366 (A): Stochastic Processes
ST 346: Statistical Computing Using R Software	ST 3511: SEC 2:Statistical Computing using R software
ST 347 : Practical Paper – I	No equivalent paper *
ST 348 : Practical Paper – II	No equivalent paper *
ST 349 : Practical Paper – III	No equivalent paper *

*The Examination of the papers having 'No equivalent papers' will be conducted as per University provisions prescribed in such cases.

GENERAL INFORMATION

1. A student of the three year B.Sc. degree course will not be allowed to offer Statistics and Statistical Techniques simultaneously in any of the three years of the course.
2. Students offering Statistics at the first year of the three year B.Sc. course may be allowed to offer Statistical Techniques as one of their subjects in the second year of the three year B.Sc. course, in place of Statistics.
3. Students offering Statistical Techniques at the first year of the three year B.Sc. course may be allowed to offer Statistics as one of their subjects in the second year of the three year B.Sc. course in place of Statistical Techniques, provided they satisfy other requirements regarding subject combinations, if any.
4. Each theory courseis of 2 credits. There will be 03 lectures per week each of 50 minutes. Each practical course is of 1.5 credits. The duration of each practical course is 04 hour 20 minutes per week.
5. **Students must complete all the practicals (experiments) in each of the practical papers including skill enhancement courses(SEC) to the satisfaction of the teachers concerned.**
6. Students must produce the laboratory journal along with the completion certificate duly signed by the Head of the Departmentat the time of practical examination.
7. The practical examination will be conducted semester wise. Internal and external examiner will examine the candidates answer books jointly after examination is over at the centre.
8. In **semester VI**, a student shall opt for any one of the following papers:

   i) ST 365(A): Actuarial Statistics **OR** ST 365(B): Operations Research – II

   ii) ST 366 (A): Stochastic Processes **OR** ST 366(B): Reliability Theory and Applications **OR** ST 366 (C): Medical Statistics and Clinical Trials.

   All other papers of semester VI are compulsory.
9. The theory question paper for each theory paper shall cover all the topics in the pertaining syllabus with proportional weightage to the number of hours of instruction prescribed.
10. Use of statistical tables is allowed for theory as well as practical examination.

11. To perform and complete the practical, it is necessary to have computing facility at the college. So,college will provide sufficient number of computers, UPS, and printer in the laboratory.
12. **Study Tour**: In order to acquaint the students with applications of statistical methods in various fields such as industries, agricultural sectors, government institutes, etc. at least one Study Tour for T.Y. B.Sc. Statistics students should be arranged and study report should be attached in the journal.
13. **Instructions for Examination**:
    a) **Medium of Instructions**: English
    b) **Pattern of examination**: Semester wise.
    c) **Standard of passing**: 20 Marks out of 50 marks for each paper. There is separate passing for internal and end semester university examination. (Student should obtain minimum 14 marks out of 35 in the external university examinationand minimum 06 marks out of 15 in the internal assessment).
    d) **Verification / Revaluation**: Allowed for Theory papers only.
    e) **Pattern of university question papers for ESE (Total 35 marks):**

For ST−351 to ST−356 and ST−361 to ST−366 (A), (B), (C).

Q.1	***(A) Multiple choice questions: 03 questions each of 01 marks.*** ***(B) True or false:02 questions each of 01 marks.***	***[03 Marks]*** ***[02 Marks]***
Q.2.	***Attempt any 02 out of 03 questions each of 05 marks.***	***[10 Marks]***
Q.3.	***Attempt any 02 out of 03 questions each of 05 marks.***	***[10 Marks]***
Q.4.	***Attempt any 01 out of 02 questions each of 10 marks.***	***[10 Marks]***

14. **Skill Enhancement Courses (SEC)**
    a) Skill Enhancement Courses (SEC) are considered as the practical courses.
    b) For SEC concerned teacher should conduct atleast 10 practicals (experiments) and it shall cover all the topics in the respective course with weightageproportional to the number of contact hours prescribed.

c) Students must complete all the practicals (experiments) in each of the SEC to the satisfaction of concernedteachers. Also, students must produce the journal along with the completion certificate duly signed by the Head of the Departmentat the time of the examination of SEC.

15. **Structure of evaluation of practical courses: ST 357, ST 358, ST 359, ST 367, ST 368 and skill enhancement courses (SEC) as:**

A) Continuous internal assessment (CIA)	
Section	Marks
I) Journal	10
II) Viva-Voce	05
Total of A	**15**

B) End of semester examination (ESE)			
Section	Nature	Marks	Time
I	To solve 2 questions out of 4, each of 14 marks	28	2 hour 30 minutes (for calculator users) 2 hour (for computer users)
II	Viva-Voce	7	10 minutes
Total of B		**35**	**2 hour 40 minutes (for calculator users)** **2 hour 10 minutes (for computer users)**

Grand Total of A and B : 15 + 35 = 50 marks

16. **Guidelines for conducting University examination (as per circular number 61 of 2005) for skill enhancement courses (SEC),**

- **ST 3510: Turbo C (Practical course),**
- **ST 3511: Statistical Computing using R-software (Practical course),**
- **ST 3610: Introduction to Python (Practical course) and**
- **ST 3611: Data Analytics (Practical course)**

a. The examination will be conducted in Statistics laboratory on computers.

b. Provision of at least 15 computers with necessary Turbo C, R-software and Pythonsoftwares installed should be made available by the centre.

c. Duration of examination is TWO hours.

d. Examination will be conducted at the time of theory examination of T.Y.B.Sc. Semester V and VI.

e. The examination will be conducted batch wise. A batch size will preferably be 12 candidates.

f. There will be no verification and revaluation of the aforesaidSECs.

g. If possible, the candidate will attach the printout of his/her above referred answer book.

h. The duration of this examination will be extended by 10 minutes for getting printouts.

i. Printouts of charts, graphs are not required. However they should be shown to the examiner on computer itself.

j. In case of partial power failure proportionate additional time may be given at that centre for the concerned batch. In case of total power failure candidates are required to write the answers in the answer book as in the case of regular theory examination.

k. The slips (question paper) made available for skill enhancement courses (SEC) shall be allotted to the candidates at random so that the total of marks in the slips will be exactly 28.

l. A candidate will solve the problems in the slip given to him/ her on computer and the output of work obtained by him/her will be evaluated by the examiner.

m. Answer book for this examination will be the answer book which is used at the time of theory examination.

n. One internal examiner and one external examiner will be appointed by the University for this Examination.

o. Internal and External examiners will examine the answer books jointly at the centre immediately after examination is over. **They will prepare mark list and enter the marks on University marks entry link after examination is over.**

p. For the conduct of this examination following staff will be appointed at the centre for each batch: **One peon, one technical assistant (computer maintenance person), one junior supervisor, one laboratory supervisor, one laboratory assistant.**

q. Remuneration to both examiners will be paid separately at the rate which is prescribed by the University for the Examiner of Practical examination of science subjects after the examination work is over.

Semester V

ST 351: DISTRIBUTION THEORY – I

1. Beta Distributions **(8L)**

1.1 Beta distributions of first kind : p.d.f.

$$f(x) = \frac{1}{B(m,n)} x^{m-1}(1-x)^{n-1}; \quad 0 \le x \le 1, \quad m,n > 0$$

= 0; elsewhere

Notation :$X \sim \beta_1(m,n)$, Nature of probability curve, symmetry, mean, variance, properties, r[th] raw moment, harmonic mean, median for $\beta_1(m,m)$.

1.2 Relation with U(0,1). The probability distributions of $\frac{1}{X}, X+Y, X-Y, XY, \frac{X}{Y}$where X and Y are i.i.d. $\beta_1(1,1)$.

1.3 Beta distributions of second kind

p.d.f.

$$f(x) = \frac{1}{B(m,n)} \frac{x^{m+1}}{(1+x)^{m+n}}; \quad x \ge 0, \quad m,n > 0$$

= 0; elsewhere

Notation :$X \sim \beta_2(m,n)$, Nature of probability curve, symmetry, mean, variance, properties, r[th] raw moment, harmonic mean, median for $\beta_2(m,m)$.

1.4 Interrelation between $\beta_1(m,n)$ and $\beta_2(m,n)$.

1.5 Distribution of $\frac{X}{Y}$, $\frac{X}{X+Y}$ etc. when X and Y are independent gamma variates.

1.6 Relation between distribution functions of $\beta_1(m,n)$ and binomial distribution.

1.7 Real life situations and applications.

2. Order Statistics **(10L)**

2.1 Order statistics for a random sample of size n from a continuous distribution, definition, derivation of distribution function and density function of the i-th order statistic $X_{(i)}$, particular cases for $i = 1$ and $i = n$. Distribution of $X_{(i)}$froma random sample following uniform and exponential distributions.

2.2 Derivation of joint p.d.f. of $(X_{(i)}, X_{(j)})$, probability distribution of sample range $X_{(n)} - X_{(1)}$.

2.3 Distribution of sample median

2.4 $Corr(X_{(i)}, X_{(j)})$when$X_1, X_2, \ldots . X_n$are i.i.d. uniform r.v.s ,distribution of $X_{(n)} - X_{(1)}$ and sample median. Comment on unbiased estimator of θ for $U(0,\theta)$ and exponential(θ) based on order statistics.

2.5 Joint distribution of $X_{(1)}, X_{(2)}, \ldots . X_{(n)}$

3. Cauchy distribution **(6L)**

3.1 p.d.f.

$$f(x) = \frac{\lambda}{\pi}\frac{1}{\lambda^2 + (x-\mu)^2};\ -\infty < X < \infty;\ -\infty < \mu < \infty;\ \lambda > 0$$

=0; elsewhere

3.2 Nature of the probability curve.

3.3 Distribution function, quartiles, non – existence of moments, distribution of i) $1/X$ ii) X^2 where $X \sim C(0,1)$ iii) $aX + b$

3.4 Additive property for two independent Cauchy variates (statement only), statement of distribution of the sample mean, comment on limiting distribution of X .

3.5 Relationship with uniform, Student's-t and normal distributions.

3.6 Applications of $C(\mu, \lambda)$

4. Chebychev's Inequality. **(4L)**

4.1 Chebychev's theorem: If g (x) is a non – negative function of r.v. X such that $E[g(X)] < \infty$ then, $P[g(X) \geq k] \leq \{E[g(X)]/k\}$ where k is positive real number.

4.2 Chebychev's inequality for discrete and continuous distributions (with proof) in the forms $P[|X-\mu| \geq k] \leq \left\{\sigma^2/k^2\right\}$, where $k > 1$, $P[|X-\mu| \geq k\sigma] \leq \left\{1/k^2\right\}$, $k > 1$. Where $\mu = E(X)$ and $\sigma^2 = Var(X) < \infty$.

4.3 Applications of Chebychev's inequality in control charts, statistical inference.

5. Central Limit Theorem and Weak Law of Large Numbers **(8L)**

5.1 Sequence of r.v.s. , convergence of sequence of r.v. in a) probability b) distribution, with simple illustrations.

5.2 De Moivre - Laplace theorem (Binomial distribution tends to Normal distribution for large n), Statement and proof of the central limit theorem for i.i.d. r.v.s. (proof based on MGF), simulation-based demonstrations.

5.3 Weak law of large numbers (WLLN), Simulation-based demonstrations

5.4 Applications of CLT and WLLN.

Books Recommended :

1. H. Cramer (1992). Mathematical Methods of Statistics, Princeton University Press

2. Mood, A.M. Graybill, F.Boes, D. (2017). Introduction to Theory of Statistics, 3rdEdn.,Mc-Graw Hill Series.

3. B.W. Lindgren (1993). Statistical Theory, 4thEdn., CRC Press, London.

4. Hogg, R.V. McKean, J. and Craig A.T. (2012). Introduction to Mathematical Statistics, 7thEdn., Pearson,

5. Sanjay Arora and BansiLal (1989). New Mathematical Statistics: A problem-oriented First Course, SatyaPrakashan New Delhi.

6. S.C. Gupta and V. K. Kapoor (2020). Fundamentals of Mathematical Statistics, 12thEdn.,Sultan Chand and Sons, 88, Daryaganj, New Delhi, 2.

7. V.K. Rohatgi and Saleh A. K. Md. E. (2015). An Introduction to Probability Theory and

Statistics, 3rdEdn. Wiley, New York
8. Feller W. (1968). An Introduction of Probability Theory and Its Applications, Vol. I, 3rdEdn., Wiley.
9.Sheldon Ross (2018). A first course in probability, 10thEdn.,Pearson Education.
10. Buyan, K. C. (2010). Probability theory and Statistical inference ,1stEdn., New Central Book Agency.

ST 352: THEORY OF ESTIMATION

1. Point Estimation and Interval Estimation (4L)

1.1 Notion of a parameter, parameter space.

1.2 General problem of estimating an unknown parameter by point and interval estimation (using Pivotal quantity approach).

1.3 Point Estimation: Definition of an estimator, distinction between estimator and estimate, illustrative examples. Mean Square Error (MSE) of an estimator.

2. Methods of Estimation (8L)

2.1 Likelihood Function, Definition of likelihood as a function of unknown parameter for a random sample comes from i) discrete ii) continuous distribution.

Distinction between the likelihood function and p.d.f. or p.m.f.

2.2 Method of maximum likelihood: Derivation of maximum likelihood estimator (M.L.E.) for parameters of only standard distributions (case of two unknown parameters only for normal distribution). Invariance property of M.L.E. M.L.E. of θ in uniform distribution over i) (0, θ) ii) (- θ, θ) iii) (mθ, nθ) (m < n), M.L.E. of θ in f(x ; θ)= Exp {-(x- θ)}, x >θ, M.L.E. of location parameter in Laplacedistribution.

2.3 Method of moments: Derivation of moment estimator for standard distributions. Illustrations of situations where M.L.E. and moment estimators are distinct and their comparison using MSE.

3. Properties of Estimator (20L)

3.1 Unbiasedness: Definition of an unbiased estimator, biased estimator, positive and negative bias, illustrations and examples (these should include unbiased and biased estimators for the same parameters). Proofs of the following results regarding unbiased estimators: (i) Two distinct unbiased estimators of (θ) give rise to infinitely manyestimators. (ii) If T is an unbiased estimator of θ, then ϕ(T) is unbiased estimator of ϕ(θ) provided ϕ(.) is a linearfunction.

Variance oftheestimator: Notion of the Best Linear Unbiased Estimator and uniformly minimum variance unbiased estimator (UMVUE), uniqueness of UMVUE whenever it exists.

3.2 Sufficiency: Concept and definition of sufficiency, statement of the Fisher-Neyman factorization theorem with proof for discrete probability distribution. Pitmann – Koopman form and sufficient statistic; Exponential family of probability distributions and sufficient statistic. Proofs of the following properties of sufficient statistics: (i) If T is sufficient for θ, then ϕ(T) is also sufficient for θ provided ø is a oneto one and ontofunction. (ii) If T is sufficient for

θ then T is also sufficient for $\phi(\theta)$. (iii) M.L.E. is a function of sufficientstatistic.

3.3 Fisher information function: Amount of information contained in statistic $T = T(X_1, X_2, \ldots, X_n)$. Statement regarding information in sample and in a sufficient statistic T.

3.4 Cramer- Rao Inequality: Statement and proof of Cramer - Rao inequality, Cramer – Rao Lower Bound (CRLB), definition of minimum variance bound unbiased estimator (MVBUE) of ø (θ). Proofs of following results: (i) If MVBUE exists for θ then MVBUE exists for $\phi(\theta)$ where $\phi(.)$ is alinear function.(ii) If T is MVBUE for θ then T is sufficient forθ.

3.5 Efficiency: Comparison of variance with CRLB, relative efficiency of T_1 w.r.t. T_2 for (i) unbiased (ii) biased estimators. Efficiency of unbiased estimator T w.r.t. CRLB.

4. Asymptotic Behavior of an Estimator (4L)

4.1Consistency: Definition.

4.2 Proof of the following theorems: (i) An estimator is consistent if its bias and variance both tend to zero asthe sample size tends toinfinity. (ii) If T is consistent estimator of θ and $\phi(.)$ is a continuous function,then $\phi(T)$ is a consistent estimator of $\phi(\theta)$.

Books Recommended:

1. Dudewecz, E.J. and Mishra, S.N. (1988). Modern Mathematical Statistics, John Wiley and Sons,Inc.
2. Hoel, P.G. Port, S. and Stone, C.(1972). Introduction to Statistical Theory, Houghton Mifflin Company (International) Dolphin Edition.
3. Hogg, R.V. McKean, J. and Craig A.T. (2012). Introduction to Mathematical Statistics, 7thEdn., Pearson,
4. Kendall, M. and Stuart, A. (1943). The advanced Theory of Statistics, Vol 1, Charles and Company Ltd., London
5. B.W. Lindgren (1993). Statistical Theory, 4thEdn., CRC Press, London.
6. Mood, A.M. Graybill, F.Boes, D. (2017). Introduction to Theory of Statistics, 3rdEdn.,Mc-Graw Hill Series.
7. V.K. Rohatgi and Saleh A. K. Md. E. (2015). An Introduction to Probability Theory and Statistics, 3rdEdn. Wiley, New York
8. Ramchandran, K.M. and Tsokos C. P. (2009). Mathematical Statistics with Applications, Academic Press.
9. Buyan, K. C. (2010) (Probability theory and Statistical inference , 1stEdn., New Central Book Agency.

ST 353: DESIGN AND ANALYSIS OF EXPERIMENTS

1. Design of Experiments (22L)

1.1 Analysis of variance (ANOVA): only concept and technique.

1.2 Basic terms: Experimental unit, treatment, layout of an experiment.

1.3 Basic principles: Replication, randomization and local control. Choice of size and shape of a plot for uniformity trials, the empirical formula for the variance per unit area of plots, definitions of Linear Treatment contrasts, orthogonal treatment contrasts

1.4 Completely Randomized Design (CRD): Application of the principles of design of experiment in CRD, Layout, Model: $X_{ij} = \mu + \alpha_i + \varepsilon_{ij}$; i= 1,2, ...t. j = 1,2,....., n_i, Assumptions and interpretations. Testing normality of residuals (ε_{ij}) graphically (normal probability plot). Breakup of total sum of squares into components. Estimation of parameters, expected values of mean sums of squares, components of variance, preparation of ANOVA table, testing equality of treatment effects, Hypothesis to be tested $H_0 : \alpha_1 = \alpha_2 = ... = \alpha_t = 0$. Comparison of treatment means using box plot techniques. Statement of Cochran's theorem. F test for testing H_0 with justification (independence of chi- square is to be assumed), test for equality of two specified treatment effects using critical difference (C.D). Equivalence between ANOVA and regression model.

1.5 Randomized Block Design (RBD): Application of the principles of design of experiments in RBD, layout. Model: $X_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij}$; i= 1,2, ...t. j = 1,2,..... b. Assumptions and interpretations. Breakup of total sum of squares into components. Estimation of parameters, expected values of mean sums of squares, components of variance, preparation of analysis of variance table, Hypotheses to be tested

$H_{01}: \alpha_1 = \alpha_2 = \alpha_3 = ... = \alpha_t = 0$, $H_{02}: \beta_1 = \beta_2 = ... = \beta_b = 0$.

F-test for testing H_{01} and H_{02} with justification (independence of chi-squares is to be assumed), test for equality of two specified treatment effects using CD.

1.6 Latin Square Design (LSD): Application of the principles of design of experiments in LSD, layout, Model :$X_{ij(k)} = \mu + \alpha_i + \beta_j + \gamma_k + \varepsilon_{ij(k)}$; i,j,k=1,2,⋯,m, Assumptions and interpretations. Breakup of total sum of squares into components. Estimation of parameters, expected values of mean sums of squares, components of variance, preparation of analysis of variance table, hypotheses to be tested.

$H_{01} : \alpha_1 = \alpha_2 = \cdots = \alpha_m = 0$, $H_{02} : \beta_1 = \beta_2 = \cdots = \beta_m = 0$, $H_{03} : \gamma_1 = \gamma_2 = \cdots = \gamma_m = 0$ and their interpretation. Justification of F test for H_{01}, H_{02} and H_{03} Independence of chi-square is to be assumed). Preparation of ANOVA table and F test for H_{01}, H_{02} and H_{03} testing for equality of two specified treatment effects, comparison of treatment effects using C.D.

1.7 Identification of real life situations where the above designs are used.

1.8 Analysis of non- normal data using. i) Square root transformation for counts.

ii) $Sin^{-1}(.)$ transformation for proportions.

2. Efficiency of Design **(3L)**

2.1 Concept and definition of efficiency of a design.

2.2 Efficiency of RBD over CRD.

2.3 Efficiency of LSD over (i) CRD (ii) RBD.

3. Factorial Experiments **(11L)**

3.1 General description of m^nfactorial experiment, $2^2$and 2^3factorial experiments arranged in RBD.

3.2 Definitions of main effects and interaction effects in 2^2 and 2^3factorial experiments.

3.3 Yate's procedure, preparation of ANOVA table, test for main effects and

interaction effects.
3.4 General idea of confounding in factorial experiments.
3.5 Construction of layouts in total confounding and partial confounding in 2^2 and 2^3 factorial experiments.
3.6 Total confounding (confounding only one interaction) ANOVA table, testing main effects and interaction effects.
3.7 Partial confounding (confounding only one interaction per replicate); ANOVA table, testing main effects and interaction effects.

Books Recommended

1. Cochran W.G. and Cox, C.M. (1992) Experimental Design, John Wiley and Sons, Inc., New York.
2. Dass, M.N. and Giri,N.C. (1987) Design and Analysis of Experiments, II Edition Wiley Eastern Ltd., New Delhi
3. Federer W.T. (1967) Experimental Design : Oxford and IBH Publishing Co., New Delhi
4. Goon, A.M., Gupta,M.K. and Dasgupta, B. (1998). Fundamentals of Statistics, Vol.II, The world Press Pvt. Ltd. Kolkatta
5. Gupta S.C. and Kapoor V.K.(2006). Fundamentals of Applied Statistics, S.Chand Sons, New Delhi
6. Johnson, R.A., Miller, I. and Freund, J.(2010). Probability and Statistics for Engineers, Prentice Hall, India.
7. Kempthorne, O. (1994). Design of Experiments: Introduction to Experimental Design, Wiley , New York
8. Montgomery, D.C. (2012). Design and Analysis of Experiments, John Wiley and sons Inc., New Delhi.
9. Snedecor, G.W. and Cochran, W.G. (1994). Statistical Methods, 8Th edition, Affiliated East – West Press, New Delhi
10. Wu, C.F.J. and Hamda, M. (2009). Experiments, Planning, Analysis and Parameter Design Optimization, John Wiley &Sons,Inc.,Hoboken,New Jersey.

ST-354: STATISTICAL PROCESS AND PRODUCT CONTROL

1. Introduction to Statistical Quality Control (SQC) (5L)

1.1 Meaning of quality, total quality management (TQM), six-sigma, ISI, ISO,
1.2 Meaning and purpose of Statistical Quality Control (SQC), Seven Process Control
1.2 Tools of Statistical Quality Control (SQC) (i) Check Sheet, (ii) Cause and effect diagram(CED), (iii) Pareto Diagram, (iv) Histogram, (v) Control chart, (vi)Scatter Diagram,(vii) Design of Experiments (DOE). (Only introduction of 7 PC tools is expected).

2. Control Charts (4L)

2.1 Chance causes and assignable causes of variation, statistical basis of control charts, exact probability limits, k-sigma limits, justification for the use of 3- sigma limits for normal distribution and using Chebychev's inequality for non-normal distributions.

2.2 Criteria for detecting lack of control situations:

(i) At least one point outside the control limits

(ii) A run of seven or more points above or below central line.

(iii) Presence of a non random pattern eg. cycle or linear trends etc.

2.3 Control chart technique as hypotheses testing problem.

2.4 Construction of control charts for (i) standards given, (ii) standards not given.

3 Control charts for variables and attributes (12 L)

3.1 Introduction of R chart and $\bar{X}$ chart

3.2 a) Construction of R chart when the process standard deviation is specified: control limits, drawing of control chart, plotting of sample ranges, drawing conclusion-determination of state of control process, corrective action if the process is out of statistical control. Construction of $\bar{X}$chart when the process average is specified: control limits, drawing of control chart, plotting of sample means. Drawing conclusion - determination of state of control of process, corrective action if the process is out of statistical control.

b) Construction of R chart when the process standard deviation (σ) is not given:
control limits, drawing of control chart, plotting sample range values, revision of control limits if necessary, estimate of σ for future use.

3.3 Construction of $\bar{X}$chart when the process average (μ) is not given :

control limits based $\hat{\mu} = \bar{X}$, $\hat{\sigma} = {\bar{R}}/{d_2}$ drawing of control chart, plotting sample means, revision of control limits of $\bar{X}$ chart, if necessary.

Note: To find revised control limits of any control chart delete the sample points above UCL and points below LCL (assuming a search for assignable causes at those points), in case of R and$\bar{X}$charts, first of all, revisions of control limits of R is to be completed and then by using the observations for which R chart shows the process is under control, the control limits for $\bar{X}$ chart should be determined. Revision of control limits of $\bar{X}$ chart be continued without revising the value of R or Estimate of $\mu$and σ for further use. Determination of state of control of the process. Probability of catching a shift. Identification of real life situations where this technique can be used. Limitations of $\bar{X}$, R charts.

3.4 p- chart: a) Construction and working of p-chart when subgroup sizes are same and value of the process fraction defective P is specified: control limits, drawing of control chart, plotting of sample fraction defectives. Determination of state of control of the process.

b) p-chart when subgroups sizes are different and value of the process fraction defective P is not specified with i) separate control limits ii) average sample size iii) standardized control chart. Drawing of control chart, plotting sample fraction defectives, determination of state of control of the process. Interpretation of high and low spots. Identification of real life situations. Probability of catching a shift.

3.5 C - Chart: a) Construction of c-chart when standard is given; control limits justification of 3 sigma limits, drawing of control chart, plotting number of defects per unit.
(b) Construction of c chart when standard is not given; control limits, explanation for the use of 3-sigma limits, drawing of control chart. Plotting number of defects per unit. Determination of state of control, interpretation of high and low spots in above cases. Identification of real life situations.

4. Process Capability Analysis (5L)

4.1 Specification limits, natural tolerance limits and their comparisons, decisions based on these comparisons, estimate of percent defectives.
4.2 Capability ratio and capability indices (Cp), capability performance indices(Cpk) with respect to machine and process, interpretation, relationship between (i) Cp and Cpk (ii) defective parts per million and Cp.

5. Sampling Plans (10 L)

5.1 Acceptance Sampling for Attributes: Introduction, Concept of sampling inspection plan, Comparison between 100% inspection and sampling inspection. Procedures of acceptance sampling with rectification, Single sampling plan and double sampling plan. Probabilities of acceptance and rejection
5.2 Explanation of the terms: Producer's risk and Consumer's risk, Operating characteristic (OC) curve, Acceptable Quality Level (AQL), Lot Tolerance Fraction Defective (LTFD) and Lot Tolerance Percent Defective (LTPD), Average Outgoing Quality (AOQ) and Average Outgoing Quality Limit (AOQL), AOQ curve, Average Sample Number (ASN), Average Total Inspection (ATI)
5.3 Single Sampling Plan: Computation of probability of acceptance using Poisson approximation, Derivation of AOQ and ATI. Graphical determination of AOQL, Determination of a single sampling plan by: a) lot quality approach b) average quality approach.
5.4 Double Sampling Plan: Evaluation of probability of acceptance using Poisson distribution, Structure of OC Curve, Derivation of AOQ, ASN and ATI (with complete inspection of second sample), Graphical determination of AOQL, Comparison of single sampling plan and double sample plan.

Books Recommended

1. Besterfield, D.H. and Michna , C.B. et al. (2009). Total Quality Management, 3rd edition, Pearson Education, Delhi.34
2. Dodge, H.F. and Roming, H.G. Sampling Inspection tables, John Wiley and Sons, Inc. New York
3. Duncan A.J. (1974). Quality Control and Industrial Statistics, fourth edition D.B. Taraporewala Sons and Co. Pvt. Ltd., Mumbai.
4. Grant, E. L. and Leavenworth (1980). Statistical Quality Control, fifth edition, Mc-Graw Hill, New Delhi.
5. Johnson, N.L. and Kotz, S. (1993). Capability Studies, Chapman and Hall Publishers.
6. Kamji and Asher (1996). 100 Methods of TQM, Sage Publishers, Delhi
7. Montgomery, D. C. (2008). Statistical Quality Control, 6thEdn., John Wiley, New York.
8. SP20 : Handbook of SQC, Bureau of Indian Standards.

ST 355: OPERATION RESEARCH - I

1 Introduction (2L)

1.1 History (Sec. 1.2)

1.2 Definition – (Sec. 1.3 – i. Daellenbach& George, ii. Theierauf&Klekamp, H. A. Taha)

1.3 Features of Operations Research Approach – Interdisciplinary Approach, Scientific Approach, Holistic Approach, Objective-Oriented Approach (Sec. 1.4).

1.4 Operations Research Approach to problem solving – Judgment, Research, Action (Sec. 1.5).

1.5 Classification of models based on Static models, Dynamic models, Deterministic models, Analytical model, Simulation model (Sec. 1.6.3 & 1.6.4,1.6.5).

1.6 Methods for solving models – Analytical method, Numerical method, Monte Carlo Method (Sec. 1.8).

1.7 Advantages, Opportunities and disadvantages of Operations research (Sec. 1.10, Sec. 1.11).

1.8 Applications of Operation Research – Finance and Accounting, Marketing, Purchase, Procurement and Exploration, Production Management (Sec. 1.13).

2 Linear Programming (15L)

2.1 Statement of the Linear Programming Problem (LPP), Formulation of problem as L.P. problem. L.P. Problem in (i) Canonical form (ii) standard form. Definition of (i) A slack variable (ii) A surplus Variable (iii) a solution (iv) a feasible solution (v) a basic feasible solution, (vi) a degenerate and non –degenerate solution vii) an optimal solution (viii) basic and non-basic variables .

2.2 Solution of L.P.P by: i) Graphical Method: solution space, unique and non-unique solutions, obtaining an optimal solution. Ii) Simplex Method: a) Initial basic feasible solution (IBFS) is readily available: obtaining an IBFS, criteria for deciding whether obtained solution is optimal criteria for unbounded solution, no solution, and more than one solution. B) IBFS not readily available: introduction of artificial variable, Big-M method, modified objective function, modifications and application of simplex method to L.P.P. with artificial variables.

2.3 Duality Theory: i) Writing dual of a primal problem, ii) Solution of a L.P.P. by using its dual problem.

3 Transportation and Assignment Problem (11L)

3.1 Transportation problem (T.P.), statement of T.P., balanced and unbalanced T.P.

3.2 Methods of obtaining basic feasible solution of T.P: i) North-West corner rule ii) Method of matrix minima (least cost method), iii) Vogel's approximation method (VAM).

3.3 U-V method of obtaining Optimal solution of T.P., degenerate solution, uniqueness and non- uniqueness of optimal solutions.

3.4 Assignment problems: i) Statement of an assignment, balanced and unbalanced problem, ii)relation with T.P. iii) optimal solution of an assignment problem using Hungarian method.

3.5 Examples and numerical problems.

4 CPM and PERT **(8L)**

4.1 Introduction (Sec. 13.1)

4.2 Basic differences between PERT and CPM. (Sec. 13.2).

4.3 Definition of (i) Events with Merge and Burst Events,(ii) Node,(iii) Activities – Predecessor, Successor, Dummy,(iv)Critical Activity,(v)Project Duration. (Sec. 13.4).

4.4 CPM: Construction of network, Definitions of (i) earliest start time (ii) earliest finish time (iii) latest start time (iii) latest finish time for an activity. Types of float - total floats, free float, independent float and their significance. Determination of critical path (Sec. 13.5).

4.5 PERT: Construction of network; (i) pessimistic time estimate, (ii) optimistic time estimate (iii) most likely time estimates, Determination of critical path, determination of mean and standard deviation of project duration, computations of probability of completing the project in a specified duration. (Sec. 13.6).

Note: All sections are from the book "Operations Research-Theory and Application" by J. K. Sharma

Books Recommended

1. Gass, S. I. (2011). Linear Programming Method and Applications, 5thEdn. Dover Publications
2. Taha, H. A. (2017). Operation Research – An Introduction, 10th Edition, Pearson,
3. Saceini, M., Yaspan, A. and Friedman, L. (2013). Operation Research: Method and Problems, Literary Licensing
4. Shrinath L.S. (1982). Linear Programming: Principles & Applications, , Affiliated East-West Press Pvt. Ltd. New Delhi.
5. Phillips, D.T., Ravindra, A., Solberg, J. (1987). Operations Research Principles and Practice, 2ndEdn.,John Wiley and Sons Inc.
6. Sharma J. K. (2012). Mathematical Models in Operations Research,5thEdn., MACIN
7. Kapoor, V. K. (2012). Operation Research: Concepts, Problems and Solutions, Sultan Chand and Sons, New Delhi.
8. Gupta, P. K. and Hira, D.S. (1976). Operations Research, S. Chand and company Ltd., New Delhi.
9. Shrinath, L.S. (2001). PERT-CPM Principles and Applications, Affiliated East-West Press Pvt. Ltd., New Delhi.

ST 356: REGRESSION ANALYSIS

1. Simple Linear Regression Model **(11L)**

1.1 Review of simple linear regression model : $Y = \beta_0 + \beta_1 X + \epsilon$, where ϵ is continuous random variable with $E(\epsilon) = 0$, $V(\epsilon) = \sigma^2$. Assumptions of simple linear regression. Estimation of $\beta_0$and β_1, by the method of least squares.

1.2 Properties of estimators of β_0, and β_1. (Sec. 2. 2. 2)

1.3 Estimation of σ^2. (Sec. 2. 2. 3)

1.4 Tests of hypothesis of β_1. (Sec. 2. 3)

1.5 Interval estimation in simple linear regression model. (Sec. 2. 4)

1.6 Coefficient of determination.(Sec. 2. 6)
1.7 Residual analysis (Sec. 4.1, 4.2.1) : Standardized residuals, Studentized residuals, (Sec. 4. 2. 2), Residual plots (Sec. 4. 2. 3)
1.8 Detection and treatment of outliers. (Sec. 4. 4)
1.9 Interpretation of three plots produced by lm command in R.

2. Multiple Linear Regression Model (15L)

2.1 Review of multiple linear regression model $Y = \beta_0 + \beta_1 X_1 + \ldots + \beta_p X_p + \epsilon$, where ϵ is a continuous random variable with $E(\epsilon) = 0$, $V(\epsilon) = \sigma^2$. Assumptions of multiple linear regression. Estimation of regression parameters β_0, β_1, … and β_p by the method of least squares, obtaining normal equations, solutions of normal equations. (Sec. 3. 2. 1)
2.2 Estimation of σ^2(Sec. 3. 2. 4)
2.3 Tests of hypothesis of regression parameters. (Sec. 3. 3. 1, 3. 3. 2)
2.4 Interval estimation in regression model. (Sec.3. 4. 1)
2.5 Residual diagnostics and corrective measures such as transformation of response variable, (Sec. 5. 1, 5. 2, 5. 3)

3. Logistic Regression Model (10 L)

3.1 Binary response variable, Logit transformation, estimation of parameters, interpretation of parameters (Sec. 13. 2. 1, 13. 2. 2, 13. 2. 3 or chapter 1 except sec. 1.5 of HL)
3.2 Tests of hypotheses of model parameters, model deviance, Test based on likelihood ratios(LR).(Sec. 13. 2. 4, or chapter 1 except sec. 1.5 of HL)
3.3 AIC and BIC criteria for model selection.
3.4 Interpretation of output produced by glm command in R.
3.5 Introduction to Multiple logistic regression (Sec.2.1, 2.2 and 2.3 of HL)

Note:
(i) All sections are from the book “Introduction to Linear Regression Analysis” by Montgomery, D. C., Peck, E.A. and Vining, G. G.
(ii) HL stands for the book “Applied Logistic Regression “ byHosmer, D.W. and Lemeshow, S.

Books Recommended

1. Draper, N. R. and Smith, H. (1998)Applied Regression analysis (John Wiley) Third Edition.
2. Hosmer, D.W. and Lameshow, S.(1989). Applied Logistic Regression (Wiley).
3. Montgomery, D. C., Peck, E. A. and Vining, G.G. (2003). Introduction to Linear Regression Analysis(Wiley).
4. Neter, J., W., Kutner, M. H. ;Nachtsheim, C. J. and Wasserman, W. (1996). Applied Linear Statistical Models, fourth edition, Irwin USA.
5. Chatterjee S. and Hadi A.S.(2012) : Regression Analysis by Example, 5 thEdition,Wiley.
6. Kleinbaum G. and Klein M. (2011) : Logistic Regression, IIIrd Edition A Self learning text, Springer.

ST 357: PRACTICAL PAPER-I

Sr. No.	Title of the Experiment	No. of Experiments
1.	Chebychev's inequality and Order Statistics.	1
2.	Central Limit Theorem and Weak law of large numbers. Verification using simulation approach.	1
3.	Model sampling from Cauchy distribution.	1
4.	Construction of confidence interval for population mean (μ) for normal distribution when σ^2 known and σ^2 unknown.	1
5.	Construction of confidence interval for Population variance (σ^2) for normal distribution when μ known and μ unknown.	1
6.	Construction of confidence interval for population median and quartiles based on order statistics.	1
7	M.L.E and moment estimator of truncated Binomial and truncated Poisson distributions (truncated at zero).	1
8.	Simple regression analysis and diagnostics. (Estimation of Parameter, Test for significance of parameters Regression model, Interval Estimation, Interpretation of parameters. Computation of R-square, Residual Analysis by graphical method).	1
9.	Multiple regression analysis and diagnostics. (Estimation of Parameter, Test for significance of parameters Regression model, Interval Estimation, Interpretation of parameters, Computation of R-square, Adjusted R-square, Residual Analysis by graphical method, Variable selection methods).	1
10.	Logistic regression. (Estimation of Parameter, Test for significance of parameters Regression model, Interval Estimation, Interpretation of parameter/(s)).	1
11.	Simulations from nonstandard distributions (for given pmf/pdf), chi-square, t-distributions and F-distributions.	1
12.	Monte Carlo techniques to find approximate numerical value of gamma and beta function with real arguments.	1
Total no. of practicals		**12**

Note: Regression analysis practicals are performed using MS-Excel or R-software. (Using built in commands/direct commands available in MS-Excel and R-software).

ST 358: PRACTICAL PAPER – II

Sr. No.	Title of the experiment	No. of experiments
1	Analysis of CRD (equal and unequal replications), pair wise comparison of treatments using critical difference (C.D) method.	1
2	Analysis of RBD pair wise comparison of treatments using i) C.D ii) Tukey and Scheff's procedure (explain its theory in brief). Efficiency of RBD w.r.t. CRD	2
3	Analysis of LSD, pair wise comparison of treatments using C.D. Efficiency of LSD w.r.t. i) CRD ii) RBD.	2
4	Analysis of variance (ANOVA) for CRD, RBD and LSD using Kruskal Wallis test (explain its theory in brief)	1
5	Analysis of covariance in CRD, testing $\beta = 0$,	1
6	Analysis of covariance in RBD , testing $\beta = 0$	1
7	Analysis of $2^2$and 2^3 factorial experiments in RBD.	1
8	Analysis of 2^3 factorial experiments in RBD (partial confounding).	2
9	Analysis of 2^3 factorial experiments in RBD (total confounding).	1
Total no. of practicals		**12**

ST 359: PRACTICAL PAPER - III

Sr. No.	Title of the Experiment	No. of Experiments
1	Construction of R and $\bar{X}$chart, $\overline{\mathrm{X}} - \mathrm{MR}$ control chart, Probability of Catching shift.	1
2	p-chart for(I) fixed sample size (ii) variable sample size based on individual control limits, probability of detecting shift.	1
3	Single sampling plan for attributes (OC Curve, Producer's and Consumer's risks, AOQ, AOQL, ATI)	1
4	Determination of single sampling plan by: a) lot quality approach b) average quality approach	1
5	Double sampling plan for attributes (OC curve, AOQ, AOQL, ATI, ASN using Poisson distribution).	1
6	Linear programming problem I (Simplex method)	1

7	Linear programming problem II (Dual Simplex method)	1
8	Transportation problem	1
9	Assignment problem	1
10	CPM and PERT	2
11	Cost Benefit Analysis: determination of project duration and its associated cost when (i) Normal times are considered (ii) Crash times are considered. Determination of optimal network.	1
Total no. of practicals		**12**

Note: Practicals Based on Operations Research are to be verified using TORA

ST 3510: TURBO C(PRACTICAL COURSE)

1. C- Fundamentals **(6 L)**

1.1 Introduction

1.1 Algorithms and flowcharts.

1.2 Introduction to procedural language, middle level language, higher level language, general language structure, character set, keywords, identifiers.

1.3 Data types: Numeric and character data types, Numeric and character constants, string constants, symbolic constants.

1.4 Operators: Numeric, logical, arithmetic, unary, relational, equality, decrement, increment, conditional assignments, precedence of operator expressions and their evaluation.

1.5 Data input/output, numeric and character data, printf ( ), scanf ( ), getchar ( ), putchar ( ), gets ( ), puts ( ).

1.6 Formatted output

Programs on this unit

i. Converting °C temperature to °F
ii. To carry out arithmetic calculations (addition, subtraction, multiplication, division).
iii. To find area and perimeter of triangle, rectangle and square.
iv. To find area and circumference of circle.

2. Control Structures **(8L)**

2.1 Introduction

2.2 If, if else, while, do....while, for, switch, goto, break, continue,nested loops, programs using control structures.

Programs on this unit

i. To find roots of quadratic equation and print the outputs according to Discriminant using switch and do while operations.
ii. To check whether given number is odd or even.
iii. To check whether given number m is divisible by n or not.
iv. To find maximum of 2 numbers or 3 numbers.
v. To check whether integer is prime or not.

3. Arrays **(11L)**

3.1 Introduction & Concept.

3.2 declaration, definition, initialization of array, problem using arrays, passing to function, arrays

3.3 string operations, string functions like strcpy(), strcat(), strlen(), strcmp(), strrev().

Programs on this unit

i. To find arithmetic mean, geometric mean, harmonic mean, median, variance and coefficient of variation of frequency distribution.
ii. To find correlation coefficient and least square regression line of Y on X for a given bivariate data.
iii. To arrange the given data in increasing/decreasing order of magnitude.
v. To obtain median of given n observations.
vi. To obtain addition of two matrices, multiplication of two matrices.
vii. To test palindrome string using string function.
viii. To sort a string using string function.
ix. To search string using string function.
x. To combine given two strings using string function.
xi. To copy the string using string copy function.
xii. To find the length of the given string using string length function (strlen()).
xiii. To reverse the given string using string reverse function (strrev()).
xiv. To concatenates destination and source string (strcat()).
xv. To compare two strings using string compare function (strcmp()).

4. Functions **(7L)**

4.1 Introduction

4.2 Declaration, definition, recursion, user defined functions, library function, calling a function by reference and by value, local and global variables.

Programs on this unit

i. To find factorial of integer number (both recursive and non-recursive).
ii. To find the value of $X_n$where n is integer(both recursive and non-recursive).
iii. To prepare a 2X2 contingency table for chi square test and to find the value of test statistic and to check whether two attributes are independent.
iv. To fit a Binomial distribution to given data.

5. Pointers **(4L)**

5.1 Introduction

5.2 Basic concept and relation to one dimensional array.

Programs on this unit:

i. To print the address of the stored variable.
ii. To print addition/ subtraction of two numbers using pointers.

Books Recommended

1. Gottfried, B.S. (1996). Programming with C (Schaum Outline series), McGraw Hill co., London

2. Kanitkar, Y. (2008). Let us C, BFB publishers, New Delhi.
3. Karnighan, B. W. and Ritchi, M.(1988). The C programming language, Second edition,Prentice Hall.
4. Rajaraman V. (2007). Computer programming in C, Prentice Hall of India.,
5. Balgurusami, E. (2004), Programming in ANSI C, Tata McGraw Hill Education India

ST 3511: STATISTICAL COMPUTING USING R SOFTWARE(PRACTICAL COURSE)

1. Fundamentals of R **(3L)**

1.1 Revision of commands and functions studied in S.Y.B.Sc. Practical Course. Creating a vector using scan function, creating a data frame using edit command, Importing data from MS- Excel file.

1.2 Using read.table command, saving the R-output in a file using MS-Excel, concept of R-script file, Graphics using R: (a) High level plotting functions (b) Low level plotting functions

(c) Interactive graphic functions. The following statistical methods using "R"

2. Diagrams **(3L)**

2.1 Simple bar diagram, Subdivided bar diagram, Multiple bar diagram,

2.2 Pie diagram, stem and leaf diagram.

3. Graphs **(3L)**

3.1 Boxplot for one and more than one variables, rod or spike plot,

3.2 histogram for raw data with **prob =TRUE option** and for both equal and unequal class intervals,

3.3 frequency polygon, ogive curves, empirical distribution function.

3.4 Saving the diagram and graphs in MS-Word file.

4. Measures of Central Tendency, dispersion, skewness and kurtosis **(5L)**

4.1 Computations of following measures for all types of data.

a) Central tendency mean, mode, median, quartiles, deciles, percentiles, geometric mean and harmonic mean.

b) Dispersion: variance, standard deviation, coefficient of variation, mean deviation.

c) Skewness: Bowley's coefficient and Karl Pearson's coefficient of skewness.

d) Moments: Computations of raw and central moments, measures of skewness and kurtosis based on it.

5. Probability distributions **(5L)** 5.1

Simulation from distributions, computations of probabilities, cumulative probabilities, quantiles and drawing random sample using d, p, q, r functions and graphs of pmf/ pdf by varying parameters for following distributions:

5.2 Binomial, Poisson, Hypergeometric , normal, exponential, gamma, Cauchy, lognormal, Weibull, uniform, Laplace.

5.3 Fitting of Poisson and normal distribution, testing normality of data by Shapiro- Wilks test.

6 . Testing of hypothesis (1L)

6.1 Chi -square test for independence of attributes.

7. ANOVA (3L)

7.1 One way and two way classification, Bartlett's test for homoscedasticity, Kruskal Wallis test.

8. Non – parametric Tests (3L)

8.1 Wilcoxon's signed rank test , Mann Whitney Test, Kolmogorov Smirnov test

9. Programming in R (10L)

9.1 Statements: if and if… else, for loop, cat and print commands.

Writing following Programs in R:

1. Formation of strata clusters using special criterion and hence drawing a sample by stratified sampling and cluster sampling method.
2. Testing normality of number of samples.
3. Verifying the assumptions in testing H_0: $\mu = \mu_0$ and then applying appropriate test.
4. Verifying the assumptions in testing H_0: $\mu_1 = \mu_2$ and then applying appropriate test.
5. Verifying the assumptions in testing H_0: $\mu_1 = \mu_2$ in paired data and then applying appropriate test.
6. Verifying the assumptions in testing H_0: $\sigma_1^2 = \sigma_2^2$ in paired data and then applying appropriate test.
7. Verifying the assumptions in one way ANOVA and then applying appropriate test.
8. Performing number of chi – square tests.

Books recommended:

1. Crawley, M.J. (2006). Statistics – An introduction using R. John Wiley London.
2. Purohit, S.G., Deshmukh, S.R. and Gore, S.D., (2015). Statistics using R. Alpha Science International.
3. Verzani, J., (2018). Using R for introductory statistics. CRC press.
4. Schumacker, R.E., (2014). Learning statistics using R. Sage Publications.

Semester VI

ST : 361 DISTRIBUTION THEORY – II

1. Weibull Distribution (5L)

1..1p.d.f.

$$f(x) = \frac{\alpha}{\beta}\left(\frac{x}{\beta}\right)^{\alpha-1} e^{-\left(\frac{x}{\beta}\right)^{\alpha}}; x \geq 0, \alpha, \beta > 0$$

= 0 , otherwise

Notation :$X \sim W(\alpha, \beta)$.

1.2 Probability curve, location parameter, shape parameter, scale parameter, Distribution function, quartiles, mean and variance, coefficient of variation, relationship with gamma and exponential distribution, Hazard rate, IFR and DFR property.

1.3 Real life situations and applications.

2. Laplace (Double Exponential) Distribution (5L)

2.1 p.d.f

$$f(x) = \frac{\lambda}{2} e^{-\lambda|X-\mu|}; -\infty < X, \mu < \infty, \qquad \lambda > 0$$

= 0 , otherwise

Notation :$X \sim L\ (\mu,\ \lambda)$.

2.2 Nature of the probability curve.

2.3 Distribution function, quartiles, comment on MLE of μ, λ.

2.4 MGF, CGF, moments and cumulants, $\beta_1, \beta_2, \gamma_1, \gamma_2$

2.5 Laplace distribution as the distribution of the difference of two i.i.d. exponential variates with mean $1/\lambda$. Applications and real life situations.

3. Lognormal Distribution (6L)

3.1 p.d.f

$$f(x) = \frac{1}{(x-a)\sigma\sqrt{2\pi}} exp\left\{\frac{-1}{2\sigma^2}[\log(x-a) - \mu]^2\right\};\quad X > a, -\infty < \mu < \infty,\ \ \sigma > 0$$

= 0 , otherwise

Notation :$X \sim LN\ (a, \mu, \sigma^2)$.

3.2 Nature of the probability curve.

3.3 Moments (r- th moment of $X - a$), first four moments , β_1 and $\gamma_1$coefficients, quartiles, mode.

3.4 Relation with $N\ (\mu, \sigma^2)$ distribution

3.5 Distribution of $\prod X_i$ Xi's are independent lognormal variates.

3.6 Applications and real life situations

4. Truncated Normal Distribution (4L)

4.1 Normal distribution $N\ (\mu, \sigma^2)$ truncated i) to the left below a ii) to the right above b iii) to the left below a, and to the right above b, (a < b) its p.d.f. and derivation of mean and statement (without derivation) of variance.

4.2 Real life situations and applications.

5. Parato Distribution (4L)

5.1 p.d.f.

$$f(x) = \frac{\lambda}{x^{\lambda+1}}; \quad X \geq 1, \qquad \lambda > 0$$

= 0 , otherwise

5.2 Nature of pdf curve ,

5.3 Mean, variance and moments. Existence of moments for different values of λ. Symmetry, CDF

5.4 Applications in the field of economics.

6. Bivariate Normal Distribution (12L)

6.1p.d.f. of a bivariate normal distribution

$$f(x) = \frac{1}{2\pi\sigma_1\sigma_2\sqrt{1-\rho^2}} exp\left\{\frac{-1}{2(1-\rho^2)}\left[\left\{\frac{x-\mu_1}{\sigma_1}\right\}^2 + \left\{\frac{y-\mu_2}{\sigma_2}\right\}^2 - 2\rho\left\{\frac{x-\mu_1}{\sigma_1}\right\}\left\{\frac{y-\mu_2}{\sigma_2}\right\}\right]\right\};$$

$$-\infty < X, Y, \mu_1, \mu_2 < \infty, ; \ \sigma_1, \sigma_2 > 0; \ -1 < \rho < 1$$

= 0 , otherwise

Notation :$(X, Y) \sim BN\ (\mu_1, \mu_2, \sigma_1, \sigma_2\rho\ ), \underline{X} \sim N_p(\underline{\mu}\ , \Sigma)$, use of matrix algebra is recommended.

6.2 Nature of surface of p.d.f. ,marginal and conditional distributions, identification of parameters, regression of Y on X and of X on Y, independence and uncorrelatedness, MGF and moments. Distribution of $aX\ + bY\ + c, \quad X/Y$.

6.3 Applications and real life situations

Books Recommended

1. H. Cramer (1992). Mathematical Methods of Statistics, Princeton University Press

2. Mood, A.M. Graybill, F.Boes, D. (2017). Introduction to Theory of Statistics, 3rdEdn.,Mc-Graw Hill Series.

3. B.W. Lindgren (1993). Statistical Theory, 4thEdn., CRC Press, London.

4. Hogg, R.V. McKean, J. and Craig A.T. (2012). Introduction to Mathematical Statistics, 7thEdn., Pearson,

5. Sanjay Arora and BansiLal (1989). New Mathematical Statistics: A problem-oriented First Course, SatyaPrakashan New Delhi.

6. S.C. Gupta and V. K. Kapoor (2020). Fundamentals of Mathematical Statistics, 12thEdn.,Sultan Chand and Sons, 88, Daryaganj, New Delhi, 2.

7. V.K. Rohatgi and Saleh A. K. Md. E. (2015). An Introduction to Probability Theory and Statistics, 3rdEdn. Wiley, New York

9. Feller W. (1968). An Introduction of Probability Theory and Its Applications, Vol. I, 3rdEdn., Wiley.

10.Sheldon Ross (2018). A first course in probability, 10thEdn.,Pearson Education.

11. Buyan, K. C. (2010). Probability theory and Statistical inference, 1stEdn., New Central Book Agency.

ST 362: TESTING OF HYPOTHESIS

1. Parametric Tests (15 L)

1.1 Statistical hypothesis, problem of testing of hypotheses. Definition and illustrations of (1) simple hypothesis, (2) composite hypothesis, (3) test of hypothesis, (4) critical region, (5) type I and type II errors. Probabilities of type I error and type II error. Problem of controlling the probabilities of errors of two kinds. (b) Definition and illustrations of (i) level of significance, (ii) observed level of significance (p-value), (iii) size of a test, (iv) power of a test.

1.2 Definition of most powerful (M.P.) level α test of simple null hypothesis against simple alternative. Statement of Neyman - Pearson (N-P) lemma for constructing the most powerful level α test of simple null hypothesis against simple alternative hypothesis. Illustrations.

1.3 Power function of a test, power curve, definition of uniformly most powerful (UMP) level α test for one sided alternative. Illustrations.

2. Likelihood ratio tests (9L)

2.1 Notion of likelihood ratio test (LRT), $\Lambda(x) = \dfrac{\underset{\theta \epsilon \text{Ⓗ}_0}{\text{Sup}} L(\theta|\underline{x})}{\underset{\theta \epsilon \text{Ⓗ}_0 \cup \text{Ⓗ}_1}{\text{Sup}} L(\theta|\underline{x})}$

2.2 Construction of LRT for H_0: $\theta = \theta_0$ against H_1: $\theta \neq \theta_0$ for the mean of normal distribution for i) Known σ^2 ii) unknown σ^2 (one sided and two sided alternatives).

2.3 LRT for variance of normal distribution for i) known μ ii) unknown μ (one sided and two sided alternatives hypotheses).

2.4 LRT for parameters of binomial and exponential distribution for two sided alternatives only.

2.5 LRT as a function of sufficient statistics, statement of asymptotic distribution of $-2\log_e\lambda(x)$.

3. Non-parametric Tests (12 L)

3.1 Concept of non-parametric tests. Distinguish between parametric and nonparametric Tests. Concept of distribution free statistic. One tailed and two tailed test procedure of i) Sign test, ii) Wilcoxon signed rank test iii) Mann Whitney U test, iv) Run test, one sample and two samples problems

3.2 Empirical distribution function $S_n(x)$. Properties of $S_n(x)$ as estimator of F(.). Kolmogorov-Smirnov test for completely specified univariate distribution (one Sample problem only) for two sided alternative hypotheses. Comparison with chi-square test.

Books Recommended

1. B.W. Lindgren (1993). Statistical Theory, 4thEdn., CRC Press, London.
2. Daniel, W.W. (2000) Applied Nonparametric Statistics, Duxbury Press Boston.
3. Dudewecz, E.J. and Mishra, S.N. (1988). Modern Mathematical Statistics, John Wiley and Sons,Inc.
4. Gibbons J.D. andChakraborti, S. (2010). Non parametric Statistical Inference, CRC Press, London
5. Hoel, P.G. Port, S. and Stone, C.(1972). Introduction to Statistical Theory, Houghton Mifflin Company (International) Dolphin Edition.

6. Hogg, R.V. McKean, J. and Craig A.T. (2012). Introduction to Mathematical Statistics, 7thEdn., Pearson,
7. Kendall, M. and Stuart, A. (1943). The advanced Theory of Statistics, Vol 1, Charles and Company Ltd., London
8. Mood, A.M. Graybill, F.Boes, D. (2017). Introduction to Theory of Statistics, 3rdEdn.,Mc-Graw Hill Series.
9. Ramchandran, K.M. and Tsokos C. P. (2009). Mathematical Statistics with Applications, Academic Press.
10. V.K. Rohatgi and Saleh A. K. Md. E. (2015). An Introduction to Probability Theory and Statistics, 3rdEdn. Wiley, New York
11. Buyan, K. C. (2010). Probability theory and Statistical inference,1stEdn., New Central Book Agency.

ST 363: SAMPLING THEORY

1. Role of Sample Surveys in Research Methodology (3L)

1.1 Objectives of a sample survey.

1.2 Designing a questionnaire, characteristics of a good questionnaire (Questions with codes & scores are to be discussed). Reliability and validity testing by using

i) Test – Retest method, ii) Internal Consistency: a) Kuder Rechardson Coefficient (KR-20)

b) Cronbach's Coefficient Alpha (α)

1.3 Planning, execution and analysis of a sample survey, practical problems at each of these stages.

1.4 Sampling and non-sampling errors with illustrations.

1.5 Study of some surveys illustrating the above ideas, rounds conducted by National Sample Surveys organization.

2. Simple Random Sampling (8L)

2.1 Concept of distinguishable elementary units, sampling units, sampling frame, random sample, Requisites of a good sample, Simple random sampling from finite population of size (N), i) with replacement (SRSWR) ii) without replacement (SRSWOR),

2.2 Definitions of population mean, population variance and population total parameters, inclusion probabilities.

2.3 Sample mean ($\bar{y}$) as an estimator of population mean ($\bar{y}$), derivation of expectation and standard error of$\bar{y}$, N$\bar{y}$ as an estimator of population total, derivation of expectation and standard error of N$\bar{y}$, Estimator of above standard errors, both in case of SRSWR and SRSWOR, confidence interval for population mean, population total, standard error.

2.4 Sampling for proportion as an application of a simple random sampling with X_i as zero or one. Sample proportion (p) as an estimator of population proportion (P) of units possessing a certain attribute, derivation of expectation and standard error of (p), Np as an estimator of total number of units in the population possessing a certain attribute, derivation of

expectation and standard error of Np. Estimator of above standard error both in case of SRSWR and SRSWOR.

3. Stratified Random Sampling (12L)

3.1 Stratification, basis of stratification, real life situation where stratification can be used.

3.2 Stratified random sampling as a sample drawn from individual strata using SRSWOR in each stratum.

3.3 (a)$\overline{y}_{st} = \frac{\sum N_i \bar{y}_i}{N}$as an estimator of population mean ($\bar{Y}$), derivation of expectation and standard error of $\overline{y}_{st}$, (b) N$\overline{y}_{st}$as an estimator of population total, derivation of expectation and standard error of N$\overline{y}_{st}$, (c) Estimator of above standard errors.

3.4 Problem of allocation, Proportional allocation, Neyman's allocation, derivation of the expressions for the standard errors of the above estimators when these allocations are used.

3.5 Gain in precision due to stratification, comparison amongst SRSWOR, stratification with proportional allocation and stratification with Neyman'sallocation.

3.6 Cost and variance analysis in stratified random sampling, minimization of variance for fixed cost, minimization of cost for fixed variance, optimum allocation, Neyman's allocation as a particular case of optimum allocation in cost and variance analysis.

4. Systematic Sampling (Population size divisible by sample size) (6L)

4.1 Real life situations where systematic sampling is appropriate. Techniques of drawing a sample using systematic sampling

4.2 Estimation of the population mean and population total, standard error of these estimators.

4.3 Comparison of systematic sampling with SRSWOR.

4.4 Comparison of systematic sampling with SRSWOR and stratified sampling in the presence of linear trend.

5. Determination of Sample Size (4L)

5.1 Determination of the sample size for estimating population mean, population total and population proportion for the given:

i) Margin of error and confidence coefficient.

ii) Coefficient of variation of the estimator and confidence coefficient.

6. **Ratio and Regression Methods of Estimation for SRSWOR (3L)**

6.1 Rationale behind using auxiliary variates in estimation.

6.2 Situations where (i) ratio method is appropriate, (ii) regression method is appropriate.

6.3 Ratio and regression estimators of the population mean and population total.

6.4 Comments regarding bias, statement of standard errors of ratio and regression estimators relative efficiency of these estimators, with respect to SRSWOR

(Derivations are not expected).

Books Recommended

1. Cochran, W.G.(2007):Sampling Techniques , Third Edition, Wiley India Pvt. Ltd., New Delhi.
2. Murthy, M. N. (1977): Sampling Theory and Methods, Statistical Publishing Society, Kolkata.

3. Singh, D. and Chaudhary, F. S. (1986): Theory and Analysis of Sample Survey Designs, Wiley Eastern Ltd., New Delhi.
4. Sukhatme, P.V., Sukhatme, B. V.(1984): Sampling theory of Surveys with Applications, Indian Society of Agricultural Statistics, New Delhi.
5. Sampath S. (2005): Sampling Theory and Methods, Second edition, Narosa, New Delhi.
6. Mukhopadhyay P (2008): Theory and methods of survey sampling. Prentice-Hall of India, New Delhi.
7. Chagbao Wu and Mary E. Thompson(2020) :Sampling Theory and Practice, Springer Nature Switzerland.
8. RaghunathArnab (2017): Survey Sampling Theory and Applications, Academic Press, Elsevier.

ST 364: INTRODUCTION TO SURVIVAL ANALYSIS

1. Ageing (18L)

1.1 Survival function, probability density function, hazard function, cumulative hazard rate, mean residual life function, equilibrium residual life function , interrelation between all these function, Total time on test transform (TTT).

1.2 No ageing, proof of the properties of no ageing:

i) Cauchy functional equation ii) Constant failure rate, iii) Constant mean residual life,

iv) Exponential life distribution, v) Exponential Equilibrium distribution, vi) Identity function as the TTT transforms

1.3 Positive and negative ageing: IFR, DFR IFRA, DFRA, NBU, NWU, NBUE, NWUE, DMRL, IMRL, bathtub failure rate. Proof of the Implications: IFR → IFRA, IFR → DMRL, IFRA → NBU, NBU → NBUE, DMRL → NBUE, DFR → DFRA, DFR → IMRL, DFRA → NWU, NWU→ NWUE, IMRL → NWUE.

1.4 Examples.

2. Some Parametric Families of life distributions (10L)

2.1 Classification of following parametric families of life distribution according to ageing: Weibull, Gamma, lognormal, linear failure rate, Makeham, Pareto, Lehman, distribution of specific parallel and series system.

2.2 Some Properties of Exponential Distribution:

i) If $T_1, T_2, \ldots\ldots, T_n$ are independent with$T_i \rightarrow$ EXP (λ_i) for $i = 1,2, \ldots\ldots, n$ and $T = \min\{T_1, T_2, \ldots\ldots, T_n\}$ then T→ Exp $(\sum_{i=1}^{n} \lambda_i)$

ii) If $T_1, T_2, \ldots\ldots, T_n$ are independent and identically distributed exponential random variable with parameter λ, then $2\lambda \sum_{i=1}^{n} T_i \rightarrow {x^2}_{2n}$

iii) If T is a continuous non-negative random variable with cumulative hazard rate R(t) then R(t) is exponential random variable with parameter 1.

iv) If T follows the Weibull distribution with parameter λ and ϒ then T^{Υ} has exponential distribution with parameter λ.

v) Concept of spacing and normalized spacing, distribution of spacing and normalized spacing

3. Censoring (8L)

3.1 Examples of life time situations, straggled and aligned entries in the survival time data, concept of censoring, time/type I censoring, order/type II censoring, right random censoring, left random censoring, undersigned censoring. Estimation of parameter of exponential distribution using Type I and Type II censoring.

3.2 Nonparametric estimation of survival function, confidence band on survival function, actuarial estimator of survival function, Greenwood's formula, Kaplan-Meier estimator of survival function in the presence of censored observations.

Books Recommended

1. Barlow, R. E. and Proschan F. (1975). Statistical theory of Reliability and Life testing: Probability Models Holt, Rinehart and Winston Inc.
2. Barlow, R. E. and Proschan F. (1996). Mathematical Theory of Reliability. John Wiley.
3. Cox, D.R. and Oakes, D. (1984).Analysis of Survival Data,Chapman and Hall.
4. Deshpande, J.V. and Purohit S.G. (2005). Life Time Data: Statistical Models and Methods, Word Scientific.
5. Tobias, P.A. and Trindane, D. C. (1995). Applied Reliability. Second edition. CRC Press.

ST 365 (A): ACTUARIAL STATISTICS

1. Introduction and Feasibility of Insurance Business. (5L)

1.1 Insurance companies as business organizations.

1.2 Role of insurance business in Economy. Concept of risk and their types

1.3 Introduction of terms: premium, policy, policyholder.

1.4 Role of Statistics in insurance business.

1.5 Expected value principle. Concept of utility function, Feasibility of insurance business

2. Survival Distribution and Life Tables (9L)

2.1 Time- until death random variable, its distribution function and survival function in actuarial notation.

2.2 Force of mortality. Curtate future life random variable, its probability mass function and survival function in actuarial notation.

2.3 Deferred probability.

2.4 Construction of life table using random survivorship approach.

3. Models for Life Insurance (9L)

3.1 Introduction of simple and compound interest rate policy.
3.2 Different types of Interest rates. Insurance payable at the end of the year of death, present value random variable, actuarial present value.
3.3 Derivation of actuarial present value for n-year term life insurance, whole life insurance and n-year endowment insurance.

4. Annuities (8L)

4.1 Annuities – certain, annuity due, annuity immediate.
4.2 Discrete life annuities: n-year temporary life annuity due and a whole life annuity due, present value random variables of the payment, and their actuarial present values.

5. Benefit Premiums (5L)

5.1 Concept of a loss random variable. Equivalence principle, Computation of fully discrete premium for n-year term life insurance, whole life insurance and endowment insurance

Books Recommended

1. Bowers N.L. Jr., H.S.Gerber, J.C. Hickan, D.A.Jones, C.J.Nesbitt, (1997). Actuarial Mathematics, Society of Actuaries, U.S.
2. Deshmukh, S. R. (2009). Actuarial Statistics, Universities Press, Hyderabad.

ST 365 (B): OPERATION RESEARCH – II

1. Replacement Theory (5L)

1.1 Introduction (Sec. 17.1)
1.2 Types of failures – Gradual failure and sudden failure (Sec. 17.2)
1.3 Replacement of item whose efficiency deteriorates with time when (a) value of money remains constant during the period (for time as a discrete variable and continuous variable), (b) value of money changes with constant rate during the period (Sec. 17.3 – Model I, Model II).

2. Inventory Theory (9L)

2.1 Introduction, meaning, functional role and reasons for carrying inventory (Sec. 14.1, 14.2, 14.3, 14.4)
2.2 Inventory Control Methods – (i) Always Better Control (ABC) analysis,(ii) Vital, Essential and Desirable (VED) Analysis,(iii) Fast moving, Nonmoving, Slow moving, Dead (FNSD) Analysis (Sec. 14.13).
2.3 Description of generalized inventory model (Sec 14.6).
2.4 Types of inventory models:
   i) The economic lot size model with uniform demand, instantaneous replenishment rate and no shortage(with derivation),
   ii) The Economic lot size model with uniform rate of demand, finite replenishment rate and no shortage(with derivation),

iii) The economic lot size model with uniform demand, instantaneous replenishment with shortage(without derivation),
iv) The economic lot size model with uniform rate of demand, finite replenishment rate with shortage (without derivation) (Sec. 14.7).

3. Decision Theory (9L)

3.1 Introduction, Types of Decision making Environment (Sec. 11.1,11.3)
3.2 Decision making under uncertainty - (i) Laplace criterion, (ii) Minimax / Maximax criterion, (iii) Savage minimax regret criterion, (iv) Hurwitz criterion (Sec. 11.4).
3.3 Decision making under risk: (i) Expected Monetary Value, (ii) Expected Opportunity Loss, (iii) Expected Value of Perfect Information (Sec. 11.5).
3.4 Decision Trees (Sec. 11.7)

4. Game Theory (8L)

4.1 Introduction, Definitions – (i) Number of players, (ii) sum of gains or losses, (iii) Strategy and its type (Sec. 12.1).
4.2 Two Person Zero-Sum Game (Sec. 12.2)
4.3 Pure & Mixed Strategies (Se. 12.3,12.4)
4.4 Principles of Dominance (Sec. 12.5)
4.5 Solution Methods for Games without Saddle Point – Algebraic, Arithmetic, Matrix and Graphical Method.

5. Sequencing (5L)

5.1 Introduction, notations, terminology, assumptions (Sec. 20.1, 20.2)
5.2 Processing n jobs through two machines (Sec. 20.3)
5.3 Processing n jobs through three machines, (reducible to two machines and n-jobs). (Sec. 20.4)
5.4 Examples and problems

Note: All sections are from the book "Operations Research-Theory and Application" by J. K. Sharma

Books Recommended

1. Gass,E.: Linear programming method and applications, Narosa Publishing House, New Delhi.
2. Taha, R.A.: Operation research, An Introduction, fifth edition, Prentice Hall of India, New Delhi.
3. Saceini, Yaspan, Friedman: Operation Research methods and problems, Willey International Edition.
4. Shrinath.L.S: Linear Programming, Affiliated East-West Pvt. Ltd, New Delhi.
5. Phillips,D.T, Ravindra , A, Solberg, I.: Operation Research principles and practice, John Willey and sons Inc.
6. Sharma, J.K.: Mathematical Models in Operation Research, Tata McGraw Hill Publishing Company Ltd., New Delhi.

7. Kapoor, V.K.: Operations Research, Sultan Chand and Sons. New Delhi.
8. Gupta, P.K.andHira, D.S.: Operation Research, S.Chand and company Ltd., New Delhi.

ST 366 (A): STOCHASTIC PROCESSES

1. Introduction (15L)

1.1 Definition of a Stochastic process, state space, index set, classification of stochastic processes with examples,

1.2 Markov Property, Markov chains (MC) {Xn, n ≥ 0}, finite MC, time homogeneous M.C.

1.3 One step transition probabilities, and transition probability matrix (t.p.m.), stochastic matrix, graphical representation Markov chain, n-step transition probability matrix ,

1.4 Chapman Kolmogorov equation, initial distribution,

1.5 joint distribution function of $\{X_0, X_1,\ldots,Xn\}$, partial sum of independent and identically distributed random variables as Markov chain.

1.6 Illustrations such as random walk, Gambler's ruin problem, Ehrenfest chain.

2. Classification of states (12L)

2.1 Communicating states (accessible, transitive, symmetry, reflexive states) first return probability, probability of ever return

2.2 Classification of states, as persistent (recurrent) and transient states,

2.3 Closed set of states, reducible state, reducible MC, irreducible states, irreducible MC, absorbing state, periodicity, aperiodic, Mean recurrence, non-null recurrent, ergodic state and ergodic M.C.

2.4 illustrate with random walk MC, Gambler's ruin MC, and other examples problem find is it ergodic MC or not.

3. Stationary distribution (5L)

3.1 Elementary property of stationary distribution, steady state distribution, for an irreducible ergodic finite

3.2 Long run behavior of a M.C**.** with illustration

4. Poisson Process (4L)

4.1 Postulates and properties of Poisson process, probability distribution of N(t), the number of occurrences of the event in (0, t], Poisson process and probability distribution of inter-arrival time ,mean, variance and covariance functions .

4.2 Definition of compound Poisson process mean and variance functions and its applications.

Books Recommended

1. Adke, S.R., Manjunath, S.M. (1984). An introduction to finite Markov processes, Wiley Eastern.
2. Bhat, B.R. (2000). Stochastic models: Analysis and applications, New Age International.
3. Hoel, P.G., Port, S.C.and Stone, C.J. (1972). Introduction to stochastic processes, Wiley Eastern.
4. Medhi J. (1982). Stochastic processes, Wiley Eastern
5. Ross, S. (2000). Introduction to probability models, 7thedn, Academic Press
6. Ross, S. (1996) Stochastic processes, John Wiley.
7. Srinivasan, S.K. and Mehta, K.M. (1981). Stochastic Processes, Tata Mc-Graw Hill.
8. Taylor, H N and Karlin, S. (1984). An introduction to stochastic modeling Academic Press.

ST 366 (B): RELIABILITY THEORY AND APPLICATIONS

1. Structural properties of coherent system (15L)

1.1 Binary system of independent components, order of the system, different types of systems, concept of the structure function, structure function of series system, parallel system,

k-out-of-n system, essentially series and parallel system, reliability block diagram, guidelines for construction of reliability block diagram.

1.2 Coherent structure function (maximum 4 components), relevant component, increasing structure function, pivotal decomposition of structure function, dual of a structure function (proof of dual of series system of order n is parallel system of order n,dual of the parallel system of order n is a series system of order n, dual of k-out -of –n system is (n-k+1)-out of –n system).

1.3 Path sets, cut sets, minimal path and cut set, representation of coherent system in terms of minimal path sets and cut sets, dual coherent structure function, relative/structural importance of components, module of the coherent system, modular decomposition of coherent system.

2. Reliability of coherent system (8L)

2.1 Reliability (h(p)) of system of independent components, Basic properties of system reliability (such as reliability function is increasing function, system and component redundancy etc.).

2.2 Computation of reliability of coherent system by using minimal path and cut set representation, upper and lower bound on system reliability by using exact system reliability, relative importance of a component.

2.3 Reliability of Binary Components and Systems, Examples to show that systems with higher reliabilities can be constructed using components of low values of reliabilities, i.e. unreliable components.

3. Ageing Properties: (7L)

3.1 Definitions: Hazard rates, hazard function, survival function, Concept of distributions with increasing and decreasing failure rate (IFR/DFR), Average Increasing (Decreasing) Failure Rate (IFRA/ DFRA)

3.2 Relationship betweena) Survival function and hazard function ii) Density function and hazard rate

3.3 Derivations of the following results :i) Hazard rate of a series system of components having independent life times is summation of component hazard rates. Ii) Lifetime of series system of independent components with independent IFR life times is IFR.

3.4 Illustrations: Exponential, gamma, Weibull, Pareto distributions.

4. Introduction to reliability data and related Inference (6L)

4.1 Reliability concepts and Reliability Data: Introduction (Sec. 1.1), Examples of reliability data (Sec. 1.2), General models for reliability data (Sec. 1.3), Repairable systems and Nonrepairable units (Sec. 1.4).

4.2 Parametric Likelihood: Likelihood for complete samples forexponential distribution (Sec. 7.2), confidence intervals for θ(Sec. 7.3) and for functions of θ(Sec. 7.4), Examples in the context of reliability estimation.

4.3Construction ofconfidence intervals for exponential distribution (Sec. 9.3).

Note: All sections of Chapter 4 are from the book "Statistical Methods for Reliability Data" by Meeker William and EscobarLuis (1998).

Books Recommended

1. Meeker William and Escobar Luis (1998). Statistical Methods for Reliability Data, AWiley-Interscience Publication, John Wiley & Sons, Inc.
2. Barlow R. E. and Proschan, Frank (1981). Statistical Theory of Reliability and Life Testing, Holt Rinebart and Winston Inc., New York.
3. Sinha, S. K. (1987). Reliability and Life testing, Second Edition, Wiley
4. Trivedi, R.S. (2001). Probability and Statistics with Reliability, Queuing and Computer Science Applications, Prentice - Hall of India Pvt. Ltd., New Delhi.
5. Besterfield, D.H. and Michna, C.B. et al. (2009). Total Quality Management, 3rd edition,Pearson Education, Delhi.34
6. Dodge, H.F. and Roming, H.G. (1959). Sampling Inspection tables, John Wiley and Sons, Inc.New York
7. Duncan A.J. (1974). Quality Control and Industrial Statistics, fourth edition D.B. Taraporewala Sons and Co. Pvt. Ltd., Mumbai.
8. Grant, E. L. and Leavenworth (1980). Statistical Quality Control, fifth edition, Mc-GrawHill,New Delhi.
9. Montgomery, D. C. (2008). Statistical Quality Control, 6thEdn., John Wiley, New York.

ST 366 (C): MEDICAL STATISTICS AND CLINICAL TRIALS

1. Population study **(6 L)**

1.1 India's population and census.

1.2 Population growth and models for population growth.

1.3 Birth and death rates.

2. Epidemiology **(10 L)**

2.1 Introduction to Epidemiology

2.2 Odds ratio: Properties, inference for odds ratios and Log odds ratios. Relationship between odds ratio and relative risk.

2.3 Estimation of odds ratio, Confidence interval for OR. Relation

2.4 Symmetry in square contingency tables, collapsing tables and Simpson's paradox.

3. Clinical trials **(10 L)**

3.1 General information on history of drug discovery including Louis Pasteur (rabies and small pox), Ronald Ross and malaria, Alexander Fleming and penicillin, Jonas Salk and polio, cholera, asthma, diabetes, blood pressure, heart attack, arthritis.

3.2 Phases of clinical trial, purpose, duration, cost, drug regulatory bodies, ICH, statistical analysis plan, clinical study report.

4. Design of clinical trials **(10 L)**

4.1 Phases of clinical trial, purpose, duration, cost, drug regulatory bodies, ICH, statistical analysis plan, clinical study report.

4.2 Parallel designs, case control studies, longitudinal studies, safety studies

4.3 Treatments, 2 periods cross over design.

4.4 Bioequivalence and bio-availability, non-inferiority trial

4.5 Practice based medical research, evidence based medicine

Books Recommended

1. Gore A. P. and ParanjapeS. A. (2000). Course on Mathematical and Statistical Ecology, Kluwer Publishing Holland,

2. Kulkarni M.B. andPrayag V. R.(2004). Introduction to Statistical Ecology,SIPF Academy, Nasik.

3.Agresti, A., (1996). An introduction to categorical data analysis. John Wiley & Sons.

4. Matthews J.N.S. (2006). Introduction to Randomized Controlled clinical Trials, Chapman and Hall

5. Stephen S.(2000). Statistical Issues in drug Development, John Wiley.

6. Steven D. (2000). Clinical Trials – A methodological perspective, John Wiley.

7. FriedmonL.M., ForbesC.D., DeMets D.L. (2015). Fundamentals of Clinical Trials, Spinner.
8. Selvin, S., (2004). Statistical analysis of epidemiologic data. Oxford University Press.
9. Shoukri, M.M. and Cihon, C., (1998). Statistical methods for health sciences. CRC press.
10. A.P. Gore, S.A.Paranjpe and M.B. Kulkarni. Lecture Notes on Medical Statistics.

ST 367: PRACTICAL PAPER - IV

Sr. No.	Title of the experiment	No. of experiment
1	Model sampling from Laplace distribution.	1
2	Applications of bivariate normal and Pareto distribution.	1
3	Fitting of log-normal distribution.	1
4	SPRT for Binomial, Poisson, Normal and Exponential distributions (graphical representation also)	2
5	Testing of hypotheses (Probability of type I and type II errors, power of a test etc).	1
6	Most Powerful (M.P.) test	1
7	Uniformly Most Powerful (U.M.P.) test. Plotting of power function of a test.	1
8	Non- parametric tests: Sign test and Wilcoxon's signed rank test	1
9	Mann-Whitney U test.	1
10	Run test and median test.	1
11	Kolmogorov- Smirnov test.	1
Total no. of Practicals		**12**

ST 368: PRACTICAL PAPER - V

Sr. No.	Title of the experiment	No. of experiment
1	Determination of sample size for variables and attributes.	1
2	Simple random sampling (estimation of population mean, population total with standard errors), i) with replacement, ii) without replacement. Confidence interval for population mean and population total.	1
3	Simple Random Sampling for Proportions (estimation of population proportion, population total with standard errors), confidence interval for population proportion and population total.	1

4	Stratified Random Sampling: Proportional and Neyman allocation, comparison with SRSWOR.	1
5	Cost and Variance Analysis in Stratified Random sampling.	2
6	Ratio and Regression methods of estimation. Comparison with SRSWOR.	1
7	M.L.E. of parameters of Weibull distribution using Newton-Raphson method.	1
8	M.L.E. of parameters of Gamma distribution using digamma function.	1
9	Estimation of parameter of exponential distribution for type I and typeII censored data.	1
10	Actuarial estimator of survival function and its standard error(in the presence of censored observations).	1
11	Kaplan-Meier estimator of survival function and its standard error(in the presence of censored observations). Plot of estimator against t.	1
Total no. of practicals		**12**

ST 369: PROJECT (EQUIVALENT TO 12 PRACTICALS)

1. For project maximum 5 students are allowed in a group.
2. Copy of the project report to be made available to the examiner on the first day of practical examination.
3. The following points should be included in the Project Report/ Dissertation:
   a. Title of the project, name(s) of the student(s), name of the Department and College. Acknowledgement, Data Sources, Description of the computing system/software(s), Programming language(s) used, etc. (if applicable)
   b. Motivation for selecting the topic, abstract of the project, key-words of the project.
   c. Text of the project. Broadly this should cover description of the selected problem using terminology in the field of application, conversion of the problem in statistical language, literature survey, description of collected data, small illustrative data set, methodology for the analysis, interpretation of the results, validation of the results, conclusions in statistical as well as user's language, limitation of proposed solutions, directions for future work, references used, etc.

4. The division of 50 marks for the project evaluation is,

A) Internal evaluation:	**15 Marks (Based on project report and viva)**
B) End semester evaluation	
i) Project report:	**25 Marks**
ii) Viva based on power point presentation:	**10 Marks**
Total marks (A+B):	**50 Marks**

i) Aspects of Assessment and marks assigned (The following are the guidelines, some modification can be done as and when required by the examiners)
Scheme of the marking of project report for end semester examination:

Sr.No.	Aspects in Project Report	Marks
i)	Dissertation in the proper format which includes (Title, abstract, Key words, methodology, conclusion, references, limitations and source of data etc.)	7
ii)	Conversion of the real life problem in statistical language	3
iii)	Appropriateness of tools (preferably learned in syllabus) used for analysis, testing the assumptions needed for analysis, methodology, program coding (if any) and numerical computations.	10
iv)	Conclusions in relevant language	5
Total		**25**

ii)**Viva of each project group consisting maximum 5 students is conducted using power point presentation only (Time duration: 10 Minutes).**

Division of marks for viva as:

Presentation (through slides)	**Marks**
Understating the Project problem	4
Understanding of statistical techniques used to solve the problem	4
Overall presentation	2
Total	**10**

ST 3610: INTRODUCTION TO PYTHON (PRACTICAL COURSE)

1. Introduction and Data types (11 L)

1.1 Introduction, Installation and Working with Python, Understanding Python variables, Python basic Operators, Understanding python blocks

1.2 Input and Output- print() statement, Numeric data types: int, float, complex, string data type and string operations, Defining list and list slicing, Sequences of Data, Dictionaries, Groupings of Data Indexed by Name, Special String Substitution Using Dictionaries, Arrays, Working with Sets

2. Control structures, Functions and File operations (15 L)

2.1 **Control structures**: Conditional blocks using if, else and elif for loop in python, Use of while loops in python, Loop manipulation using pass, continue, break.

2.2 **Python Functions, Modules and Packages**: Organizing python codes using functions, Importing own module as well as external modules, Understanding Packages, Powerful Lamda function in python, Programming using functions, modules and external packages.

2.3**File Operation**: Reading config files in python, Writing log files in python, Understanding read functions, read(), readline() and readlines(), Understanding write functions, write() and writelines(), Manipulating file pointer using seek, Programming using file operations

3. Manipulating Data (10 L)

3.1 **NumPy** : Introduction , NumPy Array , Array Indexing , Numpy Operations.

3.2 **Pandas** : Introduction , Series, DataFrame , Indexing and Slicing of DataFrame, handling missing Data , GroupBy , Merge Join and concatenate

3.3 **Data visualization using Matplotlib**: Simple line plot, simple scatter plot, Simple bar diagram,Subdivided bar diagram, Multiple bar diagram,Piediagram, Rod or Spike Plot, Boxplot, visualizing error, density and contour plot, histogram, binning and density, multiple subplot.

Books Recommended

1. Wes McKinney (2012). Python for Data Analysis, O'REILLY Publications,
2. Dr. R. Nageswara Rao (2017). Core Python Programming, Wiley Publication.
3. Lutz, M. (2013). Learning Python: Powerful Object-Oriented Programming. O'Reilly Media, Inc.
4. Jake Vanderplas (2017), Python Data Science Handbook, O'REILLY Publications, 2nd edition.
5. Mueller, J.P.&Massaron, L.(2015). Python for data science for dummies. Wiley & Sons.

ST 3611: DATA ANALYTICS(PRACTICAL COURSE)

1. **Introduction to Data Mining** **(8L)**
   1.1 Data preparation for knowledge discovery: Data understanding and data cleaning tools, Data transformation, Data Discretization, Data Visualization.
   1.2 Data Mining Process: CRISP and SEEMA, Supervised and unsupervised learning techniques.

2. **Classification** **(8L)**
   2.1 Problem of classification,
   2.2 classification techniques: k-nearest neighbour, decision tree, Naïve Bayesian, classification based on logistic regression

3. **Model Evaluation, Selection and Classification Accuracy** **(10L)**
   3.1 Model evaluation and selection: Metrics for Evaluating Classifier Performance,
   3.2 Concept of training data, testing data and validation of model, Cross-Validation, Bootstrap, Model Selection Using Statistical Tests of Significance,
   3.3 Techniques to Improve Classification
   3.4 Accuracy: Introduction to Ensemble Methods, Bagging,
   3.5 Boosting and AdaBoost, Improving Classification Accuracy of ClassIm balanced Data.
   3.6 Examples.

4. **ANN, SVM and Clustering** **(10L)**
   4.1 Introduction to Artificial Neutral Network (ANN) and Support Vector Machine (SVM),
   4.2 Clustering: k-means, k-mediods,
   4.3 Market Basket Analysis: Association rules and prediction, Apriori Algorithm, data attributes, applications to electronic commerce.
   4.4 Examples.

Books Recommended

1. Berson and Smith S.J. (1997): Data warehousing, Data Mining, and OLAP, McGraw-Hill.
2. Breiman J.H Friedman, R.A. Olshen and stone C.J. (1984): Classification and Regression Trees, Wadsworth and Brooks / Cole.
3. Han, J. and Kamber, M. and Pei, J. (2012): Data Mining: Concepts and Techniques. MorganGaufmann.3rd Edition.
4. Mitchell T.M. (1997): Machine Learning, McGraw-Hill.

5. Ripley B.D. (1996): Pattern Recognition and Neural Networks. Cambridge University Press.
6. Vapnik V.N. (2013). The nature of Statistical learning theory, Springer.
7. Cristianini N. and Shawe-Taylor J. (2000). An Introduction to support vector machines and other kernel-based learning methods, Cambridge University Press.
8. Mehrika, K., Mohan, C., and Ranka (1997) Elements of Artificial neural networks. Penram international.
9. Hastie T, Tibshirani R, Friedman J, (2009): The elements of statistical Learning, Springer.
10. Chattamvelli, R. (2015). Data mining methods. Alpha Science International.

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Savitribai Phule Pune University
(Choice Based Credit System-70:30-Pattern)
(w. e. f- 2021-2022)
T. Y. B. A- English

Semesters	New Nomenclature of Courses/Papers	Old Nomenclature of Courses/Papers	Credits
V	CC-Compulsory English	Compulsory English	03
VI	CC-Compulsory English	Compulsory English	03
V	SEC-1-C	G-3	03
VI	SEC-1-D	G-3	03
V	DSE-1-C	S-3	3+1=04
VI	DSE-1-D	S-3	3+1=04
V	DSE-2-C	S-4	3+1=04
VI	DSE-2-D	S-4	3+1=04
V	SEC-2-C	----	02
VI	SEC-2-D	----	02

T. Y. B. A.
Compulsory English

(CC-Core Course- 03 Credit)

Rationale:

The present course is a core course and it basically consists of two components: the literature component and the skills component. The literature component includes some of the best samples of English short stories, essays and poems written by writers of different nationalities (British, American, Indian etc.) This cultural mix is deliberate. We are living in a globalized world and our students need to have at least a cursory acquaintance with different cultures in the outside world. This is particularly important in a pluralistic society like ours. The core course is a part of the humanities. It aims at contributing to the linguistic and communicative abilities of the students. At the same time it also aims at fostering humanitarian attitude in our students and make them better human beings. Our prose and poetry selections in the literature part of the syllabus take care of these humanistic and aesthetic considerations.

The skills component of the syllabus includes language skills (i.e. grammar part and writing skills), soft skills and employability skills. All these are necessary in the contemporary world to make our students confident and enable them to face the real life challenges successfully. The

core course is essentially a language course. Linguistic competence is absolutely necessary for achieving success in almost all the fields of life. Hence we have concentrated on some important aspects of grammar. There are certain writing skills and communicative skills required in all work environments today. These have also been included in the syllabus. Some soft skills and employability skills are necessary from the viewpoint of the employer as well as the employee for his own career advancement. In fact no employee can survive without these skills in the modern day work place. We have kept all these practical considerations in mind while preparing the present syllabus. It is thus a composite course focusing on human values and useful, practical skills.

Objectives:

a) To familiarize students with some excellent pieces of prose and poetry in English so that they realize the beauty and communicative power of English.
b) To enable students to become competent and effective users of English in real life situations.
c) To contribute to the overall personality development of the students.
d) To instill humanitarian values and foster sympathetic attitude in the students.
e) To train the students in practical writing skills required in work environment.
f) To impart knowledge of some essential soft skills to enhance their employability.

***Each** semester shall have 3 credits for teaching. Each credit is equal to 15 hours, so this course shall have 45 teaching hours. In addition to that there shall be 03 hours allotted to internal evaluation. **(3x15=45+3=48).**

***Considering** the choice-based credit system (CBCS) and the semester pattern, both Semesters-V & VI will have a uniform evaluation pattern of 100 marks each. There will be an 'Internal Examination' for 30 marks and 'Semester-end Examination' for 70 marks.

***The Internal** Examination for 30 marks will be conducted at college level.

a) Assignment/group discussion/tutorial/seminar/oral/project for 10 marks
b) A Mid-semester Written Test for 20 marks

SEMESTER-V

Prescribed Text: *Exploring New Horizons* (Ed-Board of Editors- Orient BlackSwan)

Unit-I- Prose (12 Clock Hours)

1. The Phantom Luncheon – Saki
2. Function of Education –J. Krishnamurti
3. God sees the Truth but Waits – Leo Tolstoy

Unit-II- Poetry (12 Clock Hours)

1. The Neutral Tones – Thomas Hardy
2. Strange Meeting – Wilfred Owen
3. Have you got a brook in your little heart – Emily Dickinson

Unit-III- Grammar (08 Clock Hours)

1. Adverbs and their types (manner, place, time, frequency etc.)
2. Synthesis of sentences by using participles, infinitives, adverbials etc.)
3. Types of Sentences according to function: Declaratives, Interrogatives, Imperatives

Unit-IV- Writing (08 Clock Hours)

1. Paragraph Writing
2. Note-making and Note-taking
3. Reference Skills (Using dictionaries/thesaurus/encyclopedias/year books/table of contents/indices etc)

Unit-V- Soft Skills and Employability Skills (05 Clock Hours)

1. Body Language/Non-verbal Communication
2. Tips for Effective Communication
3. Telephone Skills
4. Teleconferences

SEMESTER-VI

Prescribed Text: *Exploring New Horizons* (Ed-Board of Editors-Orient BlackSwan)

Unit-I- Prose (12 Clock Hours)

1. Shakespeare's Sister – Virginia Woolf
2. After Twenty Years – O. Henry
3. The Conjuror's Revenge – Stephen Leacock

Unit-II- Poetry (12 Clock Hours)

1. The Man of Life Upright – Thomas Campion
2. Money Madness – D.H. Lawrence
3. The Toys – Coventry Patmore

Unit-III- Grammar (08 Clock Hours)

1. Transforming Declarative sentences into Yes-No questions
2. Transforming Declarative sentences into Wh- questions
3. Transforming Positive Imperative sentences into Negative imperatives

Unit-IV- Writing (08 Clock Hours)

1. Email Writing
2. Using Graphs and Charts

3. Dialogue Writing

Unit-V- Soft Skills and Employability Skills (05 Clock Hours)

1. Stress Management
2. Motivation and Positive Approach
3. Goal Setting
4. Adaptability Skills

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Skill Enhancement Course (SEC 1-C & SEC 1-D)
(Old G-3)
(w. e. f. 2021- 2022)

Title of the Paper: Enhancing Employability Skills

(Credit-3)

Prescribed Text- ***Aspirations: English for Careers*** **(Board of Editors- Orient Black Swan)**

Rationale:

TYBA students are on the threshold of their career. Hence, it is necessary to orient and prepare them for different careers they can join after graduation. Considering the various career opportunities available to Arts graduates, the syllabus aims at awareness raising, competence building and skill enhancement of the learners. All the units in the book, besides offering exposure to the use of English for different careers, are radically designed to keep pace with the age of technology and to empower the learners for the present as well as the upcoming career avenues.

Course Outcomes:

After studying the paper successfully, the learners will be able:

1. To get the awareness of career opportunities available to them.

2. To identify the career opportunities suitable to them.

3. To understand the use of English in different careers.

4. To develop competence in using English for the career of their choice.

5. To enhance skills required for their placement.

6. To use English effectively in the career of their choice.

7. To exercise verbal as well as nonverbal communication effectively for their career.

***Each** semester shall have 3 credits for teaching. Each credit is equal to 15 hours, so this course shall have 45 teaching hours. In addition to that there shall be 03 hours allotted to internal evaluation. **(3x15=45+3=48).**

***Considering** the choice-based credit system (CBCS) and the semester pattern, both Semesters-V & VI will have a uniform evaluation pattern of 100 marks each. There will be an 'Internal Examination' for 30 marks and 'Semester-end Examination' for 70 marks.

***The Internal** Examination for 30 marks will be conducted at college level.

a) Assignment/group discussion/tutorial/seminar/oral/project for 10 marks

b) A Mid-semester Written Test for 20 marks

SEMESTER-V(SEC 1-C)

Course contents:

Unit-I- Exploring Careers (12 Clock Hours)

1. Creative Writing
2. Translation
3. Mass Communication and Journalism
4. Academia and Other Careers

Unit-II- Basic Preparation for Jobs (08 Clock Hours)

1. Application Letter and Résumé Writing
2. GDPI
3. Writing Notices and Agendas
4. Writing Minutes

Unit-III- English for Employability Skills (13 Clock Hours)

1. Style and Techniques for Effective Communication
2. Description, Narration and Demonstration in English
3. Soft Skills for Employers
4. Soft Skills for Employees

Unit-IV- English for Corporate Field (12 Clock Hours)

1. English for Sales Services
2. English for Customer Services
3. Presentation Skills
4. Writing a Project Report

SEMESTER-VI (SEC 1-D)

Prescribed Text- *Aspirations: English for Careers* (Board of Editors- Orient Black Swan)

Unit-I- English for Competitive Examinations (09 Clock Hours)

1. Vocabulary
2. Tenses
3. Prepositions
4. Précis Writing

Unit-II- English for Research Purposes (12 Clock Hours)

1. Impersonal and Objective Style
2. Writing a Research Proposal
3. Writing a Research Paper
4. Writing a Short Dissertation

Unit-III- Content Writing (12 Clock Hours)

1. Introduction to Content Writing
2. Writing Blog Posts and Articles
3. Writing for Websites
4. Writing for Social Media Platforms

Unit-IV- English for Digital Marketing (12 Clock Hours)

1. Introduction to Advertisements
2. Newspaper Advertisements
3. Advertisements on Television and Radio Channels
4. Advertisements on Internet

SELECT BIBLIOGRAPHY

1. Bakshi Rakesh Anand. 2019. Let's Talk On Air: Conversations with Radio Presenters. Puffin
2. Bill Mascull. 2010. Business Vocabulary in Use: Elementary to Pre-intermediate. Cambridge University Press
3. Chaskar, Jagadale, Bhabad, Raskar, Pawar. Ed. 2020. Horizons English in Multivalent Contexts. Orient BlackSwan
4. Donald Miller. 2017. Building a Story Brand. HarperCollins
5. Donna Papacosta. 2013. The Podcast Scripting Book. Trafalgar Communications
6. Dorothea Brande. 1981. Becoming a Writer. TarcherPerigee
7. Elizabeth Walter. 2010. Collins Easy Learning Writing. HarperCollins UK
8. Erica Williams. 2008. Presentations in English. Macmillan
9. Gupta Kounal. 2020. Content Writing Handbook. Henry Harvin

10. Haigh Rupert. 2004. Legal English. Cavendish Publishing Limited
11. Henry Emery, Andy Roberts. 2008. Aviation English. Macmillan.
12. Karen Englander, James N. Corcoran. 2019. English for Research Publication Purposes. Routledge
13. Kohli Simran. 2006. The Radio Jockey Hand Book. Fusion Books
14. Leila R. Smith, Roberta Moore. 2009. English for Careers: Business, Professional, and Technical. USA. Pearson College Div.
15. Marie Drennan, Yuri Baranovsky (Author), Vlad Baranovsky. 2018. Scriptwriting for Web Series: Writing for the Digital Age. Routledge
16. Michael McCarthy Felicity O'Dell. 2004. English Phrasal Verbs in Use. Cambridge University Press
17. Michael Swan. 2001. Practical English Usage. Cornelsen & Oxford University Press
18. Paul J. Hamel. 2016. English for Better Jobs. Amazon Digital Services
19. Pease A. 1998. Body Language. London: Sheldon Press
20. Ronald Carter, Michael McCarthy. 2006. Cambridge Grammar of English: A Comprehensive Guide. Cambridge University Press

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Discipline Specific Elective (DSE-1C& DSE-1D)

(Old S-3)

(w. e. f. 2021- 2022)

Title of the Paper: Appreciating Novel

(Credit-3+1=4)

Rationale:

The impact of literature in human society is undeniable. Literature acts as a form of expression for each individual author. Some books mirror society and allow us to better understand the world we live in. Literature is important because it teaches the universal human experiences. It also provides different meanings to different people or teaches different lessons to the same person at different stages of his life. The novel is one of the major forms of literature which generally deals imaginatively with human experiences, usually through a connected sequence of events involving a group of persons in a specific setting. It is a genre of fiction and fiction may be defined as a form of art. It is not a short story in prose; instead, it is actually an extensive and illustrated account of series of events that happened right through the life of a character. By studying and appreciating novel, the students can develop their interpretative abilities and enhance their analytical skills.

Objectives:

a) To introduce students to the basics of novel as a literary form

b) To expose students to the historical development and nature of novel

c) To make students aware of different types and aspects of novel

d) To develop literary sensibility and sense of cultural diversity in students

e) To expose students to some of the best examples of novel

*** Each** semester shall have 3 credits for teaching. Each credit is equal to 15 hours, so this course shall have 45 teaching hours. In addition to that there shall be 03 hours allotted to internal evaluation. **(3x15=45+3=48).**
*** Considering** the choice-based credit system (CBCS) and the semester pattern, both Semesters-V & VI will have a uniform evaluation pattern of 100 marks each. There will be an 'Internal Examination' for 30 marks and 'Semester-end Examination' for 70 marks.
*** The Internal** Examination for 30 marks will be conducted at college level.
a) Assignment/group discussion/tutorial/seminar/oral/project for 10 marks
b) A Mid-semester Written Test for 20 marks
* **Semester V and VI -DSE 3+1** = One credit is for Research Project/field visit/ or any other Subject-centric activities to be undertaken by the students in consultation with the concerned teacher. The concerned teachers have to evaluate and maintain the record of research project/field visit/ or any other subject-centric activity.

SEMESTER-V (DSE-1C)

Course content:

A) Theory of Novel: (20 Clock Hours)

(a) What is Novel? A brief history of novel as a literary form

(b) Elements of Novel: Theme, Characters, Plot, Structure Narrative Techniques, Point of view, Conflict, Setting and atmosphere, Dialogue

(c) Types of Novels: epistolary, picaresque, bildungsroman, historical, regional, Psychological, satire, realistic, experimental novel, science fiction

(d) In addition to this, other literary terms related to novel/fiction be considered for background study

B) *Silas Marner*- George Eliot (25 Clock Hours)

SEMESTER-VI (DSE-1D)

A) *A Farewell to Arms*- Ernest Hemingway (20 Clock Hours)

B) *The Painter of Signs*- R. K Narayan (25 Clock Hours)

Reference Books:

1) E. M. Forster, Aspects of the Novel, Harcourt, Inc. 1955

2) Terry Eagleton, The English Novel: An Introduction. Blackwell, 2005

3) Walter Allen, The English Novel (London, 1954)

4) Arnold Kettle, Introduction to the English Novel, (2 vols, London, 1951)

5) Ian Watt, The Rise of the Novel, London,1957

6) J. Davis, Factual Fictions: The Origins of the English Novel, (New York, 1983)

7) Geoffrey Day, From Fiction to the Novel, (London, 1987)

8) Dominic Head, The Cambridge Introduction to Modern British Fiction, 1950– 2000. Cambridge, 2002

9) Walter L. Reed, An Exemplary History of the Novel: The Quixotic versus the Picaresque, (Chicago, 1981)

10) Richard Chase, The American Novel and its Tradition, New York, 1957

13) Nadel, Ira Bruce, Biography: Fiction, Fact and Form. London: Macmillan, 1984.

14) Jonathan Greenberg, Modernism, Satire and the Novel, Cambridge University Press, 2011

15) Afzal-Khan Fawzia, Cultural Imperialism and the Indo-English Novel: Genre and Ideology in R.K. Narayan, Anita Desai, Kamala Markandaya,and Salman Rushdie. University Park (Pennsylvania State UP) 1993.

16) Kermode Frank [1966], The Sense of an Ending: Studies in the Theory of Fiction, Oxford (OUP) 2000.

17) Mukherjee Meenakshi, Realism and Reality: The Novel and Society in India, Delhi (OUP) 1985.

18) Brian W Shaffer, Reading the Novel in English 1950–2000, Blackwell Publishing,2006

19) Dirk Wiemann, Genres of Modernity Contemporary Indian Novels in English. Amsterdam – New York, NY 2008

20) Jesse Matz, The Modern Novel: A Short Introduction, Blackwell, 2004

21) John Mullan, How the Novel Works, OUP, 2006

22) Meenakshi Mukherji, The Twice Born Fiction. Heinemann Educational Books, New Delhi, 1971

23) A. J. Sebastian & N. D. R. Chandra. Literary Terms in Fiction and Prose. Authors Press, 2004

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Discipline Specific Elective (DSE-2C & DSE-2D)
(Old S-4)
(w. e. f. 2021- 2022)

Title of the Paper: Introduction to Literary Criticism
(Credit-3+1=4)

Rationale:
Literary criticism is as ancient as literature. It has provided different views, perspectives, approaches and terms to understand literature in its diverse forms. It consists of interpretation, judgment, analysis and evaluation of literature. It makes readers aware of form and content of literature, structure and substance of literature. It deals with text and context in its analysis and provides many different views on literature. Literary criticism has undergone many changes in its long journey from the classical antiquity to the modern period. It has branched off from its earlier preoccupations like author's superiority and search for universal meaning and has taken on new pursuits. The present course is designed to introduce students to the basics of literary criticism and the age wise important critical concepts.

Objectives:
a) To introduce students to the basics of literary criticism
b) To make them aware of the nature and historical development of criticism
c) To make them familiar with the significant critical approaches and terms
d) To encourage students to interpret literary works in the light of the critical approaches
e) To develop aptitude for critical analysis

*** Each** semester shall have 3 credits for teaching. Each credit is equal to 15 hours, so this course shall have 45 teaching hours. In addition to that there shall be 03 hours allotted to internal evaluation. **(3x15=45+3=48).**
*** Considering** the choice-based credit system (CBCS) and the semester pattern, both Semesters-V & VI will have a uniform evaluation pattern of 100 marks each. There will be an 'Internal Examination' for 30 marks and 'Semester-end Examination' for 70 marks.
*** The Internal** Examination for 30 marks will be conducted at college level.
a) Assignment/group discussion/tutorial/seminar/oral/project for 10 marks
b) A Mid-semester Written Test for 20 marks

* **Semester V and VI -DSE 3+1** = One credit is for Research Project/field visit/ or any other Subject-centric activities to be undertaken by the students in consultation with the concerned teacher. The concerned teachers have to evaluate and maintain the record of research project/field visit/ or any other subject-centric activity.

Course Content:

SEMESTER-V (DSE-2C)

Unit-I- Orientation (15 clock hours)

1. Literary Criticism- definitions and functions
2. Types of Criticism- historical, biographical, sociological and psychological
3. Literature of knowledge and literature of power
4. Qualities of a good critic

Unit-II- Traditional Criticism (15 clock hours)

1. **Classical Criticism** - Aristotle's Concept of Imitation (Ref- Poetics), Longinus's Five Sources of Sublimity (Ref- on the Sublime)
2. **Neo-Classical Criticism**–Dryden's definition of play (Ref-An Essay on Criticism), Samuel Johnson's defense of Shakespeare

Unit-III- Romantic/Victorian Criticism (15 clock hours)

Wordsworth's definition of poetry, Coleridge's distinction between fancy and imagination, Matthew Arnold's three estimates of poetry

SEMESTER-VI (DSE-2D)

Unit-I- Modern Criticism (15 clock hours)

Eliot's theory of impersonality, William Empson's seven types of ambiguity, Georg Lukacs' concept of realism, Sigmund Freud's structure of human mind- id, ego and superego

Unit-II- New Criticism (15 clock hours)

Allen Tate's concept of tension, Cleanth Brooks' notion of paradox as the structure of poetry, Wimsatt and Beardsley's concept of intentional fallacy

Unit-III- Critical Terms and Practical Criticism (15 clock hours)

Critical Terms:

1. Catharsis
2. Allegory
3. Diction
4. Irony
5. Motif and theme
6. Genre
7. Metaphor
8. Point of view

9. Subjective and objective
10. Satire

Practical Criticism:

Practical criticism of poems, passages from novels and plays, etc.
(Teachers are advised to deal with poems, prose passages from the poems and novels that students have studied during their graduation)

Reference Books:

1) Kulkarni Anand et al. (2021). *Explaining Literary Theory*. Namya Press, New Delhi.
2) Kulkarni Anand B. & Chaskar Ashok G. *An Introduction to Literary Criticism and Theory*. Orient Blackswan, Hyderabad, 2015
3) Atherton Carol. *Defining Literary Criticism*. Palgrave, 2005
4) Dorsch T. S. *Classical Literary Criticism.* Penguin, 1981 (reprinted version)
5) Kennedy George A. *A New History of Classical Rhetoric*. Princeton: Princeton University Press, 1994.
6) Ross Andrew. *The Origins of Criticism*. Princeton Univ. Press, 2002
7) Habib M. A. R. *A History of Literary Criticism: from Plato to the Presen*t. Blackwell Publishers Ltd, 2005
8) Hardison Jr., O. B. (ed.). *Medieval Literary Criticism: Translations and Interpretations*. New York: Frederick Ungar, 1974.
9) Brown Marshall (ed.). *Cambridge History of Romanticism*. Vol. 5, Cambridge Univ. Press, 2000
10) Thorat Ashok et al (2001). *A Spectrum of Literary Criticism.* Frank Bros.
11) Hickman Miranda B. and McIntyre John D. *Rereading the New Criticism*. The Ohio State University Press, 2012
12) Levenson Michael .*The Cambridge Companion to Modernism*. Cambridge, 1997
13) Litz A. Waltom and others. *The Cambridge History of Literary Criticism (Modernism and the New Criticism), Vol. 7*. Cambridge Univ. Press, 2008
14) Ross Stephen. *Modernism and Theory*. Routledge, 2009
15) Whitworth Michael (ed.). *Modernism.* Blackwell, 2007
16) Dobie Ann B. *Theory into Practice: An Introduction to Literary Criticism*. Third Edition, Wadsworth, Boston, 2012.
17) Ellis John M. *The Theory of Literary Criticism: A Logical Analysis.* University of California Press, 1974.
18) Seaton James. *Literary Criticism from Plato to Postmodernism: The Humanistic Alternative*. Cambridge University Press, 2014.
19) Peck John and Coyle Martin. *Literary Terms and Criticism*. Macmillan, 1984.

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Skill Enhancement Course (SEC 2-C & SEC 2-D)

(w. e. f. 2021- 2022)

Title of the Paper: *Mastering Life Skills and Life Values*

[Two credit Course (2X15= 30 Clock Hours)]

Objectives:

1. To equip the students with the social skills
2. To train the students interpersonal skills
3. To build self-confidence and communicate effectively
4. To Encourage the students to think critically
5. To learn stress management and positive thinking
6. To enhance leadership qualities
7. To aware the students about universal human values
8. To develop overall personality of the students

Suggestions to Teachers:

1. It is a learner-centric course.
2. The course aims at developing skills among the students.
3. Learning can be facilitated through interactive and informal guiding sessions.
4. Participation and up-gradation of the students' performance needs to be encouraged.
5. Practical, Exercises, Activity monitoring, Projects, Seminars, Presentations, Group Discussions are some of the activities that the teachers are expected to encourage.
6. Relevant and innovative ideas of both the students and the teachers are always appreciable for a successful completion of this course
7. The concerned faculty/teachers have to maintain the record of the students as credits to the students need to be given on the basis of preserved records.

SEMESTER-V (SEC 2-C)

Course Content:

Life Skills

1. Meaning and Nature of Life Skills
2. Importance of Life Skills
3. Problem Solving and Decision-making skill
4. Critical and Creative Thinking Skill
5. Interpersonal skills: Understanding and Cooperating with Others
6. Management of Stress and Emotions

SEMESTER-VI (SEC 2-D)

Life Values

1. Meaning and Nature of Values
2. Importance of Human Values
3. Moral Values
4. Ethical Values
5. Professional Values
6. Aesthetic Values
7. Psychological Values
8. Self-Awareness and Self-Management

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Savitribai Phule Pune University, Pune

Faculty of Humanities

T.Y.B.A. in History

Choice Based Credit System Syllabus

To be implemented from the Academic Year 2021-2022

Savitribai Phule Pune University, Pune.

Faculty of Humanities

Structure of Choice Based Credit System for Undergraduate Program to be Implemented from Academic Year 2021-2022

Subject: - T.Y.B.A. History Structure Academic Year 2021-2022

Semester	Core Courses (CC)	Skill Enhancement Course (SEC)	Discipline Specific Elective Courses (DSE)
V	**CC- 3(3)** Indian National Movement (1885-1947) _____ History of Civilization – World Civilization Part I	**SEC 2 C (2)** 9.South Indian Art and Architecture 10.Research Paper Writing 11.Museology	**DSE-3 C** (3) +1 7.Introduction to Historiography **DSE-4 D** (3)+1 8.Maharashtra in the 19th Century **OR** 9.Constitutional Developments in India 1773 to 1853
VI	**CC- 4(3)** India After Independence- (1947-1991) _____ History of Civilization –World Civilization Part II	**SEC 2 D (2)** 12. Heritage management 13.Archaeology 14.Numismatics	**DSE-3 C (3)+1** 10 Applied History **DSE-4 D (3)+1** 11 Maharashtra in the 20th Century OR Constitutional Developments in India1858 to 1950

Savitribai Phule Pune University, Pune
Proposed Syllabus in History for T.Y.B.A. (Credit system)
From the Academic Year 2021-22
Under the Faculty of Humanities
Core Course 3 :(3 Credit)
Semester V: Course Title: - Indian National Movement (1885-1947)

Learning Objectives:

1. The course is designed to make the students aware about the making of Modern India and the struggle for independence.
2. To make the students aware of the multi-dimensionality of Modern India.
3. To highlight the ideas, institutions, forces and movements that contributed to be shaping of Indian Modernity.
4. To acquaint the students with various interpretative perspectives.

Learning Outcomes:

1. It will enable students to develop an overall understanding of Modern India.
2. It will increase the spirit of healthy Nationalism, Democratic Values and Secularism among the Students.
3. Students will understand various aspects of the Indian Independence Movement and the creation of Modern India.

Pedagogy: Lectures / Visual Presentation / Critical Analysis / Assignments / Test/ e-learning

Unit I: Rise and Growth of Indian Nationalism 12

a) Causes for the Rise of Indian Nationalism
b) Foundation of Indian National Congress.
c) Moderate Nationalists and Assertive Nationalists
d) Revolutionary Nationalists.

Unit II: Mass Movement 9

a) Non Co-Operation Movement.
b) Civil Disobedience Movement.
c) Quit India Movement.

Unit III: Towards Independence and Partition. 12

a) Two Nation Theory: Establishment of Muslim League and Hindu Mahasabha, Growth of Communalism, Genesis of Pakistan.
b) Indian National Army.
c) Transfer of Power: The Cripps Mission, The Cabinet Mission, The Mountbatten Plan, Indian Independence Act and Partition.

Unit IV: Subaltern Movement. 12

a) Peasant Movement.
b) Workers Movement.
c) Dalit Movement.
d) Women's Movement.
e) Tribal Movement.

Reference Books:

English

1.Chandra Bipan, Mukherjee Mridula, Mukherjee Aditya, Panikkar K.N. and Mahajan Sucheta- India's struggle for Independence, Penguin Books(India),1990.
2.Chandra Bipan, Essays on Contemporary India, Har- Anand publication, New Delhi, 1993.
3.Chandra Bipan - The Rise and Growth of Economic Nationalism in India People's Publishing House, New Delhi,1966.
4.Desai A.R. - Social Background of Indian Nationalism, Popular Prakashan, Bombay, 1984.
5.Dodwell H.H. - Cambridge History of India Vol V, VI
6.Dutt R.C. - Economic History of India Vol 1,2, London, 1901 reprint Government of India press, Nashik, 1960.
7.Guha Ramchandra (ed.), Makers of Modern India, Penguin group, New Delhi, 2010.
8.Gopal S. - British policy in India 1858-1905, Cambridge University Press, 1965.
9.Mujumdar R. C., History of the freedom movement in India, Vol. I-III.
10.Mujumdar R.C. (ed.) The History and Culture of the Indian People Vol. l - IX British paramountcy and Indian Renaissance Vol IX.
11.Menon V.P. - The Transfer of power in India Princeton University Press,1957.
12.Moon Vasant, Dr Babasaheb Ambedkar writing and speeches Government of Maharashtra, Bombay.
13.Sarkar Sumit, - Modern India :1885 - 1947, Macmillan India Ltd., Madras, 1986.
14.Sarkar Sumit - Bibliographical survey of social Reform movement in the 18th &19th century (ICHR 1975).
15.Tara Chand - History of freedom Movement, Vol. I - lV publication Division, Ministry of Information and Broadcasting, Government of India, New Delhi,1983.

संदर्भग्रंथ- मराठी:

आंबेडकर बाबासाहेब, पाकिस्तान अर्थात भारताची फाळणी, (अनु.दीपक पंचभाई) प्रबुद्धभारत पुस्तकालय, नागपूर, २०१८.

कदम मनोहर, भारतीय कामगार चळवळीचे जनक: नारायण मेघाजी लोखंडे, अक्षर प्रकाशन, २००२.

केतकर कुमार, कथा स्वातंत्र्याची (महाराष्ट्र), पुणे, १९८५.

गर्गे स. मा., भारतीय समाज विज्ञान कोश, खंड १ ते४ ,मेहता पब्लिशिंग हाऊस, पुणे,२००७ .

चपळगावकर नरेन्द्र, तीन न्यायमूर्ती आणि त्यांचा काळ, मौज प्रकाशन,मुंबई , २०१०.

चंद्र बिपन, मुखर्जी, पण्णीकर, महाजन, इंडियाज स्ट्रगल फॉर इंडिपेंडेंस, (अनु.) काळे एम.व्ही. भारताचा स्वातंत्र्य संघर्ष, के. सागर पब्लिकेशन्स, पुणे, २००३.

चौसाळकर अशोक, महात्मा फुले आणि शेतकरी चळवळ,लोकवाङमयगृह, मुंबई,२००७.
जावडेकर आचार्य श.द., आधुनिक भारत, कॉन्टिनेन्टल प्रकाशन, पुणे, १९९४.
तळवळकर गोविंद, सत्तांतर :१९४७,मौज प्रकाशन, मुंबई, १९९७.
दत्त आर. पी. अनु. आवटे लीला, भारत आजचा आणि उद्याचा, लोकवांडमयगृह, मुंबई, १९८६ .
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Savitribai Phule Pune University, Pune
Proposed Syllabus in History for T.Y.B.A. (Credit system)
From the Academic Year 2021-22
Under the Faculty of Humanities
Core Course 3: History of Civilization (3 Credit)
Semester V Course Title: - World Civilization and Heritage (Part I)

Course Objectives:

1.To Introduce students to the various concept and theories of World Civilization.
2.To study the types of Stone Culture and its various aspects.
3.To acquaint the students with rise and growth of Ancient Civilization in West Asia.
4.To understand about Ancient Civilization of China and its various parts.
5.To enable the students to understand the Ancient Indian Civilization and its town planning, socio-economic, religious life as well as Vedic Civilization.

Course Outcomes:

1. Students will be aquanaut with the knowledge of how the Human Civilization process was start
2. The History of World Civilization course will be developing the curiosity in students the rise and growth of Ancient Civilization in world.
3. This curriculum develops the attitude of contemporary students towards the World Civilization.

Pedagogy: Lectures / Visual Presentation / Critical Analysis / Assignments / Test/ e-learning

Course Content

Unit I: Stone Age Culture **12**

a) Evolution of Human

b) Types of Stone Age – Palaeolithic Age, Mesolithic Age, Neolithic Age

c) Food Production, Primitive Agriculture and Village Settlement

Unit II: Ancient Civilization in West Asia **12**

a) Egypt – Government, Socio-Economic Life, Art and Architecture

b) Mesopotamia - Socio-Economic Life, Art and Architecture

Religion and Literature.

c) Contribution of Egyptian and Mesopotamian Civilization to World History

Unit III: Ancient Civilization of China 10

a) Social Structure and Economy

b) Religion and Philosophy

c)Art and Architecture

Unit IV: Ancient Indian Civilization 11

a) Harappan Civilization – Town Planning, Socio –Economic and Religious Life, Art and Craft, Decline

b) Vedic Civilization–Vedic Literature, Socio-Economic life, Cultural and Religious belief

c) Contribution of Harappan and Vedic Civilization

Reference Book

English

1. Bowel, John, Man through the Ages, Weidenfeld and Nicolson, London, 1977.
2. Craig, A.M., Graham, W.A., Kagan, D., Ozment, S., and Turner, F.M., The Heritage of World Civilization, 2 vols. Macmillan,1986.

3. Davies H.A., An outline History of the World, Oxford University Press, London, 1964. (Fourth edition).

4. Durant Will, the Study of Civilization, Vol.I, (Our Oriental Heritage).

5. George W. Southgate, an Introduction to World History, J.M. Dent &Sons Ltd. London,1956.

6. Lucas, Henry, A short History of Civilization

7. Platt& Drummond, Our World through the Ages, Prentice-Hall, New- York,1959.

8.Sood Vishal, Ancient Civilizations of the World, ABH Publishing Corporation, New Delhi,2012.

9. Thapar Romila, India: From the origins to AD 1300, Penguin.

मराठी

कुलकर्णी. अ. रा.,पी. एन. देशपांडे व अ. म. देशपांडे, संस्कृतीचा इतिहास, सुविचार प्रकाशन मंडळ,पुणे,१९७७

कुलकर्णी. अ. रा. प्राचीन भारत-इतिहास आणि संस्कृती

जोशी लक्ष्मणशास्त्री, वैदिक संस्कृतीचा विकास

नाईकनवरे वैजयंती, प्राचीन समाज, फडके प्रकाशन, कोल्हापूर, २००८

पवार जयसिंगराव, मानव जातीचा इतिहास, अजब पुस्तकालय, कोल्हापूर, १९७२

सांझगिरी प्रभाकर, मानवाची कहाणी,पी. पी. एच. मुंबई १९६०

Savitribai Phule Pune University, Pune
Proposed Syllabus in History for T.Y.B.A. (Credit system)
From the Academic Year 2021-22
Under the Faculty of Humanities
Discipline Specific Elective Courses (DSE-3C)- (3 + 1 Credit)

Semester –V Course Title: Introduction to Historiography

Objectives:

1. To orient students about how History is studied, written and understood.
2. To explain methods and tools of data Collection
3. To study the types of Indian Historiography.
4. To describe importance of Inter-Disciplinary Research.
5. To introduce Students to the basics of Research.

Course Outcomes:

1. Students will be introduced to the information and importance of Historiography.
2. Students will be introduced to the different Methods and Tools of data collection.
3. Students can study the interdisciplinary approach of History.
4. Students will learn about the usefulness of History in the 21st century, its changing perspectives, the new ideas that have been invented, and the importance of History in a competitive World.
5. This curriculum develops Research ability and process of Research Methodology in History

Pedagogy: Lectures / Visual Presentation / Critical Analysis / Assignments / Test/ e-learning

Course Content:

Unit -I: Meaning and Scope of History 11

a) Definition, Nature & Scope of History
b) History and Social sciences
(Political science, Geography, Economics, Sociology)

Unit -II: Sources of Historical Research 10

a) Primary, Secondary and Oral sources.

b) Written, Unwritten.

c) Importance of Sources.

Unit -III: Preliminary Operations 12

a) Problem Formulation

b) Objectives

c) Hypotheses, Research Methods

Unit -IV: Synthetic Operations 12

a) External Criticism
b) Internal Criticism
c) Interpretation, Foot Note
d) Organizing Research Work, Statistical Data, Outcomes and Bibliography.

Reference Books

English

1. Avneri S., Social and Political Thought of Karl Marx, Cambridge, 1968.
2. Barnes H.E., History of Historical Writing, Dover, New York, 1963.
3. Cannadinen David (Ed.), What is History Now? Palgrave Macmillan, Basingstoke, 2002.
4. Carr E.H., What is History, Penguin Books, Harmond-sworth, 1971.
5. Chitnis K.N., Research Methodology in History
6. Collingwood, R.G., The Idea of History, Oxford University Press, New York, 1976.
7. E. Shreedharan, A Textbook of Historiography 500 BC to AD 2000, Orient Black Swan, New Delhi.
8. Elton G.R., Practice of History, Blackwell, London, 2001.
9. Grewal J.S., History and Historians of Medieval India, Guru Nanak University, Amritsar, 2000.
10. Langlois Ch, V. And Ch. Seignobos, Introduction to the study of History,
11. Mujumdar R.C., Historiography in Modern India, 1970.
12. Sarkar Sumit, Writing Social History, OUP, Delhi, 1998.
13. Sen S.P.(Ed.), Historians and Historiography in Modern India, Culcutta,1973.
14. Shiekh Ali, History: Its Theory and Method, Macmillan Publication, Madras, 1972.
15. Tikekar S.R., On Historiography, Mumbai, 1964.

16. Wilkinson and Bhandarkar, Research Methodology in Social Sciences, Himalaya, New Delhi, 2002.

मराठी

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कोठेकर शांता ,इतिहास तंत्र आणि तत्वज्ञान ,श्रीसाईनाथ प्रकाशन ,नागपूर ,२००५.

देव प्रभाकर ,इतिहास एक शास्त्र ,कल्पना प्रकाशन ,नांदेड ,मार्च१९९७.

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गायकवाड ,सरदेसाई ,हनमाने ,ऐतिहासिक कागदपत्रे व स्थळे यांचा अभ्यास ,फडके प्रकाशन , कोल्हापूर,१९८९

वळसंगकर कृ.ना,इतिहास विचारतरंग ,कॉन्टीनेन्टल प्रकाशन ,पुणे ,१९७४.

ढवळीकर मधुकर ,पुरातत्वविद्या ,म.रा.सा.सं.मं.मुंबई ,१९८०.

खोबरेकर वि .गो ,.महाराष्ट्रातील दप्तरखाने ,महाराष्ट्र राज्य साहित्य आणि सांस्कृतिक मंडळ ,मुंबई , १९८८ .

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Proposed Syllabus in History for T.Y.B.A. (Credit system)
From the Academic Year 2021-22
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Discipline Specific Elective Courses (DSE-4D)- (3 + 1 Credit)

Semester –V Course Title: Maharashtra in the 19th Century

Course Objectives:

1. To Introduce the students to the history of 19th century in Maharashtra
2. To study Political, Social, Economic and conceptual History of the 19th Century Maharashtra in an analytical way with the help of primary sources.
3. To evaluate contribution of 19th century in Maharashtra to the establishment of Maharashtra state contribution of successors and later development of the 19th century Maharashtra
4. To study Socio-religious System of the 19th Century in Maharashtra.

Course Outcomes:

1. Student will develop the ability to analyse sources for 19th century Maharashtra History.
2. Student will learn significance of Regional History and Socio- religious reformism foundation of the region.
3. It will enhance their perception of 19th Century Maharashtra.
4. Appreciate the skills of leadership and the Socio-religious System of the Maharashtra.

Pedagogy:

Lectures / Visual Presentation / Critical Analysis / Assignments / Test/ e-learning.

Course Content:

Unit-I. Foundation of British Power in Maharashtra 9

a) Background
b) British Administration.
c) Impact of British Power in Maharashtra.

Unit-II. Reformism in Maharashtra 16

a) Contribution of Intellectuals –Balshastri Jambhekar, Jagannath Shankarsheth Gopal Hari Deshmukh (Lokhitwadi) ,Mahatma Jyotiba Phule

b) Institutional Experiments-Paramahamsa Mandali**,** Prarthana Samaj**,**Satyashodhak Samaj**,** Sarvajanik Sabha

Unit-III. Uprising and Political Agitation 12

a) Local Uprisings

(Uprising of Ramoshi, Bhill, Koli, Revolt of 1857 and Deccan Riots (1875)

b) Rise of Nationalism (Indian National Congress, Moderate, Nationalist)

Unit-IV. Economic Transformation in Maharashtra 8

a) Economic Exploitation

b) Revenue (Rayatwari system)

c) Commercialization of Agriculture.

d) Economic Thought –Brief Survey

Reference Books

English:

1. Ballhatchet Kenneth, Social Policy and Social Change in Western India. 1817-1830, OUP, 1961.

2. Nurullah Syed and Naik J.P. A History of Education in India (During the British Period) Macmillan and Co.Ltd. Bombay,1951.

3. Paranjpe Shrikant, Dixit Raja and Das C.R. Western India: History Society and Culture, Itihas Shikshak Mahamandal, Maharashtra, Pune-1997.

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२. कीर धनंजय, महात्मा ज्योतिराव फुले आमच्या समाज क्रांतीचे जनक, पॉपुलर प्रकाशन, मुंबई.२०१२

३. कुलकर्णी शिल्पा, महाराष्ट्राचे समाज सुधारक, डायमंड प्रकाशन, पुणे.२०१२

४. कुलकर्णी, पु. बा. *ना. नाना शंकरशेट यांचे चरित्र,* मुंबई,१९५९

५. केतकर कुमार, कथा स्वातंत्र्याची, ग्रंथाली प्रकाशन, पुणे.१९८५

६. गरुड अण्णासाहेब, सावंत बी.बी. महाराष्ट्रातील समाज सुधारणा चळवळीचा इतिहास, कैलास पब्लिकेशन, औरंगाबाद १९८६

७. गर्गे एस. एम. गोपाळ गणेश आगरकर, नॅशनल बुक ट्रस्ट इंडिया, न्यू दिल्ली. १९९६

८.चौसाळकर अशोक, महर्षी विठ्ठल रामजी शिंदे यांचे धर्मविषयक विचार लोकवाङमय गृह प्रकाशन मुंबई.२००९

९.चौसाळकर अशोक, महाराष्ट्रातील महर्षी विठ्ठल रामजी शिंदे, लोकवाङमय गृह प्रकाशन मुंबई २०११

१०. जावडेकर आचार्य, आधुनिक भारत, कॉन्टिनेन्टल प्रकाशन, पुणे.२०१०

१.दीक्षित राजा. एकोणिसाव्या शतकातील महाराष्ट्रातील मध्यम वर्गाचा उदय, डायमंड प्रकाशन, पुणे.२००९

१४. धर्माधिकारी ए. बी. महाराष्ट्रातील समाज सुधारक, चाणक्य मंडळ परिवार प्रकाशन, पुणे. २००७

१६. नंदा बलराम (अनु.), वसंत पळशीकर, गोपाळ कृष्ण गोखले, ब्रिटीश राजवट व भारतीय नेमस्त युग, पुणे १९८६

१७. नरके हरी ,फडके य.दि. महात्मा फुले गौरव ग्रंथ, महाराष्ट्र राज्य शिक्षण विभाग, मुंबई. १९९३

१८. पवार जयसिंगराव, राजश्री शाहू स्मारक ग्रंथ, महाराष्ट्र इतिहास प्रबोधनी, कोल्हापूर. १९९९

१९. पाटील व्ही.बी.महाराष्ट्रातील समाजसुधारणेचा इतिहास, मेहता पब्लिशिंग हाऊस,पुणे. १९७८

२०. फाटक एन.आर. न्यायमूर्ती महादेव गोविंद रानडे यांचे चरित्र, नीलकंठ प्रकाशन, पुणे. १९६६

२१.फडकुले निर्मलकुमार, लोकहीतवादी कार्य आणि कर्तृत्व, कॉन्टिनेन्टल प्रकाशन, पुणे.१९७३

२२.बगाडे उमेश, महाराष्ट्रातील प्रबोधन आणि वर्गजाति प्रभुत्व, सुगावा प्रकाशन, पुणे. २००६ ,

२४.भोळे भा. ल. भारतीय राजकीय विचारवंत, पिंपलापुरे अंड कं.पब्लीशर्स,नागपूर. २०१८

२५.भोळे भास्कर लक्ष्मण, महात्मा ज्योतिराव फुले वारसा आणि वसा, साकेत प्रकाशन, औरंगाबाद.२००१

२६.पंडित नलिनी , महाराष्ट्रातील राष्ट्रवादाचा विकास, मॉडर्न बुक डेपो, पुणे.१९७४

२८.मोरे सदानंद. लोकमान्य ते महात्मा. राजहंस प्रकाशन.मुंबई.२००७

२९.रानडे महादेव गो. महाराष्ट्रातील समाज विचार १८१८ ते १८८४, सुविचार प्रकाशन मंडळ, नागपूर .

३०.सरदार ग. बा. अर्वाचीन मराठी गद्याची पूर्वपीठिका, मॉडर्न बुक डेपो ,पुणे १९३७.

३१ सरदार ग. बा. आधुनिक महाराष्ट्राचे उपेक्षित मानकरी. सुनंदा प्रकाशन, पुणे १९४१.

३२ सरदार जी. बी. महात्मा फुले व्यक्ति आणि विचार, ग्रंथाली प्रकाशन. पुणे .

३३.सरदेसाई बी. एन. आधुनिक महाराष्ट्र, फडके प्रकाशन, कोल्हापूर.२०००.

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Discipline Specific Elective Courses (DSE-4D)- (3 + 1 Credit)

Semester -V Course Title- Constitutional Development in India (1773-1853)

Course Objectives:

1. To Introduce the students to evolution of Constitution of India.
2. To study Factors and Situations that shaped the Constitutions.

Course Outcomes:

1. Students will understand evolution of Constitution of India.
2. Student will learn factors and conditions that contributed to constitution of India
3. Students will understand the Democratic Processes and thereby strengthen Democracy.

Pedagogy:

Lectures / Visual Presentation / Critical Analysis / Assignments / Test/ e-learning

Course Content:

Unit-I: Introduction. 10

a) Establishment of East India Company and its success in India
b) Structure of East India Company
c) Dual Government in Bengal: Background, Nature and Evaluation

Unit-II: Regulation on East India Company 15

a) Causes of Regulation on East India Company
b) Regulating Act of 1773-Background, Provisions, Evaluation.
c) Pitt's India Act of 1784 -Background, Provisions, Evaluation

Unit-III: Constitutional Development from 1784 to 1813 10

a) The Charter Act of 1793-Background, Provisions, Evaluation

b) The Charter Act of 1813- Background, Provisions, Evaluation.

Unit-IV: Constitutional Development from 1833 to 1853 10

a) The Charter Act of 1833- Background, Provisions, Evaluation
b) The Charter Act of 1853- Background, Provisions, Evaluation

Reference Books

English:

1. Keith A.B.; A Constitutional History of India (1600-1935), Pacific Publication o Andesite Press, India
2. Sethi R.R. and Mahajan V.D.; Constitutional history of India, S. Chand Publication, New Delhi
3. Chhabra G.S.; Advanced study in the Constitutional History of India (1773-1947), New Academic Publishing Company, Jullundur, India
4. Sikri S.L.; A Constitutional History of India, S. Nagin and Company, Jullundur, India
5. Jayapalan N.; Constitutional History of India, Atlantic publication, India
6. Mishra V.B.; Evolution of the Constitutional History of India (1773-1947), South Asia books, India
7. Khan M.M.; Constitutional History of India, Wisdom Press, Darya Ganj, New Delhi
8. Pylee Dr. M.V.; Constitutional History of India, S. Chand Publication, Darya Ganj, New Delhi
9. Aggarwala R.N.(Dr.); National Movement and Constitutional Development of India, Metropolitan Book Co. (P) Ltd. Delhi
10. Bhatnagar M. and R.C. Agarwal; Constitutional Development and National Movement, S. Chand Publishing, New Delhi

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१ . जोशी पद्माकर लक्ष्मीकांत ; भारताचा संवैधानिक इतिहास, विद्या प्रकाशन, नागपूर,१९९६.

२. भोगले शांताराम; भारतीय राष्ट्रीय आंदोलने आणि घटनात्मक विकास, विद्या प्रकाशन, नागपूर,१९९६ .

३.एस. गोपाल आणि सरोज देशपांडे; ब्रिटीशांची भारतातील राजनीती, डायमंड पब्लिकेशन, पुणे,२००६ .

४.गायकवाड रा. ज्ञा., प्रा. दि. ज्ञा. थोरात; भारताचा राजकीय आणि घटनात्मक इतिहास, रविल प्रकाशन, सातारा १९९९

हिंदी

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Savitribai Phule Pune University, Pune

Proposed Syllabus in History for TYBA (Credit System)
Form the Academic Year 2021-2022
Under the Faculty of Humanities
Skill Enhancement Courses (SEC 2 C) – (2 Credits)

Notes:

1. **The University Grants Commission has made it compulsory for students to earn two credits from a Skill Enhancement Course (SEC) in each semester second year onwards.**
2. **It is mandatory for the student to complete one Skill Enhancement Course (SEC) in each semester from Semester V to Semester VI.**
3. **It must be noted that student has to choose any one of the three Skill Enhancement Courses (SEC) for each Semester.**
4. **Each Skill Enhancement Course (SEC) will have two (2) credits only.**

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Proposed Syllabus in History for TYBA (Credit System)
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Skill Enhancement Courses (SEC 2 C) – (2 Credits)

Semester V: -SEC: 9 Course Title: South Indian Art and Architecture

(From 4th Century A.D. to 12th Century A.D.)

Objectives:

1. To acquaint the students, the Arts and Architecture of South India.
2. To acquaint the students, the and development of the Arts and Architecture of South India.
3. To enable the students to understand the Process of development of the Arts and Architecture of South India.
4. To create an interest among the students for the study of Arts and Architecture of South India.

Course Outcomes:

1.Students will get an overall understanding of the development of the Art and Architecture in South India.

2. They will understand the changing patterns of the Art and Architecture in South India.

3. They will understand the impact of Persian Art on Islamic Art and Architecture in South India

Unit. I- Introduction to Panting 10

a) Ajanta Painting.

b) Lepakshi Painting.

Unit. II - Introduction to Sculpture 10

a) Mahabalipuram.

b) Badami

Unit.III- Introduction to Architecture 10

a) Pattdakal ,Velur

b) Tanjavur, Vesara style

Reference Books

English

1. Rowland B., Art and Architecture Of India, Penguin Book, London, 1967.
2. Agarwal, O. P. Ed. Conservation of Cultural Properties in India, New Delhi, 1967-68.
3. Brown, Percy, Indian Architecture, 2 Vols., Bombay, 1959.
4. Deglurkar, G. B. Temple Architecture and Sculpture of Maharashtra, Nagpur, 1974.
5. Fletcher, Bannister, A History of Architecture, 17th Ed., London, 1961.
6. Fergusson, James, History of Indian and Eastern Architecture, 2 Vols., Delhi, 1967.
7. Kramrisch, Stella, The Hindu Temple, 2 Vols., Delhi, 1980.
8. Sastri, K. A. N. The Culture and History of the Tamils, Calcutta, 1964.
9. Sastri, K. A. N. A History of South India, Madras, 1958.

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2. रेड्डी, बालशौरि, *तमिलनाडु*, दिल्ली, १९७०.
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4. माटे, म. श्री. *प्राचीन भारतीय कला*, पुणे, १९७४.

Savitribai Phule Pune University, Pune
Proposed Syllabus in History for TYBA (Credit System)
Form the Academic Year 2021-2022
Under the Faculty of Humanities
Skill Enhancement Courses (SEC 2 C) – (2 Credits)
Semester V -SEC -:10 Research Paper Writing

Objectives

1. To describe importance of Inter-Disciplinary Research.
2. To introduce students to the Basics of Research.
3. To Describe the Research Outline

Course Outcomes:

1. Students will be introduced to the information and importance of Historiography.
2. Students can study the interdisciplinary approach History.
3. This curriculum Will help to develop Research ability and Process of Research Paper Writing in History

Unit-I: Formulation of Problem 10

a) Survey of Literature.

b) Gaps in Existing Research

c) Research Question to bridge the gaps

Unit-II: Research Procedures 10

a) Research Design and its Implementation

b) Source Collection, Close Reading, Criticism

c) Grouping and Classification of Sources

Unit-III: Findings and Reporting 10

a) Drawing Conclusions based on available data

b) Writing a Research Report

c) Footnotes and Bibliography for acknowledging the credit of others

Reference Books

English

1. Barnes H.E., *History of Historical Writing*, Dover, New York, 1963.
2. Cannadine David (Ed.), *What is History Now*?, Palgrave Macmillan, Basingstoke, 2002.
3. Carr E.H., *What is History*, Penguin Books, Harmonds worth, 1971.
4. Chitnis K.N., *Research Methodology in History, Pune.*
5. Elton G.R., *Practice of History*, Blackwell, London, 2001.
6. E.Shridharan, *A Textbook of Historiography* 500 BC to AD 2000, Orient Black Swan, New Delhi.
7. Sarkar Sumit, *Writing Social History*, OUP, Delhi, 1998.
8. Shiekh Ali, *History : Its Theory and Method*, Macmillan Publication,Madras, 1972.
9. Tikekar S.R., *On Historiography*, Mumbai, 1964.

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आठवले सदाशिव, इतिहासाचे तत्त्वज्ञान, प्रज्ञा प्रकाशन, वाई,१९८८.

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कुलकर्णी अ.रा. मराठ्यांचे इतिहासकार, डायमंड पब्लिकेशन्स, पुणे,२००९

कोठेकर शांता, इतिहासाचे तंत्र आणि तत्वज्ञान,साईनाथ प्रकाशन नागपूर, २००५

खरे ग.ह. संशोधांकाचा मित्र, भारत इतिहास संशोधन मंडळ,पुणे,१९७०.

गर्गे स.मु. इतिहासाची साधने: एक शोधयात्रा पॉप्युलर प्रकाशन, मुंबई,२०००.

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Proposed Syllabus in History for TYBA (Credit System)
Form the Academic Year 2021-2022
Under the Faculty of Humanities
Skill Enhancement Courses (SEC 2 C) – (2 Credits)
Semester V -SEC: 11 Course Title: - Museology

Objectives:

1. To acquaint the students with the rise and development of Museum.
2. To impart to the students an understanding of the importance of material history through Museum.
3. To encourage the students to collect the material or sources of History for local, regional and National History through Museum.
4. To enable the students to collect Various Articles as a tool of History.

Course Outcomes:

1.The Students will understand the Concepts of Museum ad learn the basic Principles of Museology
2 The Students will gain Comprehensive Knowledge of the Process of Cringe and Conserving Museum of objects

Unit-I: Introduction 10

a) Definition

b) History of Museum

c) Importance of Museum

Unit-II: Main Museums in Maharashtra. 10

a) Museums before Independence

b) Museums after Independence

c) Role of Curator

Unit-III: Types of Museums 10

a) Arts Museums

b) Historical Museums.

Reference Books

English

1. Agarwal, O. P. *Conservation of Manuscripts and Paintings of South-East Asia*, London, 1984.
2. Agarwal, Usha, *Directory of Museums in India*, New Delhi, 2000.
3. Bartz, Bettina Optiz, Helmut Richter, Elizabeth, Eds., *Museums of the World*, 1992.
4. Bornham, Bonnie, *Protection of Cultural Property: A Handbook of National Legislation*, Paris, 1974.
5. Colleman, L. V. *Museum Buildings, Vol. I,* Washington, 1950.
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7. Edson, Gary Dean, David, *The Handbook of Museums*, 1994.
8. Hudson, Kenneth Nicholls, Ann, Eds., *World Directory of Museums*, New York, 1975.
9. International Council of Museums, *Directory of Museums in the Arab Countries*, London, 1995.
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12. Woodhead, Peter Stansfield, Geoffrey, *Key Guide to Information Sources in Museum Studies*, 1994.

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Savitribai Phule Pune University, Pune
Proposed syllabus in History for TYBA (Credit system)
From the Academic Year 2021-22
Under the Faculty of Humanities
Core Course 4 (3 Credit)
Semester VI: Course Title: - India After Independence- (1947-1991)

Objectives:

1. To make the students aware about the making of Contemporary India and events that panned out in the Post-Independence Era.
2.To make the students aware of the Multi-Dimensionality of Modern India.
3.To highlight the ideas, institutions, forces and movements that contributed to the shaping of Indian Modernity.
4.To acquaint the students with various Interpretative and Analytical perspectives.

Course Outcomes:

1. It will enable students to develop an overall understanding of the Contemporary India.
2. To increase the spirit of healthy Nationalism, Democratic Values and Secularism among the students.
3. Students will understand various aspects of India's domestic and foreign policies that shaped Post-Independence India.

Pedagogy: Lectures / Visual Presentation / Critical Analysis / Assignments / Test/ e-learning

Unit I: Challenges after Independence 13

a) Consequences of Partition

b) Integration of Princely states- Kashmir, Junagadh, Hyderabad

c) Liberation of Portuguese and French Colonies- Goa, Pondicherry, Chandranagore

d)Indian Constitution – Salient Features

e) Linguistic Reorganization of States

Unit II: India's Foreign Policy 10

a) Non Aligned Movement

b) Indo-Pak Relations, Conflicts and the birth of Bangladesh

c) Indo-Sino Relations, Conflicts and Panchsheel

d) Indo-Sri Lanka Relations

Unit III: Domestic Policy 10

a) Hindu Code Bill: Nature and Impact

b) Emergency: Background, Nature and Impact

c) Space Research

Unit IV: Economic Policy 12

a) Mixed Economy and Five Year Plans

b) Industrial Development

c) Nationalization of Banks - First Demonetization

d) Privatization, Liberalization and Globalization: Brief Introduction

Reference Books:
English

1. Chandra Bipan: Mukherjee Mridula: Mukherjee Aditya; India After Independence; Penguin: India 1999
2. Lapierre Dominique and Collins Larry; Freedom at Mid night; William Collins and Simon & Schuster; UK & USA;1975
3. Guha Ramchandra; India After Gandhi: The History of the World's Largest Democracy; Harper Collins; India; 2007
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6. Wolpert Stanley; A New History of India, Oxford University Press; 1977
7. Ansari Sarah Life after Partition: Migration, Community and Strife in Sindh: 1947–1962; Oxford, UK: Oxford University Press; 2005.
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9. Chacko Priya; Indian Foreign Policy: The Politics of Postcolonial Identity from 1947 to 2004; Routledge; 2013.
10. Kulke, Hermann; A History of India; Routledge; 2004
11. Menon Shivshankar Menon; Choices: Inside the Making of India s Foreign Policy; Penguin; India; 2016
12. G.W. Choudhury, India, Pakistan, Bangladesh, and the major powers: politics of a divided subcontinent; Cambridge University Press; India;1975
13. Kore, V.S. "Liberation of Goa: Role Of The Indian Navy"; Bharat Rakshak; 2013.
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15. Khanna, Justice H.R.; Making of India's Constitution; Eastern Book Company; 2008.
16. Austin, Granville; The Indian Constitution: Cornerstone of a Nation (2nd ed.). Oxford University Press;1999
17. Ganguly Sumit; 'India, Pakistan, and Bangladesh: Civil-Military Relations', Oxford Research Encyclopaedia of Politics, Oxford University Press; 2020
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19. Dube, Rajendra Prasad; Jawaharlal Nehru: A Study in Ideology and Social Change; 1998
20. Maheshwari Neerja; Economic Policy of Jawaharlal Nehru. Deep & Deep; 1997
21. Jayakar Pupul; Indira Gandhi: A Biography; Penguin Books India; 1992.
22. Chandra, Bipan; In the name of democracy : JP movement and the emergency, Chapter 4, Emergency imposed; Penguin Books; New Delhi; 2003.
23. Agrawal Narayan; Lal Bahadur Shastri, Churn of Conscience. Eternal Gandhi; 2006.
24. Nehru, S., ed.; Economic Reforms in India: Achievements and Challenges; MJP Publisher; Chennai; 2019
25. Shiva, Vandana; The Violence of the green revolution : Third World agriculture, ecology, and politics; 1991.

मराठी

कोठेकर शांता ,**आधुनिक भारताचा इतिहास १९४७ ते २०००श्री**साईनाथ प्रकाशन नागपूर २००८.

कोठेकर शांता, वैद्य सुमन**, स्वतंत्र भारताचा इतिहास (१९४७ ते १९८६)**, श्रीसाईनाथ प्रकाशन नागपूर २००८

चंद्र बिपन(अनु.) पारधी मा.कृ. व इतर, स्वतांत्र्यतोतर भारत, के सागर पब्लिकेशन, पुणे.

तळवलकर गोविंद , नवरोजी ते नेहरू , माजेस्टिक प्रकाशन, मुंबई, १९८९

दिवान चंद्रशेखर, भारताची विदेशनीती , विद्या प्रकाशन, नागपूर, १९९२

ब्रम्हे सुलभा (संपा.) धं.रा. गाडगीळ लेखसंग्रह खंड १, गोखले अर्थशास्त्र संस्था पुणे

महाजन समाधान , आधुनिक भारताचा इतिहास , युनिक अकादमी पुणे २०१८

Savitribai Phule Pune University, Pune
Proposed syllabus in History for TYBA (Credit system)
From the Academic Year 2021-22
Under the Faculty of Humanities
Core Course 4 History of Civilization (3 Credit)
Semester VI Course Title: -World Civilization and Heritage (Part II)

Course Objectives:

1. To Orient students about Western Classical Civilization of Greece and Roman.
2. To introduce students to the Arab Civilization and its various aspects.
3. To study various Concept and theory's in Medieval Europe.
4. To understand the Renaissance- Reformation Movement and impact of various Past Civilizations.
5. To create motivation and curiosity among the students through the age of discoveries in Ancient and Medieval times.

Course Outcomes:

1. Students will be oriented about Western Classical Civilization of Greece and Rome.
2. Students will be introduced to Arab Civilization and its impact on world Civilization.

Pedagogy Lectures / Visual Presentation / Critical Analysis / Assignments / Test/ e-learning

Course Content:

Unit I: Western Classical Civilization 12

a) Greece Civilization- Social Life, Economy, Cultural Life, Religious belief

b) Roman Civilization – Philosophy, Socio-Economic Life, Religion, Art and Architecture,

c) Contribution of Greece and Roman Civilization in World History

Unit II: Arab Civilization 11

a) Economic and Cultural Life, Literature, Art and Architecture

b) Contribution in History Writing

c) Impact of Arab culture on World Civilization

Unit III: Life in Medieval Europe 12

a) Meaning and Nature of Feudalism, Church and State

b) Economy, Social Life, Rise of Nation States

c) Impact of Renaissance Period

Unit IV: Historical World Heritage 10

a) Introduction

b) Famous Historical World Heritage Sites- Great Wall of China: China, Great Pyramid of Giza: Egypt, Petra: Jordan, Colosseum: Rome, Chichen Itza: Mexico, Machu Pichu: Peru, Taj Mahal: India, Christ the Redeemer: Brazil

c) Importance of World Heritage Sites

Reference Books:

English

1. B. Kumar, Encyclopedic study of World History, Kunal Books, New Delhi, 2012
2. Gerrit P. Judd, A History of Civilization, Collier-Macmillan, New York, 1966, reprinted1967.
3. Nanda S.P, History of the World, Dominant Publishers and distributors. Pvt. Ltd. New Delhi, 2007, (Reprint2011)
4. Swain James Edgar (1970) -A History of World Civilization, Eurasia publishing House (P)Ltd.Delhi-55.
5. Graham, W.A., Kagan, D., Ozment, S., and Turner, F.M., The Heritage of World Civilization, 2 vols., Macmillan, 1986
6. Cambridge Medieval History. (Macmillan, 1911) 8 Vols.
7. Hause, S. and Maltby, W., The Essentials of Western Civilization, Wadsworth, USA, 2001. Lucars, H.S., A Short History of Civilization
8. Miller, David, The Black Well Encyclopedia of Political Thought, Blackwell Reference, New York, 1987.
9. Modell, S., A History of the Western World, 2 vols., Prentice-Hall Inc., New Jersey, 1974
10. Pirenne, Jacques, and The Tides of History: From the beginnings to Islam, George Allen and Union, Ltd., London, 1962 Vol. I.
11. Stavrianos, L.S., The Epic of Modern Man, Prentice Hall, Englewood Cliffs, 1966.
12. Wallbank, T.W., Taylor, A.M., Bailkry, N.M., Civilizations – Past and Present.
13. Weech, W.N., History of the World
14. Managing world heritage sites - Anna leask and Allan fall

15. World heritage conservation the World Heritage convention linking culture and nature for sustainable development - Claire cave and blene Negussie

मराठी

ओतूरकर रा. वि, आर. पोतनीस व जी. एच. महाजन, जगाचा संक्षिप्त इतिहास भाग १, अनाथ वसतिगृह प्रकाशन, पुणे १९५६.

कोलारकर शं. गो. पाश्चिमात्य जग, मंगेश प्रकाशन, नागपूर २००५.

मराठे डी. एस. जगाचा इतिहास, देशमुख आणि कं. प्रा. लि,पुणे १९५६.

Savitribai Phule Pune University, Pune
Proposed Syllabus in History for TYBA (Credit system)
From the Academic Year 2021-22
Under the Faculty of Humanities
Discipline Specific Elective Courses (DSE-3C) -(3 + 1 Credit)

Semester –VI, Course Title: Applied History

Course objectives:

1) To Introduce students to information and importance of Applied History.

2) To help students understand the usefulness of history in the 21st century, its changing perspectives, the new ideas that have been invented, and the importance of History in a Competitive World.

3) To inform the students about the historical significance of Archaeology and Archives and the opportunities in the field of Archaeology and Archives through this course.

4) To inform the students about the opportunities in the field of Media, Museums through this Course.

Course Outcomes:

1. Students will be introduced to the information and importance of applied history.
2. Student will learn about the Historical significance of Archaeology and Archives and opportunities in the field of Archaeology and Archives.
3. Through this course, students will be informed about the opportunities in the field of Media, Museums.
4. Students will learn about the usefulness of history in the 21st Century, its changing Perspectives, the new ideas that have been invented, and the importance of History in a Competitive World.

Pedagogy: Lectures / Visual Presentation / Critical Analysis / Assignments / Test/ e-learning

Course Content

Unit-I. Applied History 14

a. Applied History: Concept and Application
b. Application of History in Various Subjects
c. Co-relationship between Past and Present
d. Contemporary History: Meaning and Nature

Unit-II. Archaeology and Archives 15

a) Archaeology and Archives: Definition and Development in India
b) Archival Sources: Ancient, Medieval and Modern- A brief survey
c) Heritage Sites: Types, Preservation and Conservation
d) Historical Importance of Heritage Sites and Museums

Unit-III. Mass Media and Applied History 16

a) Mass Media: Meaning and Types
b) Print media:
i). Establishment and growth of printing press in India
ii). Newspaper: Definition, Rise, Newspaper in India - A brief survey
c) Electronic media: Radio, Television, E-media.

Unit-IV: Project Work /Study Tour Report/Historical Places Visit Rreport

Project work and Evaluation scheme

1. Candidate shall submit Project report of minimum 2000 words i.e.10 to12 pages (Should be DTP) to the department by end of the Semester.
2. A viva-voce should be conducted before theory examination and the results should be sent to the University as immediately
3. The Distribution of Marks – For Report Writing 20 Marks and for Vice-Voce 10 Marks

Reference Books

English

1) Bajaj Satish K, Research Methodology in History, Amol Pub Pvt.Ltd, New Delhi.
2) Bobade Bhajang R., Manuscriptology from Indian Sources, Pacific Publication, Delhi.
3) Carr E.H., What is History, Penguin Books, Harmondsworth, 1971.
4) Chitnis K.N., Research Methodology in History, Navi Path, Pune1979.
5) Collingwood R.G., The Idea of History, Oxford university,1961.
6) Datta.K.B., Mass Media in India, Akansha Publishing House, New Delhi,2005.
7) Director General, Archaeological Remains, Monuments and Museums Part1&2, Archaeological Survey of India, New Delhi, 1964.
8) Gaur.M. M., Electronic Media, Omega Publication, Delhi, 2006.

9) Ghose,Sallen, Archive in India, Calcuttd,1963.
10) Mehara Chandar, History of Newspapers in India, Notion Press, Chenniai,2019.
11) Mujumdar R.K., Shrivastava A.N., Historiography, subject Book, Delhi,06 ,1975.
12) Shobita Punija, Museum of India, The Guidebook, Hon Kong, 1990.

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आर्य पी .के ,.इलेक्ट्रोनिकमिडिया ,प्रभातप्रकाशन ,नवीदिल्ली ,
कटारे ,साखरे,पाटील ,पुरातत्वविद्या ,वस्तुसंग्रहालय आणि पर्यटन,जेनरिक पब्लिशर,२०१५.
कार.ई .एच ,.अनुवाद .प्रा.वि.गो.लेले ,इतिहास म्हणजे काय ,कन्टीनेन्टल प्रकाशन ,पुणे ,३०.
कोठेकर शांता ,इतिहास तंत्र आणि तत्वज्ञान ,श्रीसाईनाथ प्रकाशन ,नागपूर ,२००५ .
कोल्हटकर संजय,कुलकर्णी प्रसाद,महाराष्ट्रातील प्रसारमाध्यमे काल आणि आज,डायमंड पब्लिकेशन,पुणे.
खोबरेक रवि .गो ,.महाराष्ट्रातील दप्तरखाने ,महाराष्ट्र राज्य साहित्य आणि सांस्कृतिक मंडळ ,मुंबई ,१९८८ .
गर्गे स.मा ,.इतिहासाची साधने:एक शोध यात्रा ,पॉप्युलर प्रकाशन ,मुंबई ,१९९४.
गायकवाड ,सरदेसाई ,हनमाने ,ऐतिहासिककागदपत्रेवस्थळेयांचाअभ्यास ,फडकेप्रकाशन ,कोल्हापूर,१९८९ .
जोशी लक्ष्मनशास्री तर्कतीर्थ ,पुरातत्वविद्या ,मराठी विश्वकोश खंड ९ , महाराष्ट्र राज्य मराठी विश्वकोश निर्मिती मंडळ , मुंबई.
जोशी लक्ष्मनशास्री तर्कतीर्थ,मुद्रण ,मराठी विश्वकोश खंड १३ ,महाराष्ट्र राज्य मराठी विश्वकोश निर्मिती मंडळ ,मुंबई.
ढवळीकर मधुकर ,पुरातत्वविद्या ,म.रा.सा.सं.मं.मुंबई ,१९८०.
थोरात भास्कर वस्तुसंग्रहालयशास्त्र - पुरातत्वविद्या ,पुराभिलेख व ग्रंथालयशास्त्र ,प्राची प्रकाशन ,मुंबई,२००१
दळवी जयमती ,भारतातील प्रसारमाध्यमे काल आणि आज,डायमंड पब्लिकेशन ,पुणे.
देव प्रभाकर ,इतिहास एक शास्त्र ,कल्पना प्रकाशन ,नांदेड ,मार्च१९९७.
देव बी ,पुरातत्वविद्या ,कॉन्टीनेन्टल प्रकाशन ,मुंबई.२००८ .
देशमुख प्रशांत ,इतिहासाचे तत्वज्ञान ,विद्या बुक पब्लिशर्स ,औरंगाबाद ,२००५.
पाटील सुलोचना, उपयोजित इतिहास, प्रशांत पब्लिकेशन, जळगाव.
रानडे अनुराधा,समेळ स्वप्ना ,पुरातत्वशास्त्र ,वस्तुसंग्रहालयशास्त्र ,ग्रंथालयशास्त्र ,इतिहास अभ्यास पत्रिकाक्र.६ ,
दूरवमुक्तःअध्ययनसंस्था ,मुंबईविद्यापीठ,मुंबई.
लेले.रा.क ,.मराठी वृत्तपत्रांचा इतिहास ,कॉन्टीनेन्टलप्रकाशन ,पुणे ,१९८४.
वळसंगक रकृ.ना ,.इतिहास विचारतरंग ,कॉन्टीनेन्टल प्रकाशन ,पुणे ,१९७४.
सरदेसाईबी.एन ,.इतिहास लेखनशास्त्र,फडके प्रकाशन ,कोल्हापूर ,२००२.
सांकलीया हसमुख ,पुरातत्वपरिचय ,डेक्कन कॉलेज ,पोस्टग्रएज्युट अॅन्डरीर्सच सेंटर ,पुणे ,१९९६

Savitribai Phule Pune University, Pune
Proposed Syllabus in History for TYBA (Credit system)
From the Academic Year 2021-22
Under the Faculty of Humanities
Discipline Specific Elective Courses (DSE-4D)- (3 + 1 Credit)

Semester -VI, Course Title: History of Maharashtra in the 20th Century

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Course Objectives:

1. To Introduce the students to the history of 20th Century in Maharashtra
2. To study Political, Social, Economic and Conceptual History of the 20th Century Maharashtra in an Analytical way with the help of Primary Sources.
3. To evaluate contribution of 20th Century in Maharashtra to the establishment of Maharashtra state contribution of successors and later development of the 19th century Maharashtra
4. To study Socio-Religious System of the 20th Century in Maharashtra.

Course Outcomes:

1. Student will develop the ability to analyses sources for 20th Century Maharashtra History.
2. Student will learn significance of regional history and Socio- Religious Reformism foundation of the region.
3. It will enhance their Perception of 20th Century Maharashtra.
4. Appreciate the skills of leadership and the Socio-Religious System of the Maharashtra.

Pedagogy:

Lectures / Visual Presentation / Critical Analysis / Assignments / Test/ e-learning

Course content

Unit I. Thoughts and work of Intellectuals 15

a) Pandita Ramabai

b) Rajarshri Chhatrapati Shahu Maharaj

c) Maharshi Vitthal Ramji Shinde

d) Maharshi Dhondo Keshav Karve

e) Maharaja Sayajirao Gaikwad.

f) Dr. Babasaheb Ambedkar

g) Karmaveer Bhaurao Patil

Unit II. Industrial and Economic Development of Maharashtra **10**

a) Industrialization and Urbanization
b) Cotton and Sugar Industry
c) Co-operative Movement -Brief survey

Unit III. Movements in 20th Century Maharashtra **10**

a) Workers Movement
b) Peasants Movement
c) Dalit Movement
d) Non-Brahmin Movement

Unit IV. Integration and Reorganization of Maharashtra **10**

a) Marathawada Mukti Sangram
b) Sanyukta Maharashtra Movement
c) Maharashtra-Karnataka Border Dispute

Reference Books

English:

1. Ballhatchet Kenneth, Social Policy and Social Change in Western India. 1817-1830, OUP, 1961.
2. Nurullah Syed and Naik J.P. A History of Education in India (During the British Period) Macmillan ana Co.Ltd. Bombay,1951.
3. Paranjpe Shrikant, Dixit Raja and Das C.R. Western India: History Society and Culture, Itihas Shikshak Mahamandal, Maharashtra, Pune-1997.
4. Ravindra Kumar, Western India in the Nineteenth Century: A Study in the Social History of Maharashtra Routledge and Kegan Paul, Toronto, 1968.

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१. अत्रे शुभांगी, महाराष्ट्र संस्कृती, डायमंड प्रकाशन, पुणे.१८१८
२. कीर धनंजय, महात्मा ज्योतिराव फुले आमच्या समाज क्रांतीचे जनक, पॉपुलर प्रकाशन, मुंबई.२०१२
३. कुलकर्णी शिल्पा, महाराष्ट्राचे समाज सुधारक, डायमंड प्रकाशन, पुणे.२०१२
४. कुलकर्णी, पु. बा. *ना. नाना शंकरशेट यांचे चरित्र,* मुंबई,१९५९
५. केतकर कुमार, कथा स्वातंत्र्याची, ग्रंथाली प्रकाशन, पुणे.१९८५
६. गरुड अण्णासाहेब, सावंत बी.बी. महाराष्ट्रातील समाज सुधारणा चळवळीचा इतिहास, कैलास पब्लिकेशन, औरंगाबाद १९८६

७. गर्गे एस. एम. गोपाळ गणेश आगरकर, नॅशनल बुक ट्रस्ट इंडिया, न्यू दिल्ली. १९९६

८.चौसाळकर अशोक, महर्षी विठ्ठल रामजी शिंदे यांचे धर्मविषयक विचार लोकवाङमय गृह प्रकाशन मुंबई.२००९

९.चौसाळकर अशोक, महाराष्ट्रातील महर्षी विठ्ठल रामजी शिंदे, लोकवाङमय गृह प्रकाशन मुंबई २०११

१०. जावडेकर आचार्य, आधुनिक भारत, कॉन्टिनेन्टल प्रकाशन, पुणे.२०१०

१३.दीक्षित राजा. एकोणिसाव्या शतकातील महाराष्ट्रातील मध्यम वर्गाचा उदय, डायमंड प्रकाशन, पुणे.२००९

१४. धर्माधिकारी ए. बी. महाराष्ट्रातील समाज सुधारक, चाणक्य मंडळ परिवार प्रकाशन, पुणे. २००७

१६. नंदा बलराम (अनु.), वसंत पळशीकर, गोपाळ कृष्ण गोखले, ब्रिटीश राजवट व भारतीय नेमस्त युग, पुणे १८६६

१७. नरके हरी ,फडके य.दि. महात्मा फुले गौरव ग्रंथ, महाराष्ट्र राज्य शिक्षण विभाग, मुंबई. १९९३

१८. पवार जयसिंगराव, राजश्री शाहू स्मारक ग्रंथ, महाराष्ट्र इतिहास प्रबोधनी, कोल्हापूर. १९९९

१९. पाटील व्ही.बी.महाराष्ट्रातील समाजसुधारणेचा इतिहास, मेहता पब्लिशिंग हाऊस,पुणे. १९७८

२०. फाटक एन.आर. न्यामूर्ती महादेव गोविंद रानडे यांचे चरित्र, नीलकंठ प्रकाशन, पुणे. १९६६

२१.फडकुले निर्मलकुमार, लोकहीतवादी कार्य आणि कर्तृत्व, कॉन्टिनेन्टल प्रकाशन, पुणे.१९७३

२२.बगाडे उमेश, महाराष्ट्रातील प्रबोधन आणि वर्गजाति प्रभुत्त्व, सुगावा प्रकाशन, पुणे. २००६ ,

२३.भालेराव आनंद. मराठवाड्याचा स्वातंत्र्यसंग्राम. स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ संशोधन संस्था, औरंगाबाद.१९९९

२४.भोळे भा. ल. भारतीय राजकीय विचारवंत, पिंपलापुरे अंड कं.पब्लीशर्स,नागपूर. २०१८

२५.भोळे भास्कर लक्ष्मण, महात्मा ज्योतिराव फुले वारसा आणि वसा, साकेत प्रकाशन, औरंगाबाद.२००१

२६.पंडित नलिनी , महाराष्ट्रातील राष्ट्रवादाचा विकास, मॉडर्न बुक डेपो, पुणे.१९७४

२७.मंगुडकर एम.पी. महाराष्ट्रातील समाज प्रबोधन आणि छत्रपती शाहू महाराजांचे कार्य, पुणे विद्यापीठ प्रकाशन, पुणे.

२८.मोरे सदानंद. लोकमान्य ते महात्मा. राजहंस प्रकाशन.मुंबई.२००७

२९.रानडे महादेव गो. महाराष्ट्रातील समाज विचार १८१८ ते १८८४, सुविचार प्रकाशन मंडळ, नागपूर .

३०.सरदार ग. बा. अर्वाचीन मराठी गद्याची पूर्वपीठिका, मॉडर्न बुक डेपो ,पुणे १९३७.

३१ सरदार ग. बा. आधुनिक महाराष्ट्राचे उपेक्षित मानकरी. सुनंदा प्रकाशन, पुणे १९४१.

३२ सरदार जी. बी. महात्मा फुले व्यक्ति आणि विचार, ग्रंथाली प्रकाशन. पुणे .

३३.सरदेसाई बी. एन. आधुनिक महाराष्ट्र, फडके प्रकाशन, कोल्हापूर.२०००.

Savitribai Phule Pune University, Pune
Proposed Syllabus in History for TYBA (Credit system)
From the Academic Year 2021-22
Under the Faculty of Humanities
Discipline Specific Elective Courses (DSE-4D)- (3 + 1 Credit)

Semester -VI, Course Title- Constitutional Development in India (1858-1950)

Course Objectives:

1. To Introduce the Students to evolution of Constitution of India.
2. To Study factors and Situations that shaped the Constitutions.

Course Outcomes:

1. Student will understand evolution of Constitution of India.
2. Student will learn factors and conditions that contributed to Constitution of India
3. Students will understand democratic processes and thereby strengthen Democracy.

Pedagogy:

Lectures / Visual Presentation / Critical Analysis / Assignments / Test/ e-learning

Course Content

Unit-I: Constitutional Development 1858-1891 10

a) Government of India Act 1858 and Queen's Proclamation – Background, Provisions, Significance.

b) Indian Councils Act of 1861- Causes, Provisions, Evaluation.

c)Indian Councils Act 1891 – Causes, Provisions, Evaluation.

Unit II: Indian Councils Acts 15

a) Morley-Minto Reforms Act 1909 -Background, Provisions, Significance, Effects
b) Montagu-Chelmsford Reforms Act 1919- Background, Provisions, Significance, Effect.

Unit-III: The Government of India Act 1935 10

a) Background - Simon Commission, Nehru Report, Round table Conferences
b) The Salient Features of Government of India Act 1935
c) Provincial Autonomy

Unit-IV: Towards Independence 10

a) Cripps Mission

b) Wavell Plan, Cabinet Mission Plan

c) Mountbatten Plan and Indian Independence Act 1947

d) Indian Constitution - Salient Features

Reference Books:

English

1. Keith A.B.; A constitutional history of India (1600-1935), Pacific Publication o Andesite Press, India
2. Sethi R.R. and Mahajan V.D.; Constitutional history of India, S. Chand Publication, New Delhi
3. Chhabra G.S.; Advanced study in the constitutional history of India (1773-1947), New Academic Publishing Company, Jullundur, India
4. Sikri S.L.; A Constitutional history of India, S. Nagin and Company, Jullundur, India
5. Jayapalan N.; Constitutional History of India, Atlantic publication, India
6. Mishra V.B.; Evolution of the Constitutional history of India (1773-1947), South Asia books, India
7. Khan M.M.; Constitutional history of India, Wisdom Press, Darya Ganj, New Delhi
8. Pylee Dr. M.V.; Constitutional history of India, S. Chand Publication, Darya Ganj, New Delhi
9. Aggarwala R.N.(Dr.); National Movement and constitutional Development of India, Metropolitan Book Co. (P) Ltd. Delhi

मराठी

जोशी पद्माकर लक्ष्मीकांत ; भारताचा संवैधानिक इतिहास, विद्या प्रकाशन, नागपूर,१९९६.

भोगले शांताराम; भारतीय राष्ट्रीय आंदोलने आणि घटनात्मक विकास, विद्या प्रकाशन, नागपूर,१९९६ .

एस. गोपाल आणि सरोज देशपांडे; ब्रिटीशांची भारतातील राजनीती, डायमंड पब्लिकेशन, पुणे,२००६ .

गायकवाड रा. ज्ञा., प्रा. दि. ज्ञा. थोरात; भारताचा राजकीय आणि घटनात्मक इतिहास, रविल प्रकाशन, सातारा, १९९९

हिंदी

भटनागर महेश , आर. सी. अगरवाल; भारतीय संविधान का विकास तथा राष्ट्रीय आंदोलन, एस. चांद पब्लिकेशन,२००८.

Savitribai Phule Pune University, Pune
Proposed Syllabus in History for TYBA (Credit System)
Form the Academic Year 2021-2022
Under the Faculty of Humanities
Skill Enhancement Courses (SEC 2 D) – (2 Credits
Semester VI SEC: 12 Course Title: -Heritage Management

Course Objectives:

1. To understand the introduction of Heritage Management to the Students
2. To get an Opportunity to seek self-employment to the students

Course Outcomes:

1. Student will understand over all process of Heritage Management
2. Student will get the knowledge about scope and the fact of Heritage Management.
3. The students will enable to understand about legal and commercial framework of Heritage

Unit-I: Heritage 10

a) Define the concept of Heritage

i) Local ii) National iii) International

b) Nature and Scope

c) Importance of Heritage

Unit-II: Heritage Tourism 10

a) Define the Concept of Heritage Tourism

b) UNESCO World Heritage Site in India

c) UNESCO World Heritage Site in Maharashtra

Unit- III: Heritage Site Management 10

a) Roll of Government
b) Roll of Common People
c) Field Visit and Report

Reference Books

1. Kernal Balsar, The concept of the Common heritage of Mankind, Vol.30 Martinus Nijhoff
2. Richard Harrison (ed), Manual of Heritage Management, Butterworth Heineman.
3. Devide T Herbert (ed), Heritage Tourism and Society, Mausell.
4. Nagar S.L, Protection, Conservation and preservation of India's monuments. Aryan books
5. Chainani, S., Heritage conservation legislative and organizational policies for India. New Delhi: INTACH. 2007
6. UNESCO and its Programmes , protection of mankind's cultural heritage sites and monuments, UNESCO 1970. International, New Delhi 1998

Savitribai Phule Pune University, Pune
Proposed Syllabus in History for TYBA (Credit System)
Form the Academic Year 2021-2022
Under the Faculty of Humanities
Skill Enhancement Courses (SEC 2 D) – (2 Credits)
Semester VI: 13 Course Title: - Archaeology

Course Objectives:

1. This paper is designed to introduce the students to the Key Concepts and practical approaches in Archaeology, highlighting their applications in interpreting the Human past.

2. It will enable students to understand the definition, aims and scope of Archaeology and its development as a discipline will be introduced to the Students.

3. The nature of the Archaeological record and the unique role of science in Archaeology is explained to the students.

4. Legislation related to Archaeology and the role of Archaeology in Heritage Management is also discussed in this course.

Course Outcomes:

1. Students will learn to understand the definition, aims and scope of Archaeology so as to understand its applications in interpreting the human past.

2. They will be able to understand the nature of the archaeological record and the unique role of science in archaeology.

3. They will have an overall understanding of the Archaeology.

Course Content:

Unit- I: Definition, Aims and Scope of Archaeology **10**

a) Archaeology as the Study of the Past: Definition, Aims, and Scope
b) Significance of Archaeology
c) Archaeology and History: Differences and Similarities

Unit- II: Development of Archaeology in India **10**

a) Archaeological Survey of India
b) Tata Fundamental Research Institute Mumbai
c) Deccan College Pune

Unit-III: Value of Archaeology **10**

a) Cultural Heritage
b) Monuments

Reference Books-

1. Binford, L.R. 1972 Introduction. An Archaeological Perspective, pp. 1–14. Seminar Press, New York.
2. Chakrabarti, D.K. 1988. A History of Indian Archaeology: From the Beginning to 1947. New Delhi: Munsiram Manoharlal.
3. Daniel, Glyn, E. 1975. A Hundred and Fifty Years of Archaeology. London: Duckworth.
4. Dhavalikar, M K. 1984. Towards an Ecological Model for Chalcolithic Cultures of Central and Western India. Journal of Anthropological Archaeology 3. Pp- 133-158
5. Fagan, B. 1988. In the beginning: An Introduction to Archaeology. Glenview: Scott, Foresman and company.
6. Flannery, K.V., and J. Marcus 1998 Cognitive Archaeology. In Reader in Archaeological Theory: Post-Processual and Cognitive Approaches, edited by D. Whitley, pp. 35–48. Routledge, London.
7. Gardner, A. 2009 Agency. In Handbook of Archaeological Theories, edited by R.A. Bentley, H.G. Maschner, and C. Chippindale, pp. 95–108. AltaMira Press, Lanham, MD.
8. Gifford-Gonzalez, Diane. 2011. Just Methodology? A Review of Archaeology's Debts to Michael Schiffer. Journal of Archaeological Method & Theory (2011) 18: 299–308.
9. Hodder, I. 1995. Interpreting Archaeology: Finding Meaning in the Past. New York: Routledge.
10. Hurcombe Linda 2007. Archaeological artefacts as material culture. New York: Routledge
11. Kelly, R.L. 1995. Chapter 3, Foraging and Subsistence. In The Foraging Spectrum: Diversity in Hunter- Gatherer Lifeways. Smithsonian Institution Press, Washington, D.C. (pp. 65–110)
12. McIntosh Jane R. 2008. Ancient Indus Valley: New Perspectives. Abc Clio. California.
13. McHenry, Henry M. 2009. Human Evolution in Evolution: The First Four Billion Years, edited by M. Ruse and J. Travis. Cambridge, Massachusetts: Harvard University Press. Pp. 256-280
14. Paddayya, K. 1990. New Archaeology and Aftermath: View from Outside the Anglo-American World. Pune: Ravish Publishers
15. Paddayya, K. 2014. Multiple Approaches to the Study of India's Early Past: Essays in Theoretical Archaeology. Aryan Books International
16. Schiffer, M.B. 1995. Behavioral Archaeology: First Principles. Salt Lake City: University of Utah Press

Savitribai Phule Pune University, Pune
Proposed Syllabus in History for TYBA (Credit System)
Form the Academic Year 2021-2022
Under the Faculty of Humanities
Skill Enhancement Courses (SEC 2 D) – (2 Credits
Semester VI -SEC:14 Course Title: Numismatics

Course Objectives:

1. This paper is designed to introduce the students to the Currency system of Ancient India.
2. It aims at acquainting the students about the development in the Coinage System.

Course Outcomes:

1. Students will be able to identify and decipher the Coins.
2. They will also be able to understand the Socio-Political background that accurse through the coinage of that time; thus getting holistic picture of that economic system prevalent in Ancient India.

Course Content:

Unit-I: Introduction to Numismatics 7

a) Numismatic Studies: Terminology and Scope
b) Importance in the Reconstruction of Socio-Cultural and Economic History

Unit-II: Study of Ancient Indian Coinage: Polity-Economic Dimensions 8

a) The Mauryan Age - Karshapanas Coins
b) Coins of the Post Mauryan Age
c) Coins of the Guptas

Unit-III: Study of Medieval Coins 7

a) Coinage of the Delhi Sultanate and Mughal Period
b) Coins of Vijaynagar
c) Coins of the Marathas

Unit –IV: Study of Modern Coins 8

a) Coins of the British East India Company
b) Coins of Independent India
c) Indian Institute of Research in Numismatic Studies (IIRNS), Anjineri.

Reference Books:

1. Allan, J. 1935. Catalogue of Coins of Ancient India. London: British Museum.
2. Altekar, A.S., 1937. Catalogue of Coins of the Gupta Empire. Varanasi: Numismatic Society of India.
3. Bhandarkar, D.R., 1921. Carmichael Lectures on Ancient Indian Numismatics. Calcutta: Calcutta University.. Bharadwaj, H.C. 1979. Aspects of Ancient Indian Technology. Delhi: Motilal Banarasidas. Chattopadhyaya, Bhaskar 1967. The Age of the Kushanas – A Numismatic Study. Calcutta: Punthi Pustak.
4. Chattopadhyaya, Brajdulal 1977. Coins and C u r r e n c y S ys t e m in South India. Delhi: Munshiram Manoharlal
5. Dasgupta, K.K. 1974. A Tribal History of Ancient India – A Numismatic Approach. Calcutta: Nababharat Pablications.
6. Datta, Mala 1990. A Study of the Satavahana coinage. Delhi: Harman Publishing House. Dhavalikar, M.K. 1975. Pracheena Bharatiya Nanakshastra. Pune: Maharashtra Vidyapeeth Granthanirmiti Mahamandal.
7. Handa, Devendra 2007. Tribles Coins of Ancient India. New Delhi: Aryan Books International. Elliot, W. 1970. (Reprint) Coins of South India. Varanasi: Indological Book House. Gardener, P. 1886. The Coinage of the Greek and Scythic Kings of Bactria and India in British Museum. London: British Museum.
8. Gokhale, Shobhana 1981. New Discoveries in the Satavahana Coinage, JNSI vol. XLIII: 54-59.
9. Goyal, S.R. 1995. Dynastic Coins of Ancient India. Jodhpur: Kusumanjali Book World.
10. Gupta, P.L. 1979. (2 nd Revised Edition) Coins. New Delhi: National Book Trust.
11. Gupta, P.L. 1981. Coins: Source of Indian History. Ahmedabad: B.J. Institute of Learning and Research.
12. Gupta, P.L. and Sarojini Kulashreshtha 1993. Kushana Coins and History. New delhi: D.K. Publishers.
13. Gupta, P.L. and T.R. Hardaker 1985. Ancient Indian Silver Punch-Marked Coins ofthe Magadha – Maurya Karshapana Series. Nasik: Indian Institute of Research in Numismatic Studies.
14. Jha, A.K. 1998. Observations on the Principles of Typology: A Study of Ancient Indian Coinage, in Ex Moneta: Essays on Numismatics in Honour of Dr. David W. Macdowall (A.K. Jha and Sanjay Garg eds.) Volume I, pp. 33-42. New Delhi: Harman Publishing House.

15. Jha, Amiteshwar and Dilip Rajgor 1994. Studies in the Coinage of Western Kshatrapas. Anjaneri: Indian Institute of Research in Numismatic Studies.

16. Krishnamurti, R. 1997. Sangam Age Tamil Coins. Madras: Garnet Publishers. Lahiri, A.N. 1965. Corpus of Indo-Greek Coins. Calcutta Journal of the Numismatic Society of India, Varanasi.

17. Mangalam, S.J. 2001. Shankar Tiwari Collection of Early Coins from Narmada Valley. Bhopal: Directorate of Archaeology and Museums, Government of Madhya Pradesh.

18. Numismatic Digest A Journal Published by Indian Institute of Research in Numismatic Studies, Anjaneri (Nasik).

19. Rajgor, Dilip 2001. Punch-Marked Coins of Early Historic India. California: Reesha Books International.

20. Rapson, E.J. 1908. Catalogue of Coins of Andhra Dynasty, Western Kshatrapas etc. London: British Museum.

21. Ray, S.C. 1977. The Stratigraphic Evidence of Coins in Indian Excavations and Some Allied Issues. Varanasi: Numismatic Society of India.

22. Sahni, Birbal 1973. The Technique of Casting Coins in Ancient India. Varanasi: Bharatiya Publishing House.

23. Sarma, I.K. 1980. Coinage of the Satavahana Empire. Delhi: Agam Kala Prakashan.

24. Shastri, A.M. (Ed.) 1972. Coinage of Satavahanas and Coins from Excavations, Nagpur: Nagpur University.

25. Shastri, A.M. (Ed.) 1999. Age of the Satavahanas (two volumes): New delhi: Aryan Prakashan. Srivastava, A.K. 1969. Catalogue of Indo-Greek Coins in the State Museum, Lucknow. Lucknow: State Museum.

26. Srivastava, A.K. 1972. Catalogue of Saka-Pahlava Coins of Northern India in the State Museum, Lucknow. Lucknow: State Museum.

27. Studies in South Indian Coins: A Journal Published by South Indian Numismatic Society, Madras.

SAVITRIBAI PHULE PUNE UNIVERSITY

TYBA Psychology Syllabus

From the academic year 2021-22

Outcome Based Syllabus

	Semester-V		Semester-VI	
G-3 35223	SEC- 1C (Industrial and Organizational Psychology) (3)		SEC- 1D (Applied Psychology) (3)	
S-3 35221	DSE-1C (Psychological Testing) (Theory) (3)+ (1) Testing Project		DSE-1D Experimental Psychology (Theory) (3)+(1) Testing Project	
S-4 35222	DSE-2C (Psychological Tests) (Practical) (3)+(1) Statistics		DSE-2D (Psychological Experiments) (Practical) (3)+(1) Statistics	
35224	SEC-2C (Personality Development-1) (2) (Value/skill based course)		SEC-2D (Personality Development-2) (2) (Value/skill based course)	
	G.E. 1 (2)		G.E.2 (2)	

- One credit is equal to one clock hour
- It is expected to refer Bloom's taxonomy

SEMESTER-V

SEC 1 C (3) : INDUSTRIAL AND ORGANIZATIONAL PSYCHOLOGY

After completing the course, student should be able to:

CO1: Describe the concept of industrial and organizational psychology, selection and training, evaluation and motivation at workplace.

CO2: Explain job profile, job analysis, recruitment techniques and employee training.

CO3: Identify and classify the appraisal rating system.

CO4: Compare different theories of motivation.

CO5: Evaluate the training programme and job performance.

UNIT-1: INDUSTRIAL AND ORGANIZATIONAL (I/O) PSYCHOLOGY- NATURE AND SCOPE

1.1: I/O Psychology: Meaning, subject matter and functions of Industrial Psychology

1.2: The history of I/O Psychology

1.3: I/O Psychology in the present

1.4: Future of I/O Psychology

UNIT-2: PERSONNEL SELECTION AND TRAINING

2.1: Job Profile, job analysis and Recruitment techniques

2.2: Interviews, psychological testing and Needs assessment for training

2.3: Psychological Principles in training and training for knowledge and skill

2.4: Evaluation of Training Programme

UNIT- 3: EVALUATING JOB PERFORMANCE, JOB SATIFACTION

3.1: Uses of performance evaluation: Downsizing, promotion, seniority

3.2: Sources of evaluation: The evaluator and performance appraisal

3.3: Appraisal rating and non-rating evaluation methods

3.4: Job satisfaction: Concept and theories

UNIT-4: MOTIVATION AND LEADERSHIP AT THE WORKPLACE

4.1: Work motivation: Concept, Self-discipline – seven step process

4.2: Need and cognitive theories: McClelland, Herzberg, Goal Setting Theory, Self Efficacy Theory

4.3: Leadership- Styles, Theories

4.4: Communication: Concept, Process

READING:

Aamodt, M.G. (2007). Industrial and organizational psychology: An applied approach. US: Thomson & Wadsworth.

Berry, L.M. (1998), reprint 2010. Psychology at work: An introduction to Industrial and Organizational Psychology. N.Y.: McGraw-Hill International Editions.

French (2015). Organization Development: Behavioral Science Interventions for Organization Improvement, 6/e , Pearson, Education

Gadekar, Jamale, Rasal (2013), Audyogik va Sanghatanatmak Manasshastra

Luthans, F. (1995). Organizational behavior (7th ed). New York: McGraw- Hill, inc.

McShane, et al. (2006). 1st reprint. Organizational behavior. N.D.: Tata McGraw-Hill

Miner, J.B. (1992). Industrial-Organizational Psychology. N.Y.: McGraw-Hill

Pandit, R., Kulkarni, AV. & Gore, C. (1999). Manasashastra: Audyogik aani vyavasayik upayojan. Nagpur: Pimpalapure & Co.

Robbins, S.P. & Sanghi, S. (2007). Organizational behavior (11th Ed.). New Delhi: Pearson Education.

Robbins, S.P.; Judge, T.A; and Sanghi, A (2009). Organizational behavior. N.D.: Pearson Prentice Hall.

Schultz, D. and Schultz, S. E. (2006). Psychology and work today. 8th ed. N.D.: Pearson Edu.

Singh (2015). Organizational Behaviour : Text and Cases, 2/e - Pearson, Education

Warren (2015). Occupational Psychology: An Applied Approach, 1/e, Pearson Education

DSE 1 C (3): PSYCHOLOGICAL TESTING (THEORY) + (1) TESTING PROJECT

After completing the course, student should be able to:

CO1: Describe the concept of psychological test, reliability, validity and norms.

CO2: Classify and categorize psychological tests, reliability- validity-norms types.

CO3: Identify the reliability and validity of psychological tests,

CO4: Evaluate the types of norms.

CO5: Conduct testing project for behaviour analysis.

UNIT-1: INTRODUCTION OF PSYCHOLOGICAL TESTS

1.1: What is psychological test? History

1.2: Classification, characteristics

1.3: Steps in test construction

1.4: Ethical issues in test construction

UNIT-2: RELIABILITY OF TESTS

2.1: Reliability: Meaning, true score estimation

2.2: Types: Test-retest, Split-half, Parallel-form and Scorer reliability

2.3: Standard error of measurement

2.4: Reliability- Influencing factors and improvement techniques

UNIT-3: VALIDITY OF TESTS

3.1: Validity: Meaning,

3.2: Types: Content, criterion and construct

3.3: Convergent and discriminant validity

3.4: Validity: Statistical calculation method

UNIT-4: NORMS AND ITEM ANALYSIS

4.1: Meaning of norms, Norm-referencing and Criterion-referencing tests

4.2: Types of norms: Age, grade, percentile and standard-score norms

4.3: Item Analysis: Item difficulty and Item discrimination

4.4: Item response theory

FOR 1 CREDIT: GROUP TESTING:

1. For group testing, a small sample (n=30 at least) should be taken.
2. Any one standardized psychological test should be administered to the sample.
3. Responses should be scored as per the instructions given in the manual.
4. Report for group testing should be structured as follows:

a. Purpose of the group testing

b. Description of the test, e.g. author, psychometric properties, uses of test.

c. Tabular presentation of scores and results

d. Qualitative analysis, if applicable

e. Interpretation at group level

f. Any other relevant finding

g. Conclusion

h. References

READING

Anastasi, A. & Urbina, S. (2009). Psychological testing. N.D.: Pearson Education.

Asch, S. E. (1955). Opinions and social pressure. Scientific American, 193, 31- 35.

Desai, B. and Abhyankar, S.C. (2001). Prayogik Manasashastra ani Samshodhan Paddhati. Pune: Narendra Prakashan.

Hechter, M. and Opp, K. D. (2001). Social Norms. New York: Russell Sage Foundation.

Kaplan R.M.& Saccuzzo D.P.(2005) Psychological Testing,Principles ,Applications and Issues.Sixth Ed. Cengage Learning India, Pvt Ltd.

Sherif, M. (1936). The Psychology of Social Norms. New York: Harper and Row. Asch, S. (1952). Social Psychology. (Englewood Cliffs, NJ: Prentice Hall)

Singh, A.K. (2006). Tests, Measurements and research methods in behavioural sciences. Patna: Bharati Bhavan.

DSE 2 C (3): PSYCHOLOGICAL TESTS + (1) STATISTICS

After completing the course, student should be able to:

CO1: Describe mapping of human behaviour.

CO2: Explain general ability testing, personality, adjustment and attitude.

CO3: Identify and classify the intellectual ability and personality patterns.

CO4: Conduct testing and evaluate intellectual ability, personality traits, adjustment and attitudes of participant.

CO5: Analyze statistical methods employed in behaviour analysis.

I] GENERAL AND SPECIAL ABILITY TESTING (any two)

1. Malin's Verbal OR Performance Scale
2. Standard Progressive Matrices (SPM)
3. Binet Kamath Test
4. Test of Creativity
5. Differential Aptitude Tests (DAT)- Any two sub tests
6. Dexterity test

II] PERSONALITY (any two)

1. Eysenck Personality Questionnaire
2. NEO-FFI
3. Sentence Completion Test
4. 16 PF
5. Introversion-Extraversion Test
6. Interest inventory
7. Type A and Type B personality test.

IV] ADJUSTMENT (any one)

1. Family
2. School
3. Marriage
4. Expectations from the Life partner Scale

V] TESTING OF ATTITUDE (any one)

1. Marriage
2. Religion
3. Optimism-pessimism
4. Attitude towards the mother scale.

FOR 1 CREDIT: STATISTICS:

1. Frequency distribution, Normal Probability curve
2. Measures of central tendency: Mean, Median, Mode for grouped and ungrouped data
3. Measures of variability: Range, Standard Deviation and Quartile Deviation (Q1, Q3 and Q) for grouped data.

READINGS:

Anastasi, A. & Urbina, S. (2009). Psychological testing. N.D.: Pearson Education.

Broota, K. D. (1989, reprint 2014). Experimental design in Behavioural Research. New Age International Pvt. Ltd., New Delhi.

Chadha N.K.(2009),Applied Psychometry, Sage Publication Pvt Ltd. New Delhi.

Desai, B. and Abhyankar, S.C. (2001). Prayogik Manasashastra ani Samshodhan Paddhati. Pune: Narendra Prakashan.

Garrett, Henry E. (2006). Statistics in Psychology and Education(1st Indian reprint).Surjeet Publications, Delhi-7.

Gliner, J. A., & Morgan, G. A. (2000). Research methods in applied settings: An integrated approach to design and analysis. Mahwah, NJ: Lawrence Erlbaum.

Kaplan R. M. & Saccuzzo D.P.(2005) Psychological Testing, Principles, Applications and Issues. Sixth Ed. Cengage Learning India, Pvt Ltd.

Mangal, S. K. (2009).*Statistics in Psychology and Education* (2nd Edition- 10th printing). PHI learning Pvt. Ltd., New Delhi.

SEC 2 C (2) (VALUE/SKILL-BASED COURSE) : PERSONALITY DEVELOPMENT-1

After completion of this course, student should be able to:

CO1: Describe the concept of personality.

CO2: Identify and classify various personality traits.

CO3: Correlate real life behavioural patterns with theoretical assumptions.

CO4: Apply psychological skills in daily life situations.

UNIT-1: PERSONALITY

-Concept and Role of Personality: Definitions,

-Factors affecting personality

UNIT -2: TRAITS

-Personality Traits

- The 7 habits of highly effective people

UNIT -3: FIVE PILLARS OF PERSONALITY DEVELOPMENT

-Introspection,

-Self- Assessment,

-Self-Appraisals,

-Self-Development,

-Self-Introduction

READINGS:

Covey Stephen (2004). The 7 habits of highly effective people. Franklin Covey Co.

Hurlock Elizabeth (1988). Personality Development, McGraw Hill

Natu, S.A, (2021). Personality Development, Revised Edition, Nirali Prakashan, Pune

SEMESTER-VI

SEC 1 D (3): APPLIED PSYCHOLOGY

After completing the course, student should be able to:

CO1: Describe the concept of applied psychology, educational psychology, family structure and developmental patterns.

CO2: Know the clinical psychology related mechanisms, social issues, and criminal behavior.

CO3: Classify the intellectual ability, abnormality, criminal behavior.

CO4: Identify the problems and solutions in the field of education,

CO5: Evaluate the interpersonal relations.

CO6: Apply psychological remedies to assess abonormal behaviour, to tackle the social issues and to rectify the problematic behaviour.

UNIT-1: INTRODUCTION APPLIED PSYCHOLOGY

1.1 Definition, Nature and Scope of applied Psychology

1.2 Fields of Applied psychology

1.3 Clinical applications (classification of mental disorders DSM V , ICD 10 , therapies – CBT, Clint centered therapy, REBT)

1.4 Cognitive Neuro Science (nature and major applications – PNI, EEG, MRI, CT, PET etc)

UNIT-2: APPLICATIONS IN EDUCATION

2.1 Definition, Nature and Scope of Educational Psychology

2.2 Effective Teaching – Learning Methodologies / Pedagogies (group discussions, projects, presentations, interactive methods)

2.3 Issues of Various Categories of Challenged Students – Physically, mentally, economically challenged, Intellectual Disabilities (ID)

2.4 Problems and Solutions to Educational Problems – physical environment, Government policies, school and higher education, Ashramshalas

UNIT-3: FAMILY AND DEVELOPMENTAL APPLICATIONS

3.1 Definition, Nature and Scope of Developmental Psychology

3.2 Issues of Adolescents (stress and strain, identity crisis, adjustment to physiological and psychological changes)

3.3 Family and Marital Problems and Solutions

3.4 Love, Relationships (dating, live in) and Break Ups

UNIT-4: SOCIAL ISSUES AND NEW TRENDS IN APPLIED PSYCHOLOGY

4.1 Role of Psychologists in tackling Social Issues (interventions, research, policy level work)

4.2 Psychology of Terror, Psychology of Corruption

4.3 Definition, Nature and Fields (correctional, investigative)

4.4Criminal Psychology, Cyber Crimes, Violence (meaning and types), Investigative Procedures (role of the psychologist) Law – contribution of Psychology to law

READINGS: : -

Bayne and Horton (2003). *Applied psychology*, Sage Publications

Weiten and Lloyd (2004). Psychology applied to Modern Life and Adjustment in 21st Century, Thomas Wadsworth Publications.

Sharma, R (2009). Applied Psychology, Atlantic Publications

Bachhav, A. M. (2012). Applied Psychology, Chandralok Prakashan, Basant Vihar, Kanpur-21

David F. Marks,Michael Murray,Brian Evans, Carla willing Cailine Woodall & Catherine E Sykes, (2006). Health Psychology, Sage Publications

Richard H. Cox (2002). Sport Psychology, McGraw –Hill Higher Education

DSE 1 D (3): EXPERIMENTAL PSYCHOLOGY (THEORY) + (1) RESEARCH PROJECT

After completing the course, student should be able to:

CO1: Describe the process of experiment in psychology, concept of psychophysics.

CO2: Explain problem, hypothesis, variables, sampling in experiment.

CO3: Identify and classify the learning system, methods of psychophysics.

CO4: Compare laws of psychophysics, types of hypotheses.

CO5: Conduct research based project.

UNIT-1: INTRODUCTION AND HISTORY OF EXPERIMENTAL PSYCHOLOGY

1.1: What is experiment? Characteristics, types

1.2: Contribution of eminent psychologists in experimental psychology

1.3 Scientific method: definition, nature

1.4: Social scientific research

UNIT-2: PROBLEM AND HYPOTHESIS IN RESEARCH

2.1: What is problem? Definitions, origin, sources and selection

2.2: Statement of problem

2.3: Hypothesis: Definition, formulation, sources

2.4: Types of hypotheses

UNIT-3: VARIABLES AND SAMPLING

3.1: What is variable? Definitions, types

3.2: Controlling of variables

3.3: Sampling: Meaning and types

3.4: Sampling distribution and sampling error

UNIT-4: PSYCHOPHYSICS AND HUMAN LEARNING

4.1: What is psychophysics? Methods of psychophysics

4.2: Weber's law and Fechner's law, Signal detection theory (SDT)

4.3: Definition and nature of Human learning.

4.4: Methods of Human learning.

1. Serial Learning,2. Distributed Vs Undistributed,3. Partial Vs Whole 4 Structured

For 1 Credit: PROJECT:

1. For project, a sample of at least 30 subjects should be taken
2. Project report should be structured as follows

a. Introduction and definition of basic concepts

b. Rationale/significance of the study

c. Hypothesis / Or Exploratory Study if Qualitative

d. Sample

e. Tools for data collection

f. Statistical analysis / Qualitative Analysis

g. Results, discussion and conclusion

h. Limitations and suggestions

i. References

READING

Christensen, L. B.; Johnson, R. B.; Turner, L. A (2014). Research Methods, Design and Analysis. Pearson

D'Amato, M.R. (2009). Experimental psychology: Methodology, psychophysics and learning. N.D.: Tata McGraw-Hill.

Kerlinger, F.N. (1995). Foundations of behavioral research. New York: Rinehart Winston. Inc. Surjeet Publications.

Kothari, C.R. (reprint 2009). Research methodology: Methods and techniques. New Delhi: Wiley Eastrn Ltd.

McBurney, D.H. and White, T.L. (2007). Research methods. US: Cengage

Singh, A.K. (2006). Tests, Measurements and research methods in behavioural sciences. Patna: Bharati Bhavan.

Solso, R.L., MacLin, M.K. (2008). Experimental psychology: A case approach. N.D.: Dorling Kindersley Pvt. Ltd.

Tiwari Govind and Pal Roma (1985). Experimental Psychology: A Dynamic Approach. Vinod Pustak Mandir, Agra

Woodworth, R.S. & Schlosberg, H. (reprint 2008, 6th ed.), Experimental Psychology. ND: Oxford & IBH Publishing Co. Pvt. Ltd.

Zachmeister, J.E., Zachmeister, E.B., and Shaughnessy, J.J. (2009). Essentials of research methods in psychology. N.D.: Tata McGraw-Hill.

DSE 2 D (3): PSYCHOLOGICAL EXPERIMENTS + 1 STATISTICS

After completing the course, student should be able to:

CO1: Explain psychophysics, various cognitive processes of human being.

CO2: Classify and compare psychological experiments.

CO3: Conduct laboratory experiments.

CO4: Analyse statistical base of human behavior.

I] PSYCHOPHYSICS (any one)

1. Method of Limits- RL or DL
2. Method of Constant Stimuli- RL or DL
3. Method of Average Error: PSE and CE

II] ATTENTION (any one)

1. Divided attention
2. Span of attention
3. Stroop effect

III] PERCEPTUAL PROCESSSES (any one)

1. Illusion
2. Size constancy
3. Retinal color zones
4. Reaction time
5. Depth perception

IV] THINKING AND PROBLEM SOLVING (any one)

1. Effect of mental set on problem solving
2. Maze learning
3. Problems solving- Pyramid puzzle / Wiggly Blocks / Heart-and-Bow puzzle

V] LEARNING (any one)

1. Bilateral transfer
2. Effect of knowledge of results
3. Habit interference
4. Serial learning

VI] MEMORY (any one)

1. Recall and recognition
2. Retroactive inhibition / Proactive inhibition
3. Short Term Memory

FOR 1 CREDIT: Statistics:

1. Rank Difference Correlation and Chi-square.

2: Product moment correlation

READINGS:

D'Amato, M.R. (2009). Experimental psychology: Methodology, psychophysics and learning. N.D.: Tata McGraw-Hill.

Desai, B. and Abhyankar, S.C. (2001). Prayogik Manasashastra ani Samshodhan Paddhati. Pune: Narendra Prakashan.

Jalota, S. (1962). Experiments in psychology. Asia Publishing House.

Mohanthy. Experiments in psychology.

Mohsin, S. M. (1975). Experiments in psychology. Orient Longman.

Parameshwaran, E. G. & Rao, B. T. (1968). Manual of experimental psychology. Bombay: Lalvani Publishing House.

Postman, L. & Egan, J.P. (1949), reprint 2009. Experimental psychology: An introduction. ND: Kalyani Publication.

Ranjit Kumar (2014). Research Methodology: A step by step guide for beginners. Pearson

Rajamanickam, M. (2005). Experimental Psychology: with Advanced Experiments, Volume 1 & 2. New Delhi: Concept Publishing Company.

Tinker, M.A. & Russell, W.A. Introduction to methods in experimental psychology. Appleton – Century Crofts.

Tiwari Govind and Pal Roma (1985). Experimental Psychology: A Dynamic Approach. Vinod Pustak Mandir, Agra

Woodworth, R.S. & Schlosberg, H. (reprint 2008, 6th ed.), Experimental Psychology. ND: Oxford & IBH Publishing Co. Pvt. Ltd.

SEC 2 D (2) (VALUE/SKILL-BASED COURSE) : PERSONALITY DEVELOPMENT-2

After completion of this course, student should be able to:

CO1: Describe the concept of self-esteem and personality development.

CO2: Identify and classify behavioural assessment techniques.

CO3: Evaluate personality of individuals.

CO4: Apply psychological skills to develop owns personality.

UNIT -1: CORE ASPECT OF PERSONALITY: SELF

-Self Esteem and Personality Development: Definitions,

-Negative and Positive Self Esteem

UNIT -2: ASSESSMENT TECHNIQUES

- Personality Development and its Applications: Mind mapping, Competency mapping, 360-degree assessments

Unit -3: DEVELOPMENT PROCESS

- Development of an Ideal Personality: Communication, Decision making, Ethics, Time management

READINGS:

Hurlock Elizabeth (1988). Personality Development. McGraw Hill

Natu, S.A, (2021). Personality Development, Revised Edition, Nirali Prakashan, Pune

Sanghi Seema (2016). The Handbook of Competency Mapping (3rd Edn) . Sage

SN: Examination and evaluation pattern will be announced soon by BOS- Psychology

Examination and evaluation pattern for the subject:

DSE- 2C (Semester-V) : (Psychological Tests) (Practical)

DSE- 2D (Semester-VI) : (Psychological Experiments) (Practical)

GENERAL GUIDELINES:

1: For the above 2 subjects, practical examination will be conducted at the time of semester-end for 100 marks. There will be no internal examination.

2. For the regular practical conduction and practical examination each batch of students should consist of 08 students.

3: Workload distribution will be based on credit structure.

4: Each batch will conduct practical twice per week.

5. The concerned teacher should verify the completion of practical journal (Tests and Experiments) and issue a completion certificate signed by the head of the department.

GUIDELINES FOR ASSESSMENT (SEMESTER-END EXAMINATION)

1. One chairman will be appointed for semester end practical examination by SPPU. Two or three district coordinators will assist him. They will prepare the total examination program. They will decide the internal and examiners panel.

2: While preparing the programme for final examination, the number of students in any given batch should not exceed 8.

3. The examiners should set one question paper (6 tests/ experiments with statistical example) on the spot.

4. Before conducting the examination the external examiner should confirm that all the guidelines mentioned in the syllabus were strictly followed while teaching and conducting the practical. The examiner should also see whether the numbers of practical are conducted as per the specifications given in the syllabus.

5. While appearing for the final examination, students must produce the fair journal containing the report of the practical duly completed and signed by the concerned teacher and head of the department.

6. External Examiner should allow students to appear for final examination only on producing the Completion Certificate.

7. The structure of the question paper is as follows:

Journal (Tests or Experiments)	Statistics	Instructions	Report	Oral examination	Total
20 Marks	20 Marks	20 Marks	20 Marks	20 Marks	**100**

8: The duration for practical examination will be of three clock hours per batch.

9: Assessment of statistics and practical report should be done by the external examiner only.

10: Practical Journal, Instructions, Oral examination be assessed by the internal and external examiners. Average marks of the two examiners should be considered as final assessment.

11: The following items should be considered for billing purpose, as per the revised rates of examiners' remuneration of S P Pune University.

Sr. No.	**Particulars**
1	Paper setting (Per batch)
2	Candidate evaluation – Each examiner
3	Model answer (Per batch)
4	Scheme of marking (Per batch)
5	Translation - (Per batch)

12. Total remuneration for the examination should be equally divided between the two examiners. Admissible staff – Lab supervisor, expert assistant and Peon.

SAVITRIBAI PHULE PUNE UNIVERSITY

TYBA - SEMESTER END PRACTICAL EXAMINATION IN PSYCHOLOGY

DSE 2 C (Semester-V): (Psychological Tests) **DSE 2 D (Semester-VI): (Psychological Experiments)**

Name of the College and exam centre:

Date and Time: **Batch:**

Sr. No.	**Seat No.**	**Journal (Tests or Experiments)** 20 Marks				**Statistics** 20 Marks	**Instructions** 20 Marks				**Report** 20 Marks	**Oral examination** 20 Marks				**Total 100**
		Int.	Ext.	Total	Ave.		Int.	Ext.	Total	Ave.		Int.	Ext.	Total	Ave.	
1																
2																
3																
4																
5																
6																
7																
8																

Internal Examiner (Name and Sign) **External Examiner** (Name and Sign)

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE

(Formerly University of Pune)

M.A. Syllabus – Semester III and IV

(Credit and Semester System)

Clinical Psychology

(To be implemented from the Academic Year, 2020-2021)

MA-II Year (Semester III and IV) From 2020-21

Semester		Clinical Psychology			Industrial Psychology	
III	**Core subject**	**Counselling Process and Skills**		**Core Subject**	**Counselling Process and Skills**	
		Psychopathology-1			Personnel Psychology	
		Psycho-diagnostics			Organizational Behavior	
		Project- Clinical Base			Project – Industrial Base	
IV	**Core subject**	**Areas of Counselling**		**Core subject**	**Areas of Counselling**	
		Psychopathology-2			Human Resource Management	
		Psychotherapies			Organisational Development	
		Practicum- Clinical Base			Practicum – Industrial Base	

Semester-III: Core Paper-1: COUNSELLING PROCESS AND SKILLS

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At the conclusion of this course, students will be able to:

- understand the nature of the counselling process
- know the groundwork for understanding the use of basic and specialized counselling skills
- engage with different models of counselling skills

Course Contents:

Unit 1. Counselling: Nature and goals

1.1. Defining counselling, stages of counselling process, role of counsellors

1.2. Approaches to counselling and helping, the helping relationship, the helping process

1.3. Development of counsellor –counselee relationship, counselling goal setting process

1.4. Counselling in India

Unit 2. Basic Counselling Skills

2.1. Building relationship, core conditions, in-depth exploration

2.2. Nature and importance generic skills of Counselling, Micro and macro skills of Counselling

2.3. Inside and outside skills of counselling, Self-monitoring skills as a counsellor

2.4. An Indigenous Model of Counselling

Unit 3. Specific Counselling Skills

3.1. Paraphrasing and reflecting feelings, asking questions, self-disclosing, facilitating problem solving

3.2. Interviewing skills, listening, asking questions, monitoring

3.3. Training clients in relaxation

3.4. Improving client's self-talk and self-perceptions, terminating helping

Unit 4. Models of Counselling Skills

4.1. Nature and importance of counselling skills and working alliance

4.2. Rogers model of counselling skills, Carkhuff model of counselling skills, IPR model of counselling training

4.3. Indian models of Counselling: the role of detachment and self-surrender

4.4. Modern trends in counselling

Readings:

Berman, Pearl and Shopland Susan (2005). Interviewing and Diagnostic Exercises for Clinical and Counselling Skills Building. Lawrence Erlbaum

Chen, Mei-whei and Giblin, Nan J. (2018).Individual Counselling and Therapy: Skills and Techniques (3rd Edn).Taylor and Francis

Dryden, Windy; Feltham, Colin (2006). Brief Counselling : A Practical Integrative Approach (2nd Edn). Open University Press

Feltham, C., & Hanley, T; Winter L. A. (2017). The Sage handbook of Counselling and psychotherapy(4th Edn). Sage Publications.

Gibson, Robert L. and Mitchell, Marianne H. (2015). Introduction to Counseling and Guidance (7th Edn.). Pearson

Gladding, S. T. (2018). Counselling: A Comprehensive profession (9th Edn). Pearson

Jones, R. N. (2012). Basic Counsellings Skills: A helper's manual (3rd Ed.). Sage Publications.

Palmer Stephen and Bor Robert (2008). The Practitioner's Handbook: A Guide for Counsellors, Psychotherapists and Counselling Psychologists. Sage

Patterson, L.E. and Welfel, E. R. (2000). The Counselling Process (5th Edn). Wadsworth

Rao, S. N. (2006). Counselling and Guidance (2nd Edn). Tata McGraw Hill

Singh, K. (2007). Counselling skills for managers. New Delhi: Prentice Hall of India.

Soundararajan, Radhika (2012). Counselling: Theory, Skills and Practice. Tata Mcgraw Hill Education Private Limited.

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Semester-III: Paper-2: PSYCHOPATHOLOGY-1

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At the end of this semester, students would be able to

1: Know the etiology of mental disorder

2: Identify the classification of the symptoms of mental disorder

3: Understand the causes, criteria of abnormal behaviour

Course content:

UNIT-1: Psychopathology: An Overview

1.1. What do we mean by abnormality- Indicators

1.2. Definition of mental disorder

1.3. Historical and contemporary views

1.4. Diagnosing Psychological Disorders: DSM-5 and ICD-11

UNIT-2: Panic, Anxiety, Obsessions Disorders

2.1. Panic disorder, phobia- causes, symptoms and treatment

2.2. Anxiety disorders - causes, symptoms and treatment

2.3. Obsessive-compulsive and related disorders

2.4. DSM-5: Criteria for Panic, Anxiety, Obsessions Disorders

UNIT-3: Mood Disorders And Suicide

3.1. Mood disorders- structure and types, depression, mania- causes, treatment

3.2. Depressive Disorders- causes, symptoms and treatment

3.3. Suicide- types, causes, symptoms and treatment

3.4. DSM-5 criteria for depressive disorders

UNIT-4: Eating Disorders and Substance Related Disorders

4.1. Anorexia Nervosa, Bulimia Nervosa- causes, symptoms and treatment

4.2. Obesity- Risk and Causal factors

4.3. Alcohol related disorders, Drug abuse- Treatment

4.4. DSM-5 criteria for eating disorders and alcohol use disorders

Readings:

Barlow, David H.; Durand, Mark V.; Hofmann, Stefan G. (2018). Abnormal Psychology: An Integrative Approach (8th Edn). Cengage Learning

Butcher, James N.; Hooley, Jill M.; Mineka Susan (2020). Abnormal Psychology (17th Edn.). Pearson

Comer, Ronald J; Comer, Jonathan S. (2018). Abnormal Psychology (10th edn). Worth Publishers

Dozois, David J. A. (2019). Abnormal Psychology: P E R S P E C T I V E S (6th Edn). Pearson

DSM-5 (2013) Diagnostic and Statistical Manual of Mental Disorders (5th Edn). American Psychiatric Association

Hooley, Jill M.; Butcher, James N.; Nock, Matthew K.; Mineka Susan (2017). Abnormal Psychology (17th Edn). Pearson

ICD-11 (2018). New International Classification of Diseases (ICD-11). The World Health Organization (WHO). Geneva

Kearney, Christopher A.; Trull, Timothy J. (2018). Abnormal Psychology & Life: A Dimensional Approach (3rd Edn). Cengage Learning

Morrison, James (2014). DSM-5® Made Easy: The Clinician's Guide to Diagnosis. THE GUILFORD PRESS

Nevid, Jeffrey S.; Rathus Spence A.; Greene Beverly (2018). Abnormal Psychology: In a Changing World (10th edn). Pearson

Nolen-Hoeksema, Susan (2013). Abnormal Psychology (6th Edn). McGraw-Hill

Sadak, B. J.; Sadok V. A.; Ruiz Petro (2015). KAPLAN & SADOCK'S Synopsis Of Psychiatry: Behavioural Sciences/Clinical Psychiatry (11th Edn). Wolters Kluwer

Sue David, Sue Derald Wing, Sue Diane, Sue Stanley (2016). Understanding Abnormal Behavior (11th Edn). Wadsworth Publishing

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Semester-III: Paper-3: Psycho-diagnostics

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After completion of this course the students will be able:

1. To explain what is psychodiagnostics and its basics
2. To enable to discuss and assess the behavioural and clinical problems of the clients and making diagnosis, and estimating prognosis
3. To enable oneself in writing psychological report
4. To get acquainted with different clinical measures apart from paper pencil testing

Course content:

Unit 1: Basics of Psychodiagnostics in Psychological Setting

1.1 Basic principles of psychodiagnostics

1.2 Difference between psychometrics and psychodiagnostics and its relationship with treatment

1.3 Data gathering, clinical judgment and data synthesis

1.4 Assessment: Principles and techniques, explaining assessment results

Unit 2: Use of various tests in different setting

2.1 Contexts of different setting: General medical setting, psychiatric, educational, & legal setting

2.2 Intellectual functioning: Wechsler Adult Intelligence Scale-III, Stanford-Binet (4th ed.) Kaufman Assessment Battery for Children, Million Adolescent Personality Inventory or Personality Inventory for Children, Beck Depression Inventory, Wechsler Memory Scale-III,

2.3 Emotional functioning and level of psychopathology: General patterns and severity Symptom Checklist 90-Revised, Brief Symptom Inventory, Vineland Adaptive Behaviour Scale, AAMD Adaptive Behaviour Scale

2.4 Career Assessment Inventory, Kuder Occupational Interest Survey, Dyadic Adjustment Scale, Family Environment Scale, Taylor Johnson Temperament Analysis

Unit 3 Psychological testing in clinical and severe disorders

3.1 Mental Status Examination: Mini-Mental Status Examination (MMSE) & Cognitive Functioning & its criteria: Structured Clinical Interview for DSM 5, Diagnostic Interview Schedule, Structured Interview for DSM 5 Personality Disorders, Diagnostic Interview for Children and Adolescents

3.2 Content of thought Processes: Thematic Apperception Test & Children's Apperception, Test & Sentence completion tests

3.3 Personality & other clinical measures: MMPI- I, 2, & RF, NEO-PI-R, Million Clinical Multiaxial Inventory-III, Hamilton Rating Scale for Depression & State-Trait Anxiety Inventory, STAXI - 2

3.4 California Verbal Learning Test, Bender Visual Motor Gestalt Test, Draw a person Intellectual ability test for children

Unit 4: Clinical Report

4.1 Behavioural observation, Synthesis of information from different sources, context of clinical assessment

4.2 Clinical analysis questionnaire, IPDE

4.3 Psychological clinic, formats of report writing, Prognosis and risk

4.4 Behavioural assessment: Cognitive behavioural assessment, psychophysiological assessment (GSR, EEG, Biofeedback)

Readings:

Anastasi, A., & Urbina, S. (2005). Psychological Testing. 7th edn. Pearson Education:

Butcher, James N.; Hooley, Jill M.; Mineka Susan (2020). Abnormal Psychology (17th Edn.). Pearson

Ettinger, Alan B.; Weisbrot, Deborah M.; Gallimore, Casey E. (2019). Synopsis of Neurology, Psychiatry, and Related Systemic Disorders. Cambridge University Press

Gary Groth- Marnat (2003). Handbook of Psychological Assessment , 4th edition: John Wiley & Sons, Inc.

Irving B. Weiner & Roger L. Greene (2008). Handbook of Personality Assessment: John Wiley & Sons, Inc.,

Kaplan, H. I., Sadock, B. J., & Grebb, J. A. (1994). *Kaplan and Sadock's synopsis of psychiatry: Behavioral sciences, clinical psychiatry* (7th ed.). B. I. Waverly Pvt. Ltd.

Kapur, M. (1995). *Mental health of Indian children.* Sage.

Kellerman, H. & Burry, A.(1981). *Handbook of diagnostic testing: Personality analysis and report writing*. Grune & Stratton

Lezak, M.D. (1995). *Neuropsychological assessment*. Oxford University Press.

Rychlak, F. (1973). *Introduction to personality and psychopathology.* Houghton Miffin.

Sundberg, N.D., Winebarger, A.A.& Taplin, J.R. (2002). *Clinical psychology: Evolving theory, practice and research.*: Prentice-Hall.

Wolberg Lewis R., The technique of Psychotherapy 4th edition : International Psychotherapy Institute E-Books, www.freepsychotherapybooks.org

Wolman, B.B. (1975) . *Handbook of clinical psychology*. McGraw-Hill.

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Semester-III: Paper-4: Project

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GENERAL INSTRUCTIONS:

1. Each batch of project should consist of maximum 8 students and a separate batch will be formed if this number exceeds even by one.
2. Workload for each batch will be equivalent to 8 lecture periods.
3. Students should select a problem pertinent to their specialization area in consultation with concerned faculty.
4. Sample size should be minimum 30 in each group, e.g.: Normal and maladapted.
5. Project report should be written in APA format followed with plagiarism's guidelines provided by SPPU.
6. Eligibility for the Project Examination is subject to Certification of Project by the teacher-in-charge and HOD.

PREREQUISITES:

Before starting the actual work of the project, students should be well versed with the following concepts:-

- Research Methodology
- Ethical issues in Research
- APA Format and style of writing along with references
- Plagiarism policy of SPPU

DISSERTATION FORMAT:

- Title Page
- Abstract
- Introduction (Contains brief introduction of constructs, Rationale and Significance of study, Problem Statement, literature review, concluded with Objectives and Hypotheses-if applicable. In a qualitative study there is no hypothesis testing. It is an exploratory study)
- Method: (Participants, Tools, Design, Procedure.)
- Results
- Discussion
- References
- Appendix

DISSERTATION SUBMISSION

- The student will submit a bound hard copy of the dissertation to the Department by the end of the semester, along with a soft copy on a CD/DVD/Pen drive.
- The final dissertation will have a word limit of 5000-8000 words and will be typed in one and a half spacing on one side of the paper. The APA style shall be followed for the writing of dissertation.

The final dissertation shall be presented in accordance with the following specifications:

(a) The paper used for printing shall be of A4 size.

(b) Printing shall be in a standardized form on both sides of the paper and in1.5 line spacing.

(c) A margin of 1.5 inches shall be on the left hand side.

(d) The card for cover shall not be more than 330 GSM.

(e) The title of the thesis/dissertation name of the candidate, degree, name of the Research Supervisor, place of research and the month and year of submission shall be printed on the title page and the front cover.

(f) The hard-bound a cover of thesis/dissertation shall be of black colour. Spine of the binding [side cover] should mention 'MA thesis' on the top, name of the candidate and month and year. The specifications are shown in Appendix – 'A'.

(g) The thesis/dissertation shall include a Certificate of the Research Supervisor [Appendix 'B'] and a Declaration by the candidate [Appendix 'C'] that the work reported in the thesis/dissertation has been carried out by the candidate himself and that the material from other sources, if any, is duly acknowledged.

PROJECT ASSESSMENT– 100 MARKS

1. Project assessment will be based on presentation of the project before the internal and external examiners.
2. There will be 50 marks for continuous (internal) assessment and 50 marks for End of Semester Examination (ESE).

a) Continuous (Internal) Assessment of project-50 marks

1. **Term Paper 1**: Introduction, Definitions of main concepts, rationale, and significance of the topic of research project -15 marks
2. **Term Paper 2:** Review of literature-15 marks
3. **Presentation of project report** in the classroom -20 marks

(Expert teacher appointed by HOD will give marks to each student)

b) Semester-End Examination (SEE)-50 marks

b (1) Evaluation of Project Report-30 marks

Division of marks for project report will be as follows and will be based on relevance and appropriateness of

1. Problem selected, its rationale and significance-5
2. Review work-10
3. Method -05
4. Interpretation, discussion & implications-5
5. Overall quality of the report-5

b (2) Presentation & Viva-voce –20marks

1. Presentation -10 marks
2. Viva-voce-10 marks

Note :

1. External Examination will be conducted by two examiners, one internal and one external, appointed as per the rules of Savitribai Phule Pune University.
2. Each batch will consist of only 8 students
3. Duration of examination for each batch will be 4 hours.
4. Marks for Project Report, Presentation & Viva-voce will be given by both examiners and average marks will be considered as final marks of the candidate.
5. Remuneration for External Examination will be equally divided between the two examiners.
6. Those who are appointed as external examiners for any of our university exam will not take up other activities or programs in the same time. If they are found to be missing during this important task this matter is cognizable as an administrative offence.

Appendix 'A'

Cover page for M.A. Thesis

M.A. THESIS **WRITE HERE NAME OF THE CANDIDATE** **MONTH,** **YEAR**	"Write here title of the thesis in all upper-case (capital letters) with a 'centre' alignment. Place this title on the upper central part of the cover with sufficient margin from top and both sides. Use a font size suitable to the length of the title." **A THESIS SUBMITTED TO** **SAVITRIBAI PHULE PUNE UNIVERSITY** **FOR AWARD OF DEGREE OF** **MASTER OF ARTS (M.A.)** **IN THE FACULTY OF HUMANITIES** **SUBMITTED BY** ……. **UNDER THE GUIDANCE OF** …….. ……. **RESEARCH CENTRE** ……. …… MONTH & YEAR OF SUBMISSION

Spine ***Cover Page***

Appendix 'B'

Certificate of the Guide

Certified that the work incorporated in the dissertation/thesis _____ (Title) submitted by Mr./Ms _____ was carried out by the candidate under my supervision/ guidance. Such material has been obtained from other sources and has been duly acknowledged in the dissertation /thesis.

Date:

(Supervisor/ Research Guide)

Appendix 'C'

Declaration by the Candidate

I declare that the dissertation /thesis entitled _____submitted by me for the degree of Master of Arts is the record of work carried out by me during the period from _____ to _____ under the guidance of _____ and has not formed the basis for the award of any degree, diploma, associateship, fellowship, titles in this or any other University or other institution of Higher learning.

I further declare that the material obtained from other sources has been duly acknowledged in the dissertation.

Date :

Signature of the Candidate

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SEMESTER-IV

Semester-IV: Core Paper-1: Areas of Counselling

==========

At the conclusion of this course, students will be able to:

- know the application of counselling at educational and career setting
- understand the counselling at workplace setting
- engage with the counselling at clinical setting
- study the counselling in special situations

Course Contents:

Unit-1: Counselling in the Educational Setting and Career Counselling

1.1. School counselling: School counsellor, his role and responsibilities, system of school counselling,

1.2. Counselling for Emotionally Disturbed children, ADHD, LD

1.3. College and career counselling, Career theories

1.4. Campus recruitment and training programs

Unit-2: Counselling at Workplace Settings

2.1. Workplace counselling, nature and skills

2.2. Models of workplace counselling

2.3. Occupational stress-Theoretical models of stress

2.4. Workplace counselling in India

Unit-3: Counselling in clinical settings

3.1. What is Psychological First Aid? Its applications, PFA for Students and Teachers

3.2. PTSD, Grief Counselling

3.3. Counselling the Terminally Ill, geriatric counselling

3.4. Rehabilitation Counselling in the Hospital

Unit-4: Counselling in Special Situations

4.1. Relationship counselling, social Injustice Issue counselling

4.2. Addiction counselling, anger control

4.3. Suicide counselling, nature, definition and types, prevention

4.4. Modern Trends in counselling- Life Coaching, Mentoring, Consulting, Training

Readings:

Berman, Pearl and Shopland Susan (2005). Interviewing and Diagnostic Exercises for Clinical and Counselling Skills Building. Lawrence Erlbaum

Chen, Mei-whei and Giblin, Nan J. (2018).Individual Counselling and Therapy: Skills and Techniques (3rd Edn).Taylor and Francis

Dryden, Windy; Feltham, Colin (2006). Brief Counselling : A Practical Integrative Approach (2nd Edn). Open University Press

Feltham, C., & Hanley, T; Winter L. A. (2017). The Sage handbook of Counselling and psychotherapy(4th Edn). Sage Publications.

Gibson, Robert L. and Mitchell, Marianne H. (2015). Introduction to Counseling and Guidance (7th Edn.). Pearson

Gladding, S. T. (2018). Counselling: A Comprehensive profession (9th Edn). Pearson

Jones, R. N. (2012). Basic Counsellings Skills: A helper's manual (3rd Ed.). Sage Publications.

Palmer Stephen and Bor Robert (2008). The Practitioner's Handbook: A Guide for Counsellors, Psychotherapists and Counselling Psychologists. Sage

Patterson, L.E. and Welfel, E. R. (2000). The Counselling Process (5th Edn). Wadsworth

Rao, S. N. (2006). Counselling and Guidance (2nd Edn). Tata McGraw Hill

Singh, K. (2007). Counselling skills for managers. New Delhi: Prentice Hall of India.

Soundararajan, Radhika (2012). Counselling: Theory, Skills and Practice. Tata Mcgraw Hill Education Private Limited.

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Semester-IV: Paper-2: PSYCHOPATHOLOGY-2

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At the end of this semester, students would be able to

1: Know the personality disorders

2: Identify the classification of the symptoms of mental disorder

3: Understand the causes, criteria of abnormal behaviour

Course contents:

Unit-1: Personality Disorders

1.1. Cluster-A- Characterised by odd and eccentric behaviours

1.2. Cluster-B- Characterised by dramatic, emotional and erratic behaviors

1.3. Cluster-C- Characterised by anxious or fearful behaviours

1.4. DSM-5 Personality assessment

Unit-2: Sexual Dysfunctions, Gender Dysphoria, Paraphilic Disorders

2.1. Sexual Dysfunctions- Causes, symptoms and treatment

2.2. Gender Dysphoria - Causes, symptoms and treatment

2.3. Paraphilia- Causes, symptoms and treatment

2.4. DSM-5 criteria for different sexual dysfunctions, gender dysphoria and paraphilia

Unit-3: Schizophrenia Spectrum And Other Psychotic Disorders

3.1. Schizophrenia- Introduction and historical perspective

3.2. Positive and negative symptoms of schizophrenia

3.3. Other psychotic disorders

3.4. DSM-5 criteria for schizophrenia

Unit-4: Neurodevelopmental, Neurocognitive And Sleep-Wake Disorders

4.1. ADHD, LD, Autism

4.2. Major and mild Neurocognitive disorders – Parkinson's, Huntington's, Alzheimer's disease

4.3. Sleep-wake disorders

4.4. DSM-5 criteria for neurocognitive disorders

Readings:

Barlow, David H.; Durand, Mark V.; Hofmann, Stefan G. (2018). Abnormal Psychology: An Integrative Approach (8th Edn). Cengage Learning

Butcher, James N.; Hooley, Jill M.; Mineka Susan (2020). Abnormal Psychology (17th Edn.). Pearson

Comer, Ronald J; Comer, Jonathan S. (2018). Abnormal Psychology (10th edn). Worth Publishers

Dozois, David J. A. (2019). Abnormal Psychology: P E R S P E C T I V E S (6th Edn). Pearson

DSM-5 (2013) Diagnostic and Statistical Manual of Mental Disorders (5th Edn). American Psychiatric Association

Hooley, Jill M.; Butcher, James N.; Nock, Matthew K.; Mineka Susan (2017). Abnormal Psychology (17th Edn). Pearson

ICD-11 (2018). New International Classification of Diseases (ICD-11). The World Health Organization (WHO). Geneva

Kearney, Christopher A.; Trull, Timothy J. (2018). Abnormal Psychology & Life: A Dimensional Approach (3rd Edn). Cengage Learning

Morrison, James (2014). DSM-5® Made Easy: The Clinician's Guide to Diagnosis. THE GUILFORD PRESS

Nevid, Jeffrey S.; Rathus Spence A.; Greene Beverly (2018). Abnormal Psychology: In a Changing World (10th edn). Pearson

Nolen-Hoeksema, Susan (2013). Abnormal Psychology (6th Edn). McGraw-Hill

Sadak, B. J.; Sadok V. A.; Ruiz Petro (2015). KAPLAN & SADOCK'S Synopsis Of Psychiatry: Behavioural Sciences/Clinical Psychiatry (11th Edn). Wolters Kluwer

Sue David, Sue Derald Wing, Sue Diane, Sue Stanley (2016). Understanding Abnormal Behavior (11th Edn). Wadsworth Publishing

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Semester-IV: Paper-3: PSYCHOTHERAPIES

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After completion of this course the students will be able to:

- understand what is psychotherapy, what are its ingredients, therapist skills.
- identify compare varieties of psychotherapies and identify best kind of psychotherapy.
- practice the activities that are conducted by psychotherapist in the initiate phase such as establishing working relationship, evaluating problems, making diagnosis, and estimating prognosis.
- describe and evaluate the process and techniques of various psychotherapies.

Course contents:

Unit-1: Introduction to Psychotherapies and Psychoanalytic Approach

1.1 Nature, Definition and Objectives of Psychotherapies, Therapeutic Process

1.2 Basic Psychotherapeutic Skills, Characteristics of Good Therapist and Client

1.3 Psychoanalytic Therapies: Classical & Modern

1.4 Transactional Analysis

Unit-2: PSYCHOTHERAPIES - I

2.1 Basic assumptions and various forms of behaviour therapy

2.2 Systematic Desensitization, eye movement desensitization & Flooding, Implosive Therapy

2.3 Aversive Therapy, Biofeedback Technique, Assertiveness Training, Psychodrama

2.4 Autogenic Psychotherapy, Brief therapy, Core process psychotherapy

Unit-3: PSYCHOTHERAPIES - II

3.1 Cognitive Therapies: A) REBT, B) Mind-fullness & REBT C) Beck's Cognitive Therapy,

3.2 Roger's Client Centered Therapy

3.3 Gestalt Therapy, Empty Chair Technique

3.4 Logo Therapy & Reality Therapy

Unit-4: PSYCHOTHERAPIES – III

4.1 Lazarus Multimodal Therapy

4.2 Eastern Therapies: A) Vipassana, Zen Buddhisum, B) Islam & Sufism, C) Yoga Therapy

4.3 Family Therapy, Group therapy, Feminist Psychotherapy

4.4 Recent trend in Psychotherapies, Narrative, Play, Art, Music & Dance Therapies(Arts Based Therapies) etc.

BOOKS FOR READING:

Ajay, S.(1989). Psychotherapy: East and West. Hinsdale, Penn.: Himalayan International Inst.

Beck, A.T. (1976). Cognitive therapy and behavior disorders. Cliffs, N.J.: Prentice-Hall.

Brown, C & August-Scott, T (2007) "Narrative Therapy". Sage Publications.

Butcher J.N; Mineka Susan; and Hooley Jill M. (2014) Abnormal Psychology (15th Ed.) *Dorling Kindersley(India) Pvt.Ltd. of Pearson Education.*

Capuzzi, D., & Gross, D.R. (2008). Counseling and Psychotherapy: theories and interventions 4thEdn. Pearson Education: India.

Corey, G. (2008). Theory and practice of group counseling. Thomson Brooks/Cole: Belmont CA

Corsini, R.J. & Wedding, D. (Eds.) (1995). Current psychotherapies. Itasca, Ill.: F.E. Peacock.

Ellis, A. & Harper, A. (1975). A new guide to rational living. Englewood.

Gregory, R.J. (2005). *Psychological Testing* (4th ed.). Delhi: Pearson education Pte.Ltd.

Nelson R ., Jones (2009). Theory and Practice of Counselling and Therapy (4th Ed). Sage Publication.

Prochaska, J.O., & Norcross, J.C. (2007). Systems of psychotherapy: a transtheoretical analysis. 6th Edn. Thomson Brooks/Cole: Belmont, CA : USA.

Rama,S. Ballentine, R. &Ajaya, S.(1976). Yoga and psychotherapy. Hinsdale, PA: Himalayan International Inst.

Richard S. Sharf (2012) Theories of Psychotherapy & Counseling - Concepts and Cases, 5th Edition, BROOKS/COLE, CENGAGE Learning.

Rimm, D.C. & Masters, J.C. (1987). Behavior therapy: Techniques and empirical findings. New York: Harcourt, Brace, Jovanich.

Stewart, I. (2000). Transactional analysis counseling in action. Sage.

Veereshwar, P. (2002). Indian systems of psychotherapy. Kalpaz publications

Verma, L. (1990). The management of children with emotional and behavioral difficulties. Routledge.

Watts, A. W. (1973). Psychotherapy: East and West. Penguin books.

Woolfe, R. & Dryden, W. (Eds.) (1996). Handbook of counseling psychology. Sage.

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SEMESTER-IV: Paper-4: PRACTICUM

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GENERAL INSTRUCTIONS:

1. Each batch of practicum should consist of maximum 8 students and a separate batch will be formed if this number exceeds even by one.

2. Workload for each batch will be equivalent to 8 lecture periods.

3. Each student should study clinical cases in hospital / clinic / correctional institution / NGO set up; one teacher supervisor should accompany a group of students.

4. Eligibility for the Practicum Examination is subject to Certification of Practicum by teacher-in-charge and HOD.

PREREQUISITES & SKILLS:

Before starting to work on actual work students must be learn about-

- Case History taking and Behavioral observation
- Mental status examination and MMSE
- Clinical Interview and SCID-II
- Syntheses of information from different sources
- Ethics in Clinical assessment & research

Students should select at least 10 types of maladapted cases in consultation with the teacher, and prepare a detailed report of 5 cases and among them students should present at least three cases. The following stages should be followed (wherever applicable):

a. Taking of case history.

b. Assessment and multi-axial diagnosis.

c. Validation in consultation with teachers.

d. Prognosis.

e. News breaking.

f. Contracting of therapy sessions.

g. Writing session reports for each case.

h. Presentation of 3 cases in classroom

PRACTICUM ASSESSMENT (100MARKS)

a. Continuous (Internal) Assessment and Distribution of Marks (50 Marks).

1. Presentation of one case report and viva (latest by five weeks from the commencement of the semester)-15 marks.
2. Hypothetical case (one) analysis-10 marks.
3. Presentation of another case and viva (latest by ten weeks from the commencement of the semester)-15 marks.
4. Overall performance (e.g. regularity, sincerity, quality of work etc.) and variety of disorders.- 10 marks

b. Semester-End Examination (SEE)-50 Marks.

1. External Examination will be conducted by two examiners, one internal and one external, appointed as per the rules of Savitribai Phule Pune University.
2. Each batch will consist of only 8 students
3. Duration of examination for each batch will be 4 hours.
4. Hypothetical problems will be prepared by the External Examiner.
5. Marks for Viva and Exercise Report will be given by both examiners and average marks will be considered as final marks of the candidate.
6. There will be no presentation of cases before the external examiner.
7. Assessment of analyses of hypothetical case analyses will be done by External Examiners only.
8. Remuneration for External Examination will be equally divided between the two examiners.
9. Those who are appointed as external examiners for any of our university exam will not take up other activities or programs in the same time. If they are found to be missing during this important task this matter is cognizable as an administrative offence.

Break –up of 50 marks for external examination will be as follows:

1. Analysis of 2 hypothetical problems and its reports (20 marks, i.e.10 marks each)-1 ½ hours.
2. Viva -15 marks
3. Practicum reports-15 marks

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SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE

(Formerly University of Pune)

M.A. Syllabus – Semester III and IV

(Credit and Semester System)

Industrial and Organizational (I/O) Psychology

(To be implemented from the Academic Year, 2020-2021)

MA-II Year (Semester III and IV) From 2020-21

Semester		Clinical Psychology			Industrial Psychology	
III	**Core subject**	**Counselling Process and Skills**		**Core Subject**	**Counselling Process and Skills**	
		Psychopathology-1			Personnel Psychology	
		Psycho-diagnostics			Organizational Behavior (OB)	
		Project- Clinical Base			Project – Industrial Base	
IV	**Core subject**	**Areas of Counselling**		**Core subject**	**Areas of Counselling**	
		Psychopathology-2			Human Resource Management	
		Psychotherapies			Organizational Development (OD)	
		Practicum- Clinical Base			Practicum – Industrial Base	

Semester-III, Core Paper-1: COUNSELLING PROCESS AND SKILLS

==========

At the conclusion of this course, students will be able to:

- understand the nature of the counselling process
- know the groundwork for understanding the use of basic and specialized counselling skills
- engage with different models of counselling skills

Course Contents:

Unit 1. Counselling: Nature and goals

1.1. Defining counselling, stages of counselling process, role of counsellors

1.2. Approaches to counselling and helping, the helping relationship, the helping process

1.3. Development of counsellor –counselee relationship, counselling goal setting process

1.4. Counselling in India

Unit 2. Basic Counselling Skills

2.1. Building relationship, core conditions, in-depth exploration

2.2. Nature and importance generic skills of Counselling, Micro and macro skills of Counselling

2.3. Inside and outside skills of counselling, Self-monitoring skills as a counsellor

2.4. An Indigenous Model of Counselling

Unit 3. Specific Counselling Skills

3.1. Paraphrasing and reflecting feelings, asking questions, self-disclosing, facilitating problem solving

3.2. Interviewing skills, listening, asking questions, monitoring

3.3. Training clients in relaxation

3.4. Improving client‘s self-talk and self-perceptions, terminating helping

Unit 4. Models of Counselling Skills

4.1. Nature and importance of counselling skills and working alliance

4.2. Rogers model of counselling skills, Carkhuff model of counselling skills, IPR model of counselling training

4.3. Indian models of Counselling: the role of detachment and self-surrender

4.4. Modern trends in counselling

Readings:

Berman, Pearl and Shopland Susan (2005). Interviewing and Diagnostic Exercises for Clinical and Counselling Skills Building. Lawrence Erlbaum

Chen, Mei-whei and Giblin, Nan J. (2018).Individual Counselling and Therapy: Skills and Techniques (3rd Edn).Taylor and Francis

Dryden, Windy; Feltham, Colin (2006). Brief Counselling : A Practical Integrative Approach (2nd Edn). Open University Press

Feltham, C., & Hanley, T; Winter L. A. (2017). The Sage handbook of Counselling and psychotherapy(4th Edn). Sage Publications.

Gibson, Robert L. and Mitchell, Marianne H. (2015). Introduction to Counseling and Guidance (7th Edn.). Pearson

Gladding, S. T. (2018). Counselling: A Comprehensive profession (9th Edn). Pearson

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Palmer Stephen and Bor Robert (2008). The Practitioner's Handbook: A Guide for Counsellors, Psychotherapists and Counselling Psychologists. Sage

Patterson, L.E. and Welfel, E. R. (2000). The Counselling Process (5th Edn). Wadsworth

Rao, S. N. (2006). Counselling and Guidance (2nd Edn). Tata McGraw Hill

Singh, K. (2007). Counselling skills for managers. New Delhi: Prentice Hall of India.

Soundararajan, Radhika (2012). Counselling: Theory, Skills and Practice. Tata Mcgraw Hill Education Private Limited.

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Semester-III, Paper-2: PERSONNEL PSYCHOLOGY

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At the conclusion of this course, students will be able to:

- know an overview of the key concepts, topics and issues in personnel psychology
- understand the potential characteristics of employee
- identify the effective development and training programs
- examine the process of performance evaluation

UNIT-1: PERSONNEL PSYCHOLOGY: INTRODUCTION

1.1. Overview of personnel psychology - Cascio

1.2. Staffing: Screening and selection methods - cascio

1.3. Job analysis: meaning, purpose and methods - amodt

1.4. Job evaluation: determining internal and external pay equity, sex and race equity am

UNIT-2. COMPETENCY MAPPING

2.1. The art of finding talent, Competency mapping: Introduction, necessity - sanghi

2.2. Competency models and related issues

2.3. Competency framework formation

2.4. Writing and assessing competencies

UNIT-3. EMPLOYEE DEVELOPMENT

3.1. Employee training: Characteristics of Effective Training Practice - cascio

3.2. Designing training programs

3.3. Learning enhancement techniques

3.4. Assessment methods

UNIT-4. PERFORMANCE MANAGEMENT

4.1. Managing for maximum performance. – cascio

4.2. Methods of Performance-Appraisal

4.3. Evaluation of performance: Factors -

4.4. Proactive career management

Readings:

Aamodt, Michael G. (2016). Industrial/Organizational Psychology: An Applied Approach (8th Edn). Cengage Learning

Bisen Vikram and Priya (2010). Industrial Psychology. New Age International (P) Limited, Publishers

Cascio, Wayne F. (2010).Managing Human Resources: Productivity, Quality of Work Life, Profits (8th Edn). McGraw-Hill

Cascio, Wayne F.; Aguinis Herman (2014). Applied Psychology in Human Resource Management (7th Edn). Pearson

DeCenzo, David A.; Robbins, Stephen P.; Verhulst, Susan L.(2016). Fundamentals of Human Resource Management (12th Edn). Wiley

Sanghi Seema (2016). The handbook of competency mapping: Understanding, designing and implementing competency models in organizations (3rd Edn). Sage

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Semester-III, Paper-3: ORGANIZATIONAL BEHAVIOUR

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OBJECTIVES:

1. To acquaint the students with the nature of Organizational Behaviour (OB)
2. To understand how behaviour of an individual is shaped by various factors in Indian culture, society, and organization.
3. To equip the student with the knowledge of important OB processes such as Leadership and motivation
4. To understand the interpersonal transactions in organizational behaviour and their implications.

UNIT-1: FUNDAMENTALS OF ORGANIZATIONAL BEHAVIOUR

1.1. Nature of Organizational Behaviour; History of OB in India, The Indian mind set, Models of OB; Autocratic, Custodial, Supportive, Collegial, System

1.2. Trends & Challenges of OB: Globalization, Diversity, Ethics

1.3. Culture: Dimensions according to Hofstede, Trompenaar, Pareek (OCTAPACE).

1.4. Organization Structure and Design: Classical and Contemporary Designs (Matrix, Vertical, Horizontal, Network).

UNIT-2: MOTIVATION IN ORGANIZATION

2.1. Motivating by Meeting Needs and Managerial Applications: Maslow, Adlerfer, Herzberg, and McClelland.

2.2. Motivating by Setting Goals: Goal setting theory and setting effective performance goals.

2.3. Motivating by Being Fair: Distributive justice, Equity theory, procedural justice, interactional justice, and organizational justice.

2.4. Motivating by Altering Expectations and by Structuring Jobs: Quality of Work Life model, job enrichment and job enlargement, Hackman & Oldham's job characteristics model. Motivation and well-being, Understanding people's needs and using this data for motivating others

UNIT-3: LEADERSHIP AND EMPOWERMENT

3.1. Behavioral Approach to Leadership Style.

3.2. Contingency Approach to Leadership: Fiedler's contingency model; Hersey & Blanchard's situational leadership model; path goal model; and Vroom's decision making model.

3.3. Emerging Approaches to Leadership: Transactional leadership, transformational leadership; substitutes and enhancers for leadership; and self & super leadership.

3.4. Empowerment and Participation: Meaning, process, and programs.

UNIT-4: COMMUNICATION, CONFLICT AND STRESS

4.1. Organizational Communication: Meaning, functions, directions types (formal-informal, electronic) and techniques for improving communication skills

4.2. Conflict: Nature, Levels, Sources, Effects; Strategies for conflict resolution; Work-family conflict

4.3. Work stress: Sources, consequences, managing stress (individual and organizational approaches).

4.4. Employees Counselling.

READINGS:-

Greenberg, J. and Baron R.A. (2005) Behavior in organizations. N.D.: Pearson Edu.

Gupta, R. K. (1991). Employees and organization in Indian context: The need for moving beyond American and Japanese models. Economic and Political Weekly, 26(21), 68-76.

Hersey, P.& Blanchard ,K.H. (1982) . Management of organizational behaviour utilizing human resources (4th ed.).Prentice-Hall.

Ivancevich, J.M. Konsopaske R. & Matteson M.T. (2005) Organizational behaviour and management. New Delhi : Tata McGraw-Hill

Luthans, F. (2013) Organizational behaviour: An Evidence – based Approach (12thEd.) ND : McGraw-Hill Edu (India) Pvt. Ltd.

McShane ,S.L. and Von Glinow,M.A.(200). Organizational behavior: Emerging realities for the workplace revolution . New Dehli: Tata Mcgraw-Hill.

Muchinsky ,P.(2001).Psychology Applied to work .6th ed. New Delhi :Wadsworth

Mullins, L.J. (2007) 7th ed. Management and organizational behaviour N.D. : Pearson Edu

Newstrom, J.W.(2007) Organizational behaviour : Human behaviour at work N.D.: Tata McGraw-Hill

Pareek, U. and Rao, T.V.(2003). Designing and managing human resource system. N.D.: Oxford & IBH.

Rao , V.S.P. and Narayana ,P.S.(1995). Organizational theory and behaviour (2nd ed.) New Delhi :Konark Pub. Pvt.Ltd.

Robbinns,S. (2001). Organization behaviour. (9th ed.).New Delhi :Prentice Hall of India.

Robbins, S.P., Judge T.A., & Sanghi, A. (2009) Organizational behaviour N.D. Pearson Prentice Hall.

Sinha, J. B. P. (2014). Psycho-social analysis of Indian mind set. New Delhi: Springer. Sinha, J. B. P. (1979). The nurturant task leader: Model of effective executive. ASCI Journal of Management, 8(2), 109-19.

Sinha, J.B.P. (2008) Culture & Organization Behaviour. New Delhi: Sage Texts

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Semester-III: Paper-4: PROJECT -INDUSTRIAL / ORGANIZATIONAL PSYCHOLOGY:

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GENERAL INSTRUCTIONS:

1. Each batch of project should consist of maximum 8 students and a separate batch will be formed if this number exceeds even by one.
2. Workload for each batch will be equivalent to 8 lecture periods.
3. Students should select a problem pertinent to their specialization area in consultation with concerned faculty.
4. Sample size should be minimum 30 in each group, (e.g. Control and experimental, which will be subject to the nature of the industrial project).
5. Project report should be written in APA format followed with plagiarism's guidelines provided by SPPU.
6. Eligibility for the Project Examination is subject to Certification of Project by the teacher-in-charge and HoD.

PREREQUISITES:

Before starting to work on actual work students must be learn about-

- Ethical issues in Research
- APA Format and style of writing
- Plagiarism policy of SPPU

DISSERTATION FORMAT:

- Title Page
- Abstract
- Introduction (Contains brief introduction of constructs, Rationale and Significance of study, Problem Statement, literature review, concluded with Objectives and Hypotheses)
- Method: (Participants, Tools, Design, Procedure)
- Results
- Discussion
- References
- Appendix

DISSERTATION SUBMISSION

- The student will submit a bound hard copy of the dissertation to the Department by the end of the semester, along with a soft copy on a CD/DVD/Pen drive.
- The final dissertation will have a word limit of 5000-8000 words and will be typed in one and a half spacing on one side of the paper. The APA style shall be followed for the writing of dissertation.

The final dissertation shall be presented in accordance with the following specifications:

(a) The paper used for printing shall be of A4 size.

(b) Printing shall be in a standardized form on both sides of the paper and in1.5 line spacing.

(c) A margin of 1.5 inches shall be on the left hand side.

(d) The card for cover shall not be more than 330 GSM.

(e) The title of the thesis/dissertation name of the candidate, degree, name of the Research Supervisor, place of research and the month and year of submission shall be printed on the title page and the front cover.

(f) The hard-bound a cover of thesis/dissertation shall be of black colour. Spine of the binding [side cover] should mention 'MA thesis' on the top, name of the candidate and month and year. The specifications are shown in Appendix – 'A'.

(g) The thesis/dissertation shall include a Certificate of the Research Supervisor [Appendix 'B'] and a Declaration by the candidate [Appendix 'C'] that the work reported in the thesis/dissertation has been carried out by the candidate himself and that the material from other sources, if any, is duly acknowledged.

PROJECT ASSESSMENT– 100 MARKS

1. Project assessment will be based on presentation of project before the internal and external examiners.
2. There will be 50 marks for continuous (internal) assessment and 50 marks for End of Semester Examination (ESE).

a) Continuous (Internal) Assessment of project-50 marks

1. **Term Paper 1**: Introduction, Definitions of main concepts, rationale, and significance of the topic of research project -15 marks
2. **Term Paper 2:** Review of literature-15 marks
3. **Presentation of project report** in the classroom -20 marks

(Expert teacher appointed by HOD will give marks to each student)

b) Semester-End Examination (SEE) -50 marks

b (1) Evaluation of Project Report-30 marks

Division of marks for project report will be as follows and will be based on relevance and appropriateness of

1. Problem selected, its rationale and significance-5
2. Review work-10
3. Method -05
4. Interpretation, discussion & implications-5
5. Overall quality of the report-5

b (2) Presentation & Viva-voce –20marks

1. Presentation -10 marks
2. Viva-voce-10 marks

Note :

1. External Examination will be conducted by two examiners, one internal and one external, appointed by as per the rules of Savitribai Phule Pune University.
2. Each batch will consist of only 8 students
3. Duration of examination for each batch will be 4 hours.
4. Marks for Project Report, Presentation & Viva-voce will be given by both examiners and average marks will be considered as final marks of the candidate.
5. Remuneration for External Examination will be equally divided between the two examiners.
6. Those who are appointed as external examiners for any of our university exam will not take up other activities or programs in the same time. If they are found to be missing during this important task this matter is cognizable as an administrative offence.

Appendix 'A'

Cover page for M.A. Thesis

M.A.
THESIS

WRITE HERE NAME OF THE CANDIDATE

MONTH,
YEAR

Spine

"Write here title of the thesis in all upper-case (capital letters) with a 'centre' alignment. Place this title on the upper central part of the cover with sufficient margin from top and both sides. Use font size suitable to length of the title."

A THESIS SUBMITTED TO

SAVITRIBAI PHULE PUNE UNIVERSITY

FOR AWARD OF DEGREE OF

MASTER OF ARTS (M.A.)

IN THE FACULTY OF HUMANITIES

SUBMITTED BY

…….

UNDER THE GUIDANCE OF

……..

…….

RESEARCH CENTRE

…….

……

MONTH & YEAR OF SUBMISSION

Cover Page

Appendix 'B'

Certificate of the Guide

Certified that the work incorporated in the dissertation/thesis _____ (Title) submitted by Mr./Ms _____ was carried out by the candidate under my supervision/ guidance. Such material has been obtained from other sources has been duly acknowledged in the dissertation /thesis.

Date:

(Supervisor/ Research Guide)

Appendix 'C'

Declaration by the Candidate

I declare that the dissertation /thesis entitled

_____submitted by me for the degree of Master of Arts is the record of work carried out by me during the period from _____ to _____ under the guidance of _____ and has not formed the basis for the award of any degree, diploma, associateeship, fellowship, titles in this or any other University or other institution of Higher learning.

I further declare that the material obtained from other sources has been duly acknowledged in the dissertation.

Date :

Signature of the Candidate

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SEMESTER- IV

Semester-IV: Core Paper-1: Areas of Counselling

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At the conclusion of this course, students will be able to:

- know the application of counselling at educational and career setting
- understand the counselling at workplace setting
- engage with the counselling at clinical setting
- study the counselling in special situations

Course Contents:

Unit-1: Counselling in the Educational Setting and Career Counselling

1.1. School counselling: School counsellor, his role and responsibilities, system of school counselling,

1.2. Counselling for Emotionally Disturbed children, ADHD, LD

1.3. College and career counselling, Career theories

1.4. Campus recruitment and training programs

Unit-2: Counselling at Workplace Settings

2.1. Workplace counselling, nature and skills

2.2. Models of workplace counselling

2.3. Occupational stress-Theoretical models of stress

2.4. Workplace counselling in India

Unit-3: Counselling in clinical settings

3.1. What is Psychological First Aid? Its applications, PFA for Students and Teachers

3.2. PTSD, Grief Counselling

3.3. Counselling the Terminally Ill, geriatric counselling

3.4. Rehabilitation Counselling in the Hospital

Unit-4: Counselling in Special Situations

4.1. Relationship counselling, social Injustice Issue counselling

4.2. Addiction counselling, anger control

4.3. Suicide counselling, nature, definition and types, prevention

4.4. Modern Trends in counselling- Life Coaching, Mentoring, Consulting, Training

Readings:

Berman, Pearl and Shopland Susan (2005). Interviewing and Diagnostic Exercises for Clinical and Counselling Skills Building. Lawrence Erlbaum

Chen, Mei-whei and Giblin, Nan J. (2018).Individual Counselling and Therapy: Skills and Techniques (3rd Edn).Taylor and Francis

Dryden, Windy; Feltham, Colin (2006). Brief Counselling : A Practical Integrative Approach (2nd Edn). Open University Press

Feltham, C., & Hanley, T; Winter L. A. (2017). The Sage handbook of Counselling and psychotherapy(4th Edn). Sage Publications.

Gibson, Robert L. and Mitchell, Marianne H. (2015). Introduction to Counseling and Guidance (7th Edn.). Pearson

Gladding, S. T. (2018). Counselling: A Comprehensive profession (9th Edn). Pearson

Jones, R. N. (2012). Basic Counsellings Skills: A helper's manual (3rd Ed.). Sage Publications.

Palmer Stephen and Bor Robert (2008). The Practitioner's Handbook: A Guide for Counsellors, Psychotherapists and Counselling Psychologists. Sage

Patterson, L.E. and Welfel, E. R. (2000). The Counselling Process (5th Edn). Wadsworth

Rao, S. N. (2006). Counselling and Guidance (2nd Edn). Tata McGraw Hill

Singh, K. (2007). Counselling skills for managers. New Delhi: Prentice Hall of India.

Soundararajan, Radhika (2012). Counselling: Theory, Skills and Practice. Tata Mcgraw Hill Education Private Limited.

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Semester-IV: Paper-2: HUMAN RESOURCE MANAGEMENT

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OBJECTIVES:

To acquaint the students with:

1. Nature and Scope of HRM,
2. Significance and methods of training and development,
3. Industrial relations and strategic HR

UNIT-1: INTRODUCTION TO HUMAN RESOURCE MANAGEMENT

1.1. Nature, Scope and Context of HRM
1.2. HR Challenges in Global and Indian Scenario
1.3. HR for Corporate Excellence
1.4. Contemporary Issues in HR, International HR ,e-HR

UNIT-2: DEVELOPMENT OF HUMAN RESOURCE

2.1. Training :Assessing training needs, development and evaluation of training programmes
2.2. Training Methods: Classroom instructions, On-the-job training, apprenticeship, business games and in-basket training
2.3. Career development and planning, succession planning.
2.4. Buying , borrowing and building talent

UNIT-3: IMPLEMENTING HR

3.1. Impact of Attitudes: OCB job satisfaction ,Employee Engagement, job involvement,
3.2. Ethical Issues in HRM
3.3. Knowledge Management and HR : Meaning and need, knowledge management process , Knowledge management deficits ,
3.4. Human Resource Information System (HRIS): Uses, major function, steps in implementing HRIS, evaluation of HRIS.

UNIT-4: INDUSTRIAL RELATIONS AND STRATEGIC HR

4.1. Industrial Relation : Labour relation, trade unions, resolving disputes
4.2. Collective Bargaining
4.3. HR Audit : Concept and Methodology of HR Audit
4.4. Strategic HR and HR Score card

Readings:

Beardwell Julie and Thompson Amanda (2017). Human Resource Management: A Contemporary Approach (8th Edn). Pearson (ecopy)

Cascio, W.F. (2006). Managing human resources: Productivity, quality of work life, profits. Tata Mc-Graw-Hill

Decenzo, D.A. and Robbins, S.P. (1988). Personnel / human resource management. (3rd ed.). Prentice Hall

Dessler, G. (2008). Human resource management, 10th ed. Dorling Kindersley India Pvt. Ltd.

French, W.L.; Bell, C.H.; & Zawacki, R.A. (2006). Organization development and transformation: Managing effective change. Tata Mc-Graw Hill.

Ivancevich, J.M.; Konopaske, R. & Matteson, M.T. (2005). Organizational behaviour and management. Tata McGraw Hill.

K. Ashwathapa (2008). Human Resource Management. 5th edition. Tata McGraw-Hill

Noe, R.A.; Hollenbeck, J. R.; Gerhart, B. & Wright, P.M. (2006). Human Resource Management. N.D.: Tata McGraw Hill

Pareek U. and Rao T.V. (2003). Designing and Managing Human Resource System. Oxford and IBH

Pattanayak B. (2005) Human Resource Management. 3rd Edn. Prentice Hall

Rao T.V. (1999). HR Audit: Evaluating the human resource functions for business improvement. N.D. : Response Books [A Division of SAGE Pub.]

Robbins, S.P.; Judge, T.A.; & Sanghi, A. (2009). Organizational behaviour. N.D.: Pearson Prentice Hall.

Schultz, D. and Schultz, S. E. (2006). Psychology and work today. 8th ed.N.D.: Pearson Edu.

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Semester-IV: Paper-3: ORGANIZATIONAL DEVELOPMENT

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OBJECTIVES: To acquaint the students with:

1. Organizational change and its impact on individual employees,
2. Knowledge of various OD interventions.
3. Importance of various OD interventions.
4. Emerging/Future trends in OD

UNIT-1: FOUNDATIONS OF ORGANIZATIONAL DEVELOPMENT

1.1. Meaning and Nature of OD, Values, assumption and beliefs in OD, Systems theory of OD.

1.2. Approaches to OD: Laboratory training stem, survey research & feedback stem; action research stem; Socio- technical and socio-clinical stem

1.3. Organizational Change: Meaning, forces for change, Resistance to change, overcoming resistance to change, Change Management.

1.4. Theories for Planned Change

- 1.4.1. Lewin`s three- step model.
- 1.4.2. Kotter`s eight- step plan.
- 1.4.3. Burke-litwin Model.
- 1.4.4. Porras & Robertson.

UNIT-2: PROCESS OF OD INTERVENTION

2.1. OD Diagnosis: Diagnosis of the system and process. Six-Box model.

2.2. Programme management component: phases, a model for change management, Parallel learning structures.

2.3. OD Interventions: Nature, guidelines, classifications.

2.4. OD Interventions for Indian organization.

UNIT-3: TYPES OF OD INTERVENTIONS I

3.1. Team Intervention : characteristics of effective team, formal team building meeting , formal group diagnostic meeting , process consultation method, Gestalt approach

3.2. Techniques and Exercises used in Team Building , Role-focused OD intervention

3.3. Third-Party Peace-making Intervention, Walton's approach, principled negotiations, two person conflict management organizational mirroring & partnering.

3.4. Structural Interventions: self-managed teams MBO, Quality Circles, total quality management, re-engineering.

UNIT-4: TYPES OF OD INTERVENTIONS II

4.1. Comprehensive OD Interventions I: search conference, future search conference, confrontation meeting, strategic management activities.

4.2. Comprehensive OD Intervention II: real time strategic change, stream analysis survey feedback method, appreciative inquiry.

4.3. Grid Organizational Development, Schein`s cultural analysis.

4.4. Emerging trends in OD in 2020 and beyond/ Future trends in OD: New Behaviour. Technologies-Managing change in Digitalization, Use of Mobiles, Breakthrough of AI.

Readings:

Cascio, W.F. (2006). Managing human resources: Productivity, quality of work life, profits 7 th ed. N.D.: Tata McGraw-Hill

Dessler, G. (2008). Human resource management, 10th ed. Dorling Kindersley India Pvt. Ltd.

French, W.L. & Bell, C.H. (1999). 6th ed. Organizational development: Behavioral science interventions for organization improvement. Prentice-Hall.

French, W.L.; Bell, C.H.; & Zawacki, R.A. (2006) Organizational development and transformation: Managing effective Change. Tata McGraw Hill

Greenberge, J. & Baron, R.A. (2005). Behaviour in organizations (8th ed). Pearson Education.

Ivancevich, J.M.; Konopaske, R. & Matteson, M.T. (2005). Organizational behaviour and management. Delhi: Tata Mc-Graw Hill.

McGill, M. E. (1997). Organizational development for operating managers. (AMA-OH) A division of American Management Assn.

McShane, S.L. & Von Glinow, M.A.(2000). Organizational Behaviour: Emerging realities for the workplace revolution. Tata McGrawHill.

Pareek, U. and Rao, T.V. (2003). Designing and managing human resource systems. Oxford & IBH.

Ramanarayan, S.; Rao T.V. & Singh K. (eds) (1988) Organizational development: interventions and Strategies (2007 reprint):Response Book (a division of Sage Publication)

Robbins, S.P.; Judge, T.A.; & Sanghi, A. (2009). Organizational behaviour. N.D.: Pearson Prentice Hall .

Schultz, D. and Schultz, S. E. (2006). Psychology and work today. 8th ed. N.D.: Pearson Edu.

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Semester-IV: Paper-4: PRACTICUM

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Guidelines:

Students should select at least 7 types of exercises, e.g. Job analysis, performance appraisal, competency mapping, group testing, test validation, construction of psychometric test, interview of entrepreneurs, personality profile, case study, study of organizational structure, etc., in consultation with the teacher, and prepare detailed report of the cases. Students should present two cases/exercises as part of continuous assessment. Reports of exercises should be neatly typed in the standard format and a bound copy should be submitted. The report on topic like job analysis, performance appraisal, group testing, etc. should be prepared on the basis of following points:

1. Nature of organization
2. Information about the selected department.
3. Sample description (minimum size 10)
4. Job description
5. Nature of exercise
6. Tools used (if any)
7. Data collection & analysis
8. Interpretation & discussion
9. Recommendation (if applicable)
10. Limitations
11. References

General Instructions:

1. Each batch of practicum should consist of maximum 8 students.
2. A separate batch will be formed if this number exceeds even by one.
3. Workload for each batch will be equivalent to 8 lecture periods.
4. Each student should conduct exercises in various organizations / institutes; one teacher supervisor should accompany a group of students.
5. Eligibility for the Practicum Examination is subject to Certification of Practicum by the teacher-in-charge and HoD.

PRACTICUM ASSESSMENT (100 MARKS)

Continuous (Internal) Assessment and Distribution of Marks (50 Marks)

1. Presentation of one exercise and viva (latest by five weeks from the commencement of the semester)-15 marks.
2. Hypothetical case (one) analysis-10 marks.
3. Presentation of another exercise and viva (latest by ten weeks from the commencement of the semester)-15 marks.
4. Overall performance (e.g. regularity, sincerity, quality of work etc.) and variety of exercises-10 marks

Semester End Examination (SEE)-50 marks.

1. External Examination will be conducted by two examiners, one internal and one external, appointed by 48 (3) (a) Committee of S.P. Pune University.
2. Each batch will consist of only 8 students
3. Duration of examination for each batch will be 4 hours.
4. Hypothetical problems will be prepared by External Examiner.
5. Marks for Viva and Exercise Report will be given by both examiners and average marks will be considered as final marks of the candidate.
6. There will be no presentation of cases before the external examiner.
7. Assessment of analyses of hypothetical case analyses will be done by External Examiner only.
8. Remuneration for External Examination will be equally divided between the two examiners
9. Those who are appointed as external examiners for any of our university exam will not take up other activities or programs in the same time. If they are found to be missing during this important task this matter is cognizable as an administrative offence.

Division of 50 marks for external examination (SEE) will be as follows:

1. Analysis of 2 hypothetical problems (20 marks, i.e.10 marks each)-1 ½ hours.
2. Viva -15 marks
3. Exercise reports-15 marks.

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Savitribai Phule Pune University

(Formerly University of Pune)

Three Year B.A. and B.Sc. Degree Program in Geography (Faculty of Science & Technology)

T.Y.B.A. (Geography)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2021-2022

T.Y.B.A. (Geography) Choice Based Credit System Syllabus

To be implemented from Academic Year 2021-2022

Course Structure

F. Y. B. A. GEOGRAPHY

Sr. No.	Semester	Course No	Name of the Course	Category
1	Semester I	Gg.110 (A)	Physical Geography	CC – 1 A
2	Semester II	Gg.110 (B)	Human Geography	CC – 1 B

S. Y. B. A. GEOGRAPHY

Paper Code	Semester	Paper	Subject
Gg: 210(A)	III	G2 CC1C	Environmental Geography I OR Economic Geography -I
Gg: 220(A)	III	S1 DSE 1 A	Geography of Maharashtra - I OR Population Geography – I
Gg: 201(A)	III	S2 DSE 2 A	Practical Geography – I (Scale and Map Projections)
(Value/skill based course)	III	SEC 2 A	Applied Course of Disaster Management
Gg: 210(B)	IV	G2 CC1D	Environmental Geography- II OR Economic Geography -II
Gg: 220(B) DSE 1 B	IV	S1 DSE 1 B	Geography of Maharashtra – II OR Population Geography – II
Gg: 201(B) DSE 2 B	IV	DSE 2 B	Practical Geography – II (Cartographic Techniques, Surveying and Excursion / Village / Project Report)
(Value/skill based course)	IV	SEC 2 B	Applied Course of Travel and Tourism Geography

T.Y.B.A. Geography

Paper Code	Semester	Paper	Subject
Gg: 310(A)	V	CC1E	Geography of Disaster Management-I OR Geography of Tourism- I
Gg: 320(A)	V	DSE 1 C	Geography of India –I OR Geography of Rural Development -I
Gg: 301(A)	V	DSE 2 C	Practical Geography – I (Techniques of Spatial Analysis)
(Value/skill based ourse)		SEC 2C	Research Methodology – I
Gg: 310(B)	VI	CC1F	Geography of Disaster Management-II OR Geography of Tourism -II
Gg: 320(B)	VI	DSE 1D	Geography of India -II OR Geography of Rural Development -II
Gg: 301(B)	VI	DSE 2D	Practical Geography – II (Techniques of Spatial Analysis, Surveying and Excursion / Village / Project Report
(Value/skill based course)		SEC 2 D	Research Methodology – II

Equivalence of Previous syllabus along with new syllabus:

Pager	Old Course	New Course
G3	Gg-310 Regional Geography of India OR Gg-310 Human Geography	Geography of Disaster Management-I OR Geography of Tourism- I
G3		Geography of Disaster Management-II OR Geography of Tourism- II
S3	Gg-320 Agricultural Geography OR Gg-320 Population and Settlement Geography	Geography of India –I OR Geography of Rural Development -I
S3		Geography of India –II OR Geography of Rural development -II
S4	Gg-301 Techniques of Spatial Analysis	Practical Geography – I (Techniques of Spatial Analysis)
S4		Practical Geography – II (Techniques of Spatial Analysis, Surveying and Excursion / Village / Project Report

Semester V

Geography of Disaster Management-I CC1E(No. of Credits: 03)

Objectives:

1) To introduce students the concept of disaster & its relation with Geography.
2) To acquaint the students with the utility & application of hazards in different areas & its management.
3) To make the students aware of the need of protection & disaster management.

Sr. No.	Topic	Learning Points	No. of Lectures
1	Concepts in disaster management.	a) Concept of management b) Aims and objectives c) Pre-disaster management and Post – disaster management	12
2	Introduction to hazards, disasters	a) Meaning and definition of Disasters b) Geographical conditions and disasters c) Classification of Disasters	12
3	Disaster management and measures	a) Structure of disaster management - Preparedness, Response, Recovery, Mitigation, Rehabilitation b) Standard operating procedure of management on government level c) Role of media	12
4	Climatic disasters and their management	a) Hail Storm & Cloud Burst a) Cyclones and Storms b) Droughts and Floods	12

- Alexander, D. (1993): Natural Disasters. UCL Press Ltd., London
- Bloom, A.L., 1998. Geomorphology. A Systematic Analysis of Late Cenozoic Landforms. Pearson Education (Singapore) Pte. Ltd.
- Chandna, R. C., 2000. A Geography of Population, Concepts, Determinants and Patterns, Kalyani Publishers, New Delhi.
- Copola P Damon, 2007, Introduction to International Disaster Management
- Cuny, F. 1983, Development and Disaster, Oxford University Press.
- Govt. of India, 2005, Disaster Management Act Government of India, New Delhi.
- Hamblin, W.K., 1989. The Earth's Dynamic Systems, Macmillan Publishing Company, New York.
- Huggett, D.A., 2004. Fundamentals of Biogeography, Routledge.
- Kale, V.S. and Gupta, A., 2001. Introduction to Geomorphology, Orient Longman, Calcutta.
- Knox, P. and Agnew J., 1998. The Geography of the World Economy, Arnold, London.
- Lutgens, F.K. and Tarbuck, E.J., 2007. The Atmosphere. Prentice Hall, Englewood Cliffs, New Jersey, USA.
- Ross, D. A., 1988. Introduction to Oceanography. Prentice Hall, New Jersey.

- Saptarshi P. G., More J. C., Ugale V. R. and Arjun Musmade (2009), "Geography and Natural Hazard" Diamond, Pune.
- Savindra Singh, (2000): Environmental Geography. PrayagPustakBhavan, Allahabad
- Singh, S., 1998. Geomorphology, PrayagPustakBhavan, Allahabad.
- Strahler, A.A. and Strahler, A. N., 2002. Physical Geography: Science and Systems of the Human Environment, John Wiley and Sons, INC.
- Musmade Arjun. H., More J. C., 2014, Geography of Disaster Management, Diamond, Pune.
- A.H.Choudhar ,P.N.Salve, S.M.Kadam.R.H.Choudhar,V.C.Ithape (2010), "Contemporary Issues and Geography",Atharva ,Pune.

Semester V
Geography of Tourism- I CC1E(**No. of Credits: 03**)

Objectives:

1) To understand the history of Tourism
2) To introduce the students to the basic concepts in Tourism Geography.
3) To understand the types of Tourism
4) To gain knowledge different aspects of Tourism Geography.

Sr. No.	Topic	Sub Topic & Learning Point	No. of Lectures
1	Introduction	a) Definition and Nature i. Definition of Tourists and Tourism ii. Nature of Tourism iii. Importance of Tourism b) Scope and Extent i. Tourism and Travel as basic needs of mankind. ii. Tourism and Development. iii. Tourism as product c) Role of Geography in Tourism	12
2	Determinants of Tourism Development	a) Physical i. Relief ii. Climate iii. Forest b) Socio-Cultural i. Religious ii. Historical iii. Sports c) Political --i) Policies ii) Safety of Tourists iii) Accessibility	12
3	Concept and Classification of Tourism	a) Classification of tourism based on i. Nationality ii. Travel Time iii. Purpose b) Concept of Tourism - I i. Agro-Tourism ii. Eco- Tourism iii. Wildlife Tourism c) Concept of Tourism - II i. Health/medical Tourism ii Sports Tourism	12
4	Basic Infrastructure in Tourism	a) Mode of Transportation i) Road ii) Railiii) Water iv)Air b) Communication i. Role of Guide in tourism development ii. Internet/Telephone/Mobile/TV iii. Electronic and Printing Media c) Travel and Tourism Agencies	12

Reference Books

1. Geography of Tourism: Robinson H. (1996)
2. Tourism Development, Principles and Practices: Bhatia A.K., Sterling Publisher Ltd., New Delhi
3. Geography of Tourism and Recreation: S. N. Singh (1985)
4. Tourism Today: A Geographical Analysis: Douglas Pearce (1987)
5. Tourism: Economic Physical and Social Impact: Mathiseson A. and Wall C, Logman, U.K.
6. India: A Tourist Paradise: Manoj Das.
7. Tourism Today: An Indian Perspectives: Maneet Kumar
8. Geography of Travel and Tourism: Hudman L.E.
9. Successful Tourism Management: Seth P.N. (1985) Sterling Publisher Ltd., New Delhi.
10. Tourism Analysis: Smith S.L.J.
11. Tourism in India: Gupta V.K.
12. Dynamics of Tourism: Kaul R. N., Sterline Publisher Ltd.
13. Geography of Tourism: S.B. Shinde, Phadke Prakashan, Kolhapur 2

Semester V

Geography of India -I DSE 1 C(No. of Credits: 03)

Objective:

1. To acquaint the students with geography of our Nation.
2. To make the student aware of the magnitude of problems and Prospects at National level.
3. To help the students to understand the inter relationship between the subject and the society.
4. To help the students to understand the recent trends in regional studied

Sr. No	Unit	Subunit	No. of Lectures
1	Introduction	a) Location and Extent b) Historical Background c) International boundaries of India and related issues d) States and Union territories	12
2	Physiography	a) The Northern Mountains b) The North Indian Plains c) The Peninsular Plateau d) The Costal lowlands and Islands	12
3	Drainage	a) Himalayan Rivers: The Indus , The Ganga, The Brahmaputra b) East Flowing Rivers- Mahanadi, Godavari, Krishna,Kaveri c) Major West Flowing Rivers- Narmada, Tapi, Mahi d) Minor West Flowing Rivers originating in Western Ghat	12
4	Climate Soils and Natural Vegetation	a) Various Seasons and Weather Associated with them b) Types of Soils and its Distribution c) Soil Degradation and Conservation d) Types of Natural Vegetation and its Distribution	12

Reference Books

1. Aher A.B , Chaodhari A. P & Chaodhari Archna. Regional Geography of India Prashant Publication Jalgaon 2015
2. Deshpande C.D: India-A Regional Interpretation Northern Book Centre, New Delhi.1992.
3. Farmer, B.H.: An Introduction to South Asia. Methuen, London, 1983.
4. Govt. of India: India - Reference Annual, 2001 Pub. Div, New Delhi, 2001.
5. Govt. of India: National Atlas of India, NATMO Publication, Calcutta..
6. Govt. of India: The Gazetteer of India. Vol I & III Publication Division, New Delhi, 1965.
7. Learmonth, A.T.A. et.al(ed.) : Man and Land of South Asia Concept, New Delhi.
8. Mitra, A.: Levels of Regional Development India Census of India, Vol I, Part I-A (i) and (ii) New Delhi, 1967.
9. Routray, J.K.: Geography of Regional Disparity Asian Institute of Technology, Bangkok, 1993.
10. Shafi, M: Geography of South Asia, McMillan & Co., Calcutta, 2000.

11. Singh, R.L.(ed.): India: A Regional Geography. National Geogphical Society. India, Varanasi, 1971.
12. Spate, O.H.K. and Learmonth, A.T.A.; India and Pakistan - Land, People and Economy Methuen & Co., London, 1967.
13. P. G. Saptarshi, J. C. More, V. R. Ugale & A. H. Musmade :A Geographical Region of India : Diamond Publication (2009) (Marathi)
14. Patil S. G., Suryawanshi R. S., Pacharne S., Choudhar A. H. : Economic Geography, Atharav Prakashan, Pune. (2014) (Marathi).
15.Musmade Arjun. H., More J. C., 2015, Geography of India , Diamond, Pune.

Semester V

Geography of Rural Development -I DSE 1 C(No. of Credits: 03)

Objectives:

1. To understand the concept, nature and scope of rural development in India.
2. To overview various approaches to rural development.
3. To discuss some important issues related to rural development.
4. To study various schemes and policies for rural health in India.

Sr. No.	Topic	Sub Topic	Learning Points	No. of Lectures
1	Introduction	Nature and Scope	a) Concept of Rural Development b) Definition and meaning of rural development c) Causes of Rural Backwardness d) Nature and Scope of Rural Development in India	12
2	Approaches to Rural Development in India	Approach	a) Gandhian Approach b) Decentralized Planning Approach c) Sectoral Approach d) Participatory Approach	12
3	Issues of Rural Development	Issues	a) Lack of safe drinking water b) Rural Sanitation Problems and Programs c) Green revolution and its benefits to Urban and Rural Sectors d) Urban-Rural Divide	12
4	Rural Health	Health Care and Services	a) Health Care Services in Rural Areas b) Maternal and Child Health c) National Health Policy of India d) National Rural Health Mission	12

Reference Books

1. Vasant Desai: Rural Development in India, Himalaya Publishing House, Mumbai, 2012.
2. Singh, R.B. (1985): *Geography of Rural Development*. New Delhi, India: Inter India.
3. Mukherjee, Neela. (1993). *Participatory Rural Appraisal: Methodology and Application.* Delhi, India: Concept Publs. Co.
4. Rural Development Satya Sundaram , Himalaya publication House Mumbai
5. Indian economy R. D. Sudharam Chand and co. Ramnagar New Delhi.
6. Commercial Geography Dr. B.S.Nagi. KedarnathRamnath publications Meerut,
7. Human Resource Development T.Y. Rao SAGE Publication New Delhi.
8. Katar Singh -Rural Development –Principles, Policies and Management.
9. Agricultural Geography (second edition) Jasbir singh and S.S. Dhillon Tata mc crow publication

10. Intermation Technology and Globalization S.K. Bansal APII Publishing Corp. Ansari Rd. Dayraganj Delhi.
11. Economic Geography. Sadha –Khan 8. Ruural Energy criai S. Giriappa Himalaya Publishing House Mumbai
12. Anand, Subhash. (2013). *Dynamics of Rural Development*. Delhi, India: Research India Press.
13. Mukundan,N.-Rural Development and Poverty eradication in India.
14. Krishnamurthy, J. (2000). *Rural Development - Problems and Prospects.* Jaipur, India: Rawat Publs.
15. Ramachandran, H., and Guimaraes, J.P.C. (1991). *Integrated Rural Development in Asia–Leaning fromRecent Experience.* New Delhi, India: Concept Publishing.
16. Palione, M. (1984). *Rural Geography*. London, UK: Harper and Row.
17. Dutt and Sundaram- Indian Economy, S.Chand Publications, New Delhi, 2013-07-02.
18. Mishra,S.K. and PuriV.K. - Economics of Development and Planning, Himalaya Publishing House, Mumbai, 2012.
19. K Vijayakumar Empowerment of weaker section future planning and strategies for Rural Development in India.
20. Shankar Chatterjee- Implementation of Rural Development.
21. Gilg A. W., 1985: An Introduction to Rural Geography, Edwin Arnold, London.
22. Misra R. P. and Sundaram, K. V. (eds.), 1979: Rural Area Development: Perspectives

Semester V
Practical Geography- I
(Techniques of Spatial Analysis) DSE- 2 C

(No. of Credits: 04)

Workload: Six Periods per week per batch consisting of 12 Students; however the last batch needs to have more than six students.

(Examination for the course will be conducted at the end of the semester)

Objective:

1. To introduce the basic concepts and techniques of Geographical Analysis.
2. To introduce the students with SOI Toposheets and acquire the Knowledge of Toposheet interpretation.
3. To introduce the students with Weather Maps and acquire the Knowledge of its interpretation.
4. To introduce the students with Aerial Photographs and Satellite Images and acquire knowledge to interpret it .
5. To acquaint students with the spatial and structural characteristics of Practical Geography.
6. To explain the elementary and essential principles on field of practical work.

Note:

1. Students must check the practicals regularly and journal should be certified by practical in-charge and Head of the Department before examination.
2. Use of Map stencils, Log tables, Calculator, Computer, Statistical Tables are allowed at the time of examination.
3. Students without a certified journal should not be allowed for the practical examination.
4. Each of the practical batches needs a separate question paper.
5. Internal and External examiner should set jointly the question paper for each batch.

Sr. No.	Topic	Sub Topic & learning Points	No. of Lectures
1.	Introduction of S.O.I. Toposheet & Relief Representation	a. Introduction of Survey of India Toposheets: Marginal Information, Conventional signs and symbols and Colours in S.O.I. Toposheets. b. Types of toposheets / Indexing of toposheets c. Methods of Relief Representation i) Qualitative: Hachures, Hill shading, Layer Tint. ii) Quantitative: Contours, Form lines, Bench Marks, Spot Heights, Triangulation Mark, Relative Height (r)	15
2.	Interpretation of S.O.I.	**a.** Reading of SOI toposheets from plain, plateau and Mountainous region. (Minimum one	15

	Toposheets and Data generation	Toposheet per region) b. One day field Excursion for orientation of toposheets, observation and Identification of Geographical Features and Preparation of a Brief Report	
3.	Introduction & Interpretation Weather Maps	a. Introduction to Weather Maps b. Symbols in Daily Weather Report used by India Meteorological Department (IMD) c. Isobaric Pattern d. Reading of Weather Map from i) Summer ii) Monsoon iii) Winter Season (Minimum one weather map from each season)	15
4.	Introduction & Application of GIS & Remote Sensing Techniques	a. Definition and Components of GIS b. GIS Data Types (spatial and non-spatial), Raster and Vector data c. Introduction of Aerial Photographs & Satellite Images d. Use of Computer open source Software for GIS & RS techniques in Geography	15

Reference Books:

1. Ahirrao, D. Y. and Karanjkhele, E.K., 2002. Pratyakshik Bhugol, Sudarshan Publication, Nashik.
2. Buoygoot, J. 1964., An Introduction to Map work and Practical Geography, University Tutorial, London.
3. Burrough, P. A., and McDonnell, R. A., 2000. Principles of Geographical Information System, Oxford University Press.
4. Curran, P. 1989., Principles of Remote Sensing, Logman, London.
5. Dickinson, G. C., 1979, Maps and Air Photographs, Arnold Publisher, New Delhi.
6. Dr. P. G. Saptrashi and Dr. S. R. Jog., 1991, Statistical Methods (Marathi)
7. Ebdon, D., 1977. Statistics in Geography: A Practical Approach, Basil Blackwell, Oxford.
8. Kumbhar, A., 2000. Pratyakshik Bhugol, Sumeru Publications, Mumbai.
9. Lillesand, T. M. and Kiefer, R. W., 2002. Remote Sensing and Image Interpretation, John Wiley and Sons, New Delhi.
10. Lutgens, F. K. and Tarbuck, E.J., 2007. The Atmosphere. Prentice hall, Englewood Cliffs, New Jersey, USA.

11. Monkhouse, F. J. and Wilkinson, H. R. 1971. Maps and Diagrams. Methuen and Co. Ltd. London, UK.
12. Ramamurthy, K., 2006. Map Interpretation, Rex Printers, Madras.
13. Siddhartha, K., 2006. Geography Through Maps, Kisalaya Publication, Pvt. Ltd, New Delhi.
14. Singh L. R. and Singh R., 1973. Map Work and Practical Geography, Central Book Depot, Allahabad.
15. Singh R. L. and Dutt, P.K., 1968. Elements of Practical Geography, Students Friends, Allahabad.
16. Singh R. L., 2005. Elements of Practical Geography. Kalyani Pubishers, New Delhi.
17. Singh, G., 2005. Map Work and Practical Geography, Vikas Publishing House Pvt. Ltd., New Delhi.
18. Strahler, A. A. and Strahler, A. N., 2002. Physical Geography. Science and Systems of the Human Environment, John Wiley & Sons, INC.
19. Strahler, A. H. and Strahler, A. N., 1992. Modern Physical Geography. John. Wiley & Sons, INC.
20. डॉ.काळे व्ही.बी. २०२१ 'प्रात्यक्षिक भूगोल' प्रशांत पब्लिकेशन, जळगाव.

Semester V
SEC 2 C
Value/Skill based Course
Research Methodology - I
CREDIT - 2

Objectives:

1. To develop the understanding of the basic concept of research
2. To develop the understanding of the basic framework of sampling and data collection
3. To develop the understanding of various sampling methods and techniques

Topic No.	Topic	Sub-Topic	No. of Lectures
1	Introduction to Research Methodology	i. Meaning and objectives of research ii. Characteristics of Research iii. Types of Research iv. Various steps in Research Process	10
2	Research Design	i. Introduction of Research Design ii. Purpose of Research Design iii. Characteristics of Good Research Design	10
3	Research Problem	i. Definitions of the Research Problem ii. Identification of a Research Problem iii. Technique involved in defining a problem	10

References

1. Montello Daniel R. and Sutton Paul C. (2006) – Introduction to scientific research Methods if Geography. By Saga Publication
2. Kothari , C. R. (2004) – Research Methodology -Methods and techniques, New Age.
3. Mishra, H.N. and Sing, V.P. (1998)- research Methodology in Geography, Rawat Publication
4. Clifford, N. Fresh S, Valentine, G. (2010) - Key Methods in Geography , Saga Publication
5. Gregory , K. J. (2000) – The changing Nature of Physical Geography, Arnold, London
6. Gomez basil and Jones, III John Paul (editor) (2010) – Research Methods in geography : A Critical, Wiley – Blackwell
7. Harvey, David (1971) – Explanation in Geography, Edward Arnold , London
8. Chorley, R. J. and P. Hagg-tt(ed) (1967) – Models in Geography , Methuen

Semester VI

T.Y.B.A. (Geography) Choice Based Credit System Syllabus

be implemented from Academic Year 2021-2022

Paper Code	Semester	Paper	Subject
Gg: 310(B)	VI	CC1F	Geography of Disaster Management-II OR Geography of Tourism -II
Gg: 320(B)	VI	DSE 1D	Geography of India -II OR Geography of rural development -II
Gg: 301(B)	VI	DSE 2D	Practical Geography – II (Techniques of Spatial Analysis, Surveying and Excursion / Village / Project Report
(Value/skill based course)		SEC 2 D	Research Methodology – II

Semester VI

Geography of Disaster Management-II CC1F **(No. of Credits: 03)**

Sr. No.	Topic	Learning Points	No. of Lectures
1	Geological and Geomorphic disasters and their management	a) Earthquakes b) Landslides c) Tsunami	12
2	Anthropogenic disasters and their management	a) Deforestation b) Forest fire c) Soil degradation	12
3	Global Environmental issues	a) Global warming b) Ozone depletion c) Acid rain	12
4	Case Studies of disaster	a) Tsunami in Indian ocean -2004 b) Fukushima Nuclear disaster -2011 c) Kedarnath Cloud Burst -2013	12

Reference books:

- Alexander, D. (1993): Natural Disasters. UCL Press Ltd., London
- Bloom, A.L., 1998. Geomorphology. A Systematic Analysis of Late Cenozoic Landforms. Pearson Education (Singapore) Pte. Ltd.
- Chandna, R. C., 2000. A Geography of Population, Concepts, Determinants and Patterns, Kalyani Publishers, New Delhi.

- Copola P Damon, 2007, Introduction to International Disaster Management
- Cuny, F. 1983, Development and Disaster, Oxford University Press.
- Govt. of India, 2005, Disaster Management Act Government of India, New Delhi.
- Hamblin, W.K., 1989. The Earth's Dynamic Systems, Macmillan Publishing Company, New York.
- Huggett, D.A., 2004. Fundamentals of Biogeography, Routledge.
- Kale, V.S. and Gupta, A., 2001. Introduction to Geomorphology, Orient Longman, Calcutta.
- Knox, P. and Agnew J., 1998. The Geography of the World Economy, Arnold, London.
- Lutgens, F.K. and Tarbuck, E.J., 2007. The Atmosphere. Prentice Hall, Englewood Cliffs, New Jersey, USA.
- Ross, D. A., 1988. Introduction to Oceanography. Prentice Hall, New Jersey.
- Saptarshi P. G., More J. C., Ugale V. R. and Arjun Musmade (2009), "Geography and Natural Hazard" Diamond, Pune.
- Savindra Singh, (2000): Environmental Geography. PrayagPustakBhavan, Allahabad
- Singh, S., 1998. Geomorphology, PrayagPustakBhavan, Allahabad.
- Strahler, A.A. and Strahler, A. N., 2002. Physical Geography: Science and Systems of the Human Environment, John Wiley and Sons, INC.
- A.H.Choudhar ,P.N.Salve, S.M.Kadam.R.H.Choudhar,V.C.Ithape (2010), "Contemporary Issues and Geography",Atharva ,Pune.
- Musmade Arjun. H., More J. C., 2014, Geography of Disaster Management, Diamond, Pune.

Geography of Tourism- II CC1F(No. of Credits: 03)

Objectives:

1. To understand the history of Tourism
2. To introduce the students to the basic concepts in Tourism Geography.
3. To understand the types of Tourism
4. To gain knowledge different aspects of Tourism Geography.

Sr. No.	Topic	Sub Topic & Learning Point	No. of Lectures
1.	Role of Accommodation in Tourism	a) Accommodation Types i. Hotels, Motels, Inn, Dharmashalas ii. Govt. Accommodation, Tourist homes iii. Private accommodations and unrecognized accommodations b) Factors affecting choice of Accommodation c) Role of Accommodation in Tourism Development	12
2.	Impact of Tourism	a) Economic impact i. Effect on foreign exchange ii. Employment generation iii. Infrastructure development b) Physical and Environmental impacts i. Land Degradation ii. Loss of plant and animal life iii. Air and water pollution c) Social cultural impacts i. Crime and Gambling activities ii. Languages iii. Traditional arts	12
3.	Planning and Polices of tourism development	a) World Tourism Organization (WTO) b) India Tourism Development Corporation (ITDC) c) Maharashtra Tourism Development Corporation (MTDC)	12
4.	Case studies of Major Tourist Centers in India	a) Hill Station- Manali and Mahabaleshwar b) Historical- Tajmahal and Raigadh fort c) National Parks- Kaziranga, Melghat	12

Reference Book

1. A Geography of Tourism: Robinson H. (1996)
2. Tourism Development, Principles and Practices: Bhatia A.K., Sterling Publisher Ltd., New Delhi
3. Geography of Tourism and Recreation: S. N. Singh (1985)
4. Tourism Today: A Geographical Analysis: Douglas Pearce (1987)

5. Tourism: Economic Physical and Social Impact: Mathiseson A. and Wall C, Logman, U.K.
6. India: A Tourist Paradise: Manoj Das.
7. Tourism Today: An Indian Perspectives: Maneet Kumar
8. Geography of Travel and Tourism: Hudman L.E.
9. Successful Tourism Management: Seth P.N. (1985) Sterling Publisher Ltd., New Delhi.
10. Tourism Analysis: Smith S.L.J.
11. Tourism in India: Gupta V.K.
12. Dynamics of Tourism: Kaul R. N., Sterline Publisher Ltd.
13. Geography of Tourism: S.B. Shinde, Phadke Prakashan, Kolhapur 2

Semester VI

Geography of India -II DSE1 D(No. of Credits: 03)

Objective:

1. To acquaint the students with geography of our Nation.
2. To make the student aware of the magnitude of problems and Prospects at National level.
3. To help the students to understand the inter relationship between the subject and the society.
4. To help the students to understand the recent trends in regional studied

Sr. No	Unit	Subunit	No. of Lectures
1	Cultural Setting	a) Religions of India b) Languagesof India c) Major tribes, tribal areas and their problems	12
2	Transportation& Communication	a) Role of Transportation in regional development of India b) Land ways, Airways and Waterways c) Developments in communication technology	12
3	Resources	a) Iron ore and Manganese b) Coal and Petroleum c) Hydro and Thermal Power	12
4	Agriculture	a) Significance of agriculture in Indian Economy. b) Agro Based Industries: Sugar, Cotton & Textile c) Agriculture Revolution in India: Green, White & Blue	12

Reference Books

1. Aher A.B , Chaodhari A. P & Chaodhari Archna. Regional Geography of India Prashant Publication Jalgaon 2015
2. Deshpande C.D: India-A Regional Interpretation Northern Book Centre, New Delhi.1992.
3. Farmer, B.H.: An Introduction to South Asia. Methuen, London, 1983.
4. Govt. of India: India - Reference Annual, 2001 Pub. Div, New Delhi, 2001.
5. Govt. of India: National Atlas of India, NATMO Publication, Calcutta..
6. Govt. of India: The Gazetteer of India. Vol I & III Publication Division, New Delhi, 1965.
7. Learmonth, A.T.A. et.al(ed.) : Man and Land of South Asia Concept, New Delhi.

8. Mitra, A.: Levels of Regional Development India Census of India, Vol I, Part I-A (i) and (ii) New Delhi, 1967.
9. Routray, J.K.: Geography of Regional Disparity Asian Institute of Technology, Bangkok, 1993.
10. Shafi, M: Geography of South Asia, McMillan & Co., Calcutta, 2000.
11. Singh, R.L.(ed.): India: A Regional Geography. National Geogphical Society. India, Varanasi, 1971.
12. Spate, O.H.K. and Learmonth, A.T.A.; India and Pakistan - Land, People and Economy Methuen & Co., London, 1967.
13. P. G. Saptarshi, J. C. More, V. R. Ugale & A. H. Musmade :A Geographical Region of India : Diamond Publication (2009) (Marathi)
14. Patil S. G., Suryawanshi R. S., Pacharne S., Choudhar A. H. : Economic Geography, Atharav Prakashan, Pune. (2014) (Marathi).
15.Musmade Arjun. H., More J. C., 2015, Geography of India , Diamond, Pune.

Semester VI

Geography of Rural Development II DSE 1 D (No. of Credits: 03)

Objectives-

1. To study the problems and policies related to education in rural areas.
2. To create awareness among the students about various area development programmes and Target Group Programmes implemented in India.
3. To create a positive approach for rural development among the students through the examples of successful case studies.

Sr. No.	Topic	Sub Topic	Learning Points	No. of Lectures
1	Education in Rural Areas	Problems	a) Problems in School Education b) School Dropouts c) Girl Child Education d) Sarva Siksha Abhiyan: National Literacy Mission	12
2	Area Development Programmes:	Programmes	a) Drought Prone Area Programme b) Command Area Development Programme c) Desert Development Programme d) Hill Area Development Programme	
3	Target Group Programmes	Programmes	a) Suwarnajayanti Gram Swoyam rojgar Yojana b) National Rural Livelihoods Mission c) Micro Finance d) Self-help Groups for Women Empowerment	12
4	Case Studies:	Case Studies	a) Study of a successful case: Hivare Bazar b) Study of successful case: Mendhalekha c) study of people's movement: Farmers' agitation against New laws, Chipco movement d) Study of your own village, to highlight issues and remedial measures of Rural area development	12

Reference Books

1. Vasant Desai: Rural Development in India, Himalaya Publishing House, Mumbai, 2012.
2. Singh, R.B. (1985): *Geography of Rural Development*. New Delhi, India: Inter India.

3. Mukherjee, Neela. (1993). *Participatory Rural Appraisal: Methodology and Application.* Delhi, India: Concept Publs. Co.
4. Rural Development Satya Sundaram , Himalaya publication House Mumbai
5. Indian economy R. D. Sudharam Chand and co. Ramnagar New Delhi.
6. Commercial Geography Dr. B.S.Nagi. KedarnathRamnath publications Meerut,
7. Human Resource Development T.Y. Rao SAGE Publication New Delhi.
8. Katar Singh -Rural Development –Principles, Policies and Management.
9. Agricultural Geography (second edition) Jasbir singh and S.S. Dhillon Tata mc crow publication
10. Intermation Technology and Globalization S.K. Bansal APII Publishing Corp. Ansari Rd. Dayraganj Delhi.
11. Economic Geography. Sadha –Khan 8. Ruural Energy criai S. Giriappa Himalaya Publishing House Mumbai
12. Anand, Subhash. (2013). *Dynamics of Rural Development*. Delhi, India: Research India Press.
13. Mukundan,N.-Rural Development and Poverty eradication in India.
14. Krishnamurthy, J. (2000). *Rural Development - Problems and Prospects.* Jaipur, India: Rawat Publs.
15. Ramachandran, H., and Guimaraes, J.P.C. (1991). *Integrated Rural Development in Asia–Leaning fromRecent Experience.* New Delhi, India: Concept Publishing.
16. Palione, M. (1984). *Rural Geography*. London, UK: Harper and Row.
17. Dutt and Sundaram- Indian Economy, S.Chand Publications, New Delhi, 2013-07-02.
18. Mishra,S.K. and PuriV.K. - Economics of Development and Planning, Himalaya Publishing House, Mumbai, 2012.
19. K Vijayakumar Empowerment of weaker section future planning and strategies for Rural Development in India.
20. Shankar Chatterjee- Implementation of Rural Development.
21. Gilg A. W., 1985: An Introduction to Rural Geography, Edwin Arnold, London.
22. Misra R. P. and Sundaram, K. V. (eds.), 1979: Rural Area Development: Perspectives

Semester VI

Practical Geography- II (Techniques of Spatial Analysis, Surveying and Excursion /Village/ Project Report) DSE- 2 D

(No. of Credits: 04)

Workload: Six Periods per week per batch consisting of 12 Students; however the last batch needs to have more than six students.

(Examination for the course will be conducted at the end of the semester)

Sr. No.	Topic	Sub Topic & learning Points	No. of Lectures
1.	Geographical Data & its Basic Analysis	a. Introduction and Types of Geographical Data: i) Spatial and Temporal data ii)Discrete and Continuous series iii) Grouped and Ungrouped data b. Basic Analysis : i) Tally marks and frequency table ii)Frequency distribution (histogram & polygon) iii) Cumulative Frequency & Ogive curve	15
2.	Calculation of Central Tendency, & Dispersion	a. Meaning and description of central tendencies- Mean, Mode, Median b. Calculation of Mean, Mode, Median for ungrouped and grouped data (two examples each) c. Measures of Dispersion: Mean Deviation & Standard Deviation (two examples each)	15
3.	Testing and Application of Hypothesis	a) Meaning, Definition of Hypothesis & Types of Hypothesis i) Null & Alternative hypothesis ii) Level of significance, iii) Degree of freedom b) Concept of Correlation and regression I. Concept of bivariate correlation & Regression II. Meaning of coefficient of correlation III. Parametric & Non parametric tests: i) Chi-square test (two examples each) IV. Calculation of Spearman Rank order (Min. two examples for each test)	15
4.	Field Excursion / Village Survey / Project Report	a.One Short tour of two days duration and preparation of tour report **OR** b. One long Tour of more than Five days duration anywhere in the country and preparation of tour report **OR** c. Village / City / Area Survey and preparation of report	15

Reference Books:

1. Acevedo, M. F., 2012. Data Analysis and Statistics for Geography, Environmental Science and Engineering, CRC Press.
2. Ahirrao, D. Y. and Karanjkhele, E.K., 2002. Pratyakshik Bhugol, Sudarshan Publication, Nashik.
3. Creswell J., 1994. Research Design: Qualitative and Quantitative Approaches, Sage Publications.
4. Dikshit, R. D., 2003. The Art and Science of Geography: Integrated Readings. Prentice-Hall of India, New Delhi.
5. Hammond, R. and McCullagh, P. S., 1977. Quantitative Techniques in Geography: An Introduction, Clarendon Press, Oxford.
6. Harris, R., Jarvis, C. 2011. Statistics for Geography and Environmental Science, Prentice Hall.
7. Jog. S. R. and Saptarshi, P. G., 1980. Sankhikhi Bhugol, Narendra Publication, Pune.
8. Karlekar, S. N. and Kale, M., 2006. Statistical Analysis of Geographical Data, Diamond Publication, Pune.
9. Kumbhar, A., 2000. Pratyakshik Bhugol, Sumeru Publications, Mumbai.
10. Mc Grew Jr., J. C., Lembo Jr., A. J., Monroe, C. B. 2014. An Introduction to Statistical Problem solving in Geography, 3rd ed, Waveland Press.
11. Pal. S. K., 1998. Statistical Methods for Geoscientists: Techniques and Applications, Concept Pub.co.
12. Robinson, A., 1998. "Thinking Straight and Writing That Way", in Writing Empirical Research Reports: A basic guide for students of the Social & Behavioral Sciences, eds. By F. Pryczak & R. Bruce Pryczak, Publishing, Los Angleles.
13. Rogerson, P. A., 2015. Statistical Methods for Geography: A Student's Guide, 4th ed, Sage.
14. Sarkar, A. 2015. Practical Geography: A Systematic Approach, 3rd ed, Orient Blackswan.
15. Singh R. L. and Dutt, P.K., 1968. Elements of Practical Geography, Students Friends, Allahabad.
16. Singh R. L., 2005. Elements of Practical Geography. Kalyani Pubishers, New Delhi.

17. Stoddard, R. H., 1982. Field Techniques and Research Methods in Geography, Kendall/Hunt.
18. Wokcatt, H. 1995. The Art of Fieldwork, Alta Mira Press, Walnut Creek, CA.
19. डॉ. प्रवीण सप्तर्षी, सांख्यिकी भूगोल , नीराली प्रकाशन, पुणे.
20. डॉ.काळे व्ही.बी. २०२१ 'प्रात्यक्षिक भूगोल' प्रशांत पब्लिकेशन, जळगाव.

Semester VI

SEC 2 D

Value/ Skill based Course

Research Methodology – II

CREDIT - 2

Objectives:

1. To identify various sources of information for data collection.
2. Understanding of the conducting survey on various issues and develop the Report writing skill of students

Sr. No.	Topic	Sub-Topic	No. of Lectures
1	Methods of Data Collection	**A) Primary Data** Questionnaire Method i.) Questionnaire – definition ii.) Characteristics of a good questionnaire iii.) Merits and demerits Questionnaire Method **B) Secondary Data** i) Government Sources ii) Syndicated Sources iii) Other Types of Sources	10
2	Types of Research Report	i. Dissertation and Thesis, ii) Research paper, review article iii) Characteristics of Good Research Report Writing	10
3	Techniques of Research Report Writing	i) Structure and organization of research reports: Title, abstract, key words, introduction ii) Methodology, results, discussion, conclusion,references, footnotes, iii) Concepts of Case Study	10

References

1. Gaum, Carl G., Graves, Harod F., and Hoffman, Lyne, S.S., (1950): Report Writing, 3rd ed., New York: Prentice-Hall.
2. Kothari, C.R. (2004): Research Methodology: Methods and Techniques, New Age

International (P) Ltd.,New Delhi – 110002.
3. Kothari, C.R., (1984): Quantitative Techniques, 2nd ed., New Delhi: Vikas Publishing House Pvt. Ltd.
4. Mishra Shanti Bhushan and Shashi A. (2011): Handbook of Research Methodology, Educreation Publishing, New Delhi – 110075.
5. Pandey, P. and Pandey, M.M. (2015): Research Methodology: Tools and Techniques,Bridge Center, Romania, European Union.
6. Tandon, B.C., (1979): Research Methodology in Social Sciences. Allahabad, Chaitanya Publishing House.
7. Ullman, Neil R. (1978): Elementary Statistics, New York: John Wiley & Sons, Inc.
8. Yamane, T., Statistics (1973): An Introductory Analysis, 3rd ed., New York: Harper and Row.

SavitribaiPhule Pune University

(Formerly University of Pune)

S.Y.B.A. (Geography) Correction

Choice Based Credit System Syllabus

To be implemented from Academic Year 2020-2021

Semester	Core Courses	Paper No	Paper Code	Subject	Total Lecture	Credit
III	Geography CC-1C	G2	Gg: 201(A)	Environmental Geography I OR Economic Geography -I	48	3
	Geography DSE – 1A	S1	Gg: 220(A)	Geography of Maharashtra - I OR Population Geography – I	48	3
	Geography DSE – 2A	S2	Gg: 210(A)	Practical Geography – I (Scale and Map Projections)	60	4
	SEC-I		SEC - A	Introduction to Geographical Information System (GIS) / Applied Course of Disaster	30	2

				Management		
IV	Geography CC-1C	G2	Gg: 201(B)	Environmental Geography II OR Economic Geography -II	48	
	Geography DSE – 1B	S1	Gg: 210(B)	Geography of Maharashtra – II OR Population Geography – II	48	3
	Geography DSE – 2B	S2	Gg: 220(B)	Practical Geography – II (Cartographic Techniques, Surveying and Excursion / Village / Project Report)	60	4
	SEC-I		SEC - B	& Introduction to Remote Sensing / Applied Course of Travel & Tourism	30	2

S. Y. B. A. GEOGRAPHY

Equivalence of Previous syllabus along with new syllabus:

Pager	Old Course (2013 Annual Pattern)	New Course (2019 Semester Pattern)
G2	Gg-210 Elements of Climatology and Oceanography OR Gg-210 Geography of Disaster Management	Gg: 210(A)Environmental Geography I OR Gg: 210(A)Economic Geography -I
G2		Gg: 210(B)Environmental Geography II OR Gg: 210(B)Economic Geography -II
S1	Gg-220 Economic Geography OR Gg-220 Tourism Geography	Gg: 220(A)Geography of Maharashtra - I OR Gg: 220(A) Population Geography – I
S1		Gg: 220(B) Geography of Maharashtra – II OR Gg: 220(B) Population Geography – II
S2	Gg-201 Fundamentals of Geographical Analysis	Gg: 201(A)Practical Geography – I (Scale and Map Projections)
S2		Gg: 201(B)Practical Geography – II (Cartographic Techniques, Surveying and Excursion / Village / Project Report)

S.Y.B.A. Geography (G2) Syllabus for Semester III

Name of Subject: Environment Geography- I, Subject Code: Gg.210 (A)

Objectives:

1. To create the awareness about dynamic environment among the student.
2. To acquaint the students with fundamental concepts of environment geography for development in different areas.
3. The students should be able to integrate various factors of Environment and dynamic aspect of Environmental geography.
4. To make aware the students about the problems of environment , their utilization and conservation in the view of sustainable development

Sr. No.	Topic	Sub Topics	Teaching Hours	Total Credits
1	Introduction to Environmental Geography	1. Definition, Nature and scope of Environmental Geography. 2. Types of Environment 3. Importance of Environmental Geography 4. Approaches to study of environmental Geography	12	03
2	Ecosystem	1. Meaning, concept and definition of ecosystem. 2. Structure (Biotic and Abiotic factors) and food chain, Tropic Level, food web, energy flow 3. Types of ecosystem a) Equatorial Forest and b) Pond Ecosystem	12	
3	Biodiversity and its conservation	1. Concept of biodiversity 2. Economic value and potential of biodiversity 3. Loss of biodiversity and hotspots in India 4. Conservation of biodiversity	12	
4	Environmental Pollution	1. Concept of Pollution 2. Air pollution-Causes, effects and control measures 3. Water pollution-Causes, effects and control measures 4. Soil pollution-Causes, effects and control measures	12	

Reference Book:

1. Miller G.T., 2004, Environmental Science Working with the Earth, Thomson Books Cole, Singapure
2. Saxena H.M., 2017, Environmental Geography(Ed III), Rawat Publicastions, Jaipur
3. Odum E.P. et al.2005, Fundamentals of Ecology, Ceneage Learning, India

4. Sharma P.D.2015, Ecology and Environment, Rastogi Publications,Meerut
5. Kormondy, Edward J, 2012, Concept of Ecology, PHI Learning Pvt.Ltd,New Delhi
6. Singh R.B.(Eds) 2009, Biogeography and Biodiversity, Rawat Publications, Jaipur
7. Singh S,Prayag, 1997, Environment Geography, Pustak Bhawan, Allahabad
8. Chandana R.C.2002, Environmental Geography, Kalyani Publication, Ludhiana
9. Goudie A, 2001, The Nature of The Environment, Blackwell ,Oxford
10. Gholap T. N., 2000, Environment Science, Nishikant Publications, Pune. (Marathi)
11. Choudhar A.H., & et. al., 2014, Disaster Management, Atharva Publication, Pune. (Marathi)
12. Musmade A. H., More J. C. 2014, Geography of Disaster Management, Diamond Publication, Pune. (Marathi)
13. Saptarshi P. G., More J. C., Ugale V. R., 2009, Geography and Natural Hazads, Diamond Publishing, Pune. (Marathi)

S.Y.B.A. Geography (G2) Syllabus for Semester IV

Name of Subject: Environment Geography- II, Subject Code: Gg.210 (B)

Objectives:

1. To create awareness about dynamic environment among the students.
2. To acquaint students with the fundamental concepts of Environment Geography.
3. To acquaint students about the past, presents and future utility and potentials of natural resources.
4. To make aware students about the problems of environment, its utilization and conservation in the view of sustainable development.

Sr. No.	Topic	Sub Topics	Teaching Hours	Total Credits
1	Environmental Disaster	1. Meaning and concepts of environmental disaster 2. Classification of Disaster 3. Natural Disaster a) Earthquake b) Flood 4. Biological Disaster a) Swine flu b) Novel Corona (COVID-19)	12	03

2	Environmental Problems	1. Global Warming and climate change 2. Ozone Depletion 3. Acid rain 4. Over use of chemical fertilizers, pesticides and insecticides	12	
3	Environmental Planning and Management	1. Need of Planning and Management 2. Micro, macro and meso level Planning and Management with reference to India 3. Environmental impact assessment	12	
4	Environmental Policies	1. Introduction of environmental policies 2. Environmental education in India 3. Kyoto Protocol	12	

Reference Book:

1. Miller G.T., 2004, Environmental Science Working with the Earth, Thomson Books Cole, Singapure
2. Saxena H.M., 2017, Environmental Geography,(III ED) Rawat Publicastions, Jaipur
3. Odum E.P. et al.2005, Fundamentals of Ecology, Ceneage Learning, India
4. Sharma P.D.2015, Ecology and Environment, Rastogi Publications,Meerut
5. Kormondy, Edward J, 2012, Concept of Ecology, PHI Learning Pvt. Ltd, New Delhi
6. Singh R.B.(Eds) 2009, Biogeography and Biodiversity, Rawat Publications, Jaipur
7. Singh S,Prayag, 1997, Environment Geography, Pustak Bhawan, Allahabad
8. Chandana R.C.2002, Environmental Geography, Kalyani Publication, Ludhiana
9. Goudie A, 2001, The Nature of The Environment, Blackwell ,Oxford
10. Gholap T. N., 2000, Environment Science, Nishikant Publications, Pune. (Marathi)
11. Choudhar A.H., & et. al., 2014, Disaster Management, Atharv Publication, Pune. (Marathi)
12. Musmade A. H., More J. C. 2014, Geography of Disaster Management, Diamond Publication, Pune. (Marathi)
13. Saptarshi P. G., More J. C., Ugale V. R., 2009, Geography and Natural Hazads, Diamond Publishing, Pune. (Marathi)

S.Y.B.A. Geography (G2) Syllabus for Semester III

Name of Subject: Economic Geography- I, Subject Code: Gg.210 (A)

Objectives:

1. To introduce students to the basic principles and concepts of economic geography
2. To acquaint students with the applications to economic geography for development in different areas
3. The students should be able to integrate various factors of economic development and dynamic aspect of economic geography.

Sr. No.	Topic	Sub Topics	Teaching Hours	Total Credits
1	Introduction to Economic Geography	1. Definition, nature and scope of economic geography. 2. Need and significance of economic geography *3.* Economic geography and its relation with social sciences *4.* Approaches of the study of economic geography	12	03
2	Economic Activity	1. Introduction and concept of economic activity with problems and prospect 2. Primary activity 3. Secondary activity *4.* Tertiary activity	12	
3	Concept and classification of resources	1. Concept of resources 2. Renewable energy Resources i. Hydro electricity ii. Solar energy iii. Wind energy 3. Non-renewable Resources i. Coal, ii. Iron ore iii. Mineral oil 4. Conservation of resources	12	
4	Agriculture	1. Role of Agriculture in Indian economy 2. Factors influencing agriculture in India a) Physical b) Socio-economic c) Political and cultural 3. Agro-based industries in India a) Dairy industry b Cotton industry 4. Agro –Tourism	12	

Reference Books :

1. Gautam A., 2010, Advance Economic Geography, Sharda Pustak Bhavan, Allahabad
2. Chauhan R. N., 2007, Basic Principles of Economic Geography, ABD Publishers, Jaipur
3. Padey P. N., Economic Geography, Nirali Publication ,Pune
4. Sadhukhan S. K., 1994, Economic Geography An Appraisal of Resources, S Chand & Campany Ltd ,New Delhi

5. Roy P., Mukherjee S., 1993, Economic Geography: Resource Appraisal of resources-New Central Book Agency, Calcutta
6. Mannur H. G., 2008, International Economics, Vikas Publishing House PvtLtd,Noida
7. Siddharth K., 2003, Economic Geography, Theories, Processes &Patterns, Kisalaya Publications Pvt, Ltd, Noida
8. Husain M., 2008, Geography of India, Tata McGraw Hill, New Delhi
9. Bhat L. S., 1973, Regional Planning in India, Statistical Publishing Society, Kolkata
10. Desai V,1991, Fundamentals of Rural Development, Rawat Publications, New Delhi
11. Paranjape, Gupte, Karmarkar, 1974, Economic & Commercial Geography, Nirali Publication, Pune.
12. More J. C., 2014, Geography & Agriculture For MPSC Examination, Atharv Publication, Pune
13. Pagar S.D., Thorat A. M., More J. C., 2015, Agriculture Geography, Atharav Publication, Pune.

S.Y.B.A. Geography (G2) Syllabus for Semester IV

Name of Subject: Economic Geography- II, Subject Code: Gg.210 (B)

Objectives:

1. To acquaint students with the basic principles and concepts of economic geography
2. To acquaint the students with the applications to economic geography for development in different areas.
3. The main aims are to integrate the various factors of economic development and to acquaint the students with this dynamic aspect of economic geography.

Sr.No.	Topic	Sub Topics	Teaching Hours	Total Credits
1	Trade and Transport	1.Modes of Transportation and their cost effectiveness Significance of a) Road b) Rail c) Air 2.Treansportation cost of Major types 3,Types of Trade a) National b) International 4.International trade of India	12	03
2	Industries	1. Factors influencing on location of industries. 2. Weber's theory of industrial location 3. Major industrial regions in India 4. a) Iron and steel industry in India b) Sugar Industry in Maharashtra	12	

3	Regional Planning Development	1. Concept of regional planning and development. Their importance 2. Objectives of regional planning 3. Regional and sectoral imbalance in India	12	
4	Rural Development in India	1. Concept of rural development 2. Index of rural development 3. Various schemes of government for rural development a) IRD Programme b) DPAD Programme	12	

Reference Books :

1. Gautam A., 2010, Advance Economic Geography, Sharda Pustak Bhavan, Allahabad
2. Chauhan R. N., 2007, Basic Principles of Economic Geography, ABD Publishers, Jaipur
3. Padey P. N., Economic Geography, Nirali Publication ,Pune
4. Sadhukhan S. K., 1994, Economic Geography An Appraisal of Resources, S Chand &Campany Ltd ,New Delhi
5. Roy P., Mukherjee S., 1993, Economic Geography: Resource Appraisal of resources-New Central Book Agency, Calcutta
6. Mannur H. G., 2008, International Economics, Vikas Publishing House Pvt Ltd, Noida
7. Siddharth K., 2003, Economic Geography, Theories, Processes & Patterns, Kisalaya Publications Pvt, Ltd, Noida
8. Husain M., 2008, Geography of India, Tata McGraw Hill, New Delhi
9. Bhat L. S., 1973, Regional Planning in India, Statistical Publishing Society, Kolkata
10. Desai V,1991, Fundamentals of Rural Development, Rawat Publications, New Delhi
11. Paranjape, Gupte, Karmarkar, 1974, Economic & Commercial Geography, Nirali Publication, Pune.
12. More J. C., 2014, Geography & Agriculture For MPSC Examination, Atharv Publication, Pune
13. Pagar S.D., Thorat A. M., More J. C., 2015, Agriculture Geography, Atharav Publication, Pune.

S.Y.B.A. Geography (S1)Syllabus for Semester III

Name of Subject: Population Geography, Subject Code: Gg.220 (A)

Objectives:

1. To understand the history of population.
2. To introduction of the basic concepts in Population Geography.
3. To understand the types of Population data.

Sr. No.	Topic	Sub Topics	Teaching Hours	Total Credits
1	Introduction	1. Definition, Nature and Scope, 2. Contextual significance of Population Geography, 3. Relation between Population Geography and other social Sciences.	12	03
2	Population Data& Presentation	1. Census of India 2. National Sample Survey, Sample Registration Survey, NFHS, DLHS, 3. Presentation of Population Data – Maps, Graphical Presentation, Computer Application	12	
3	Population Growth and Demographic Attributes	1. Factors affecting Growth of Population 2. Fertility, Mortality - (Concept, Measurement) 3. Migration - Concept, Causes, Types	12	
4	Composition of Population	1. Age-Sex pyramid, Age Structure 2. Occupational Structure, Dependency Ratio 3. Longevity, Life Expectancy. (with Reference to India)	12	

Reference Books:

1. Barrett H. R., 1995, Population Geography, Oliver and Boyd Publication,

2. Bhende A. and Kanitkar T., 2000, Principles of Population Studies, Himalaya Publishing House.

3. Chandna R. C. and Sidhu M. S., 1980, An Introduction to Population Geography, Kalyani Publishers.

4. Clarke J. I., 1965, Population Geography, Pergamon Press, Oxford.

5. Jones, H. R., 2000, Population Geography, 3rd ed., Paul Chapman, London.

6. Lutz W., Warren C. S. and Scherbov S.,2004, The End of the World Population Growth in the 21st Century, Earth scan

7. New bold K. B.,2009, Population Geography Tools and Issues, Rowman and Littlefield Publishers.

8. Pacione M., 1986, Population Geography-Progress and Prospect, Taylor and Francis.

9. Wilson M. G. A., 1968, Population Geography, Nelson Publishers.

10. Panda B P , 1988, Population Geography, Granth Academy, Bhopal (Hindi)

11. Maurya S D, 2009, Population Geography, Sharda Putak Bhawan, Allahabad (Hindi)

12. Chandna, R C, 2006, Population Geography, Kalyani Publishers, Delhi. (Hindi)

13. Sawant, Athavale, Musmade, Population Geography, Mehta Pubication, Pune. (Marathi)

14. More J. C.,2014, Geography & Agriculture For MPSC Examination, Atharv Publication, Pune (Marathi)

15. Musmade A.H., Sonawane A.E., More J.C., 2015, Population & Settlement Geography, Diamond Publication Pune. (Marathi)

S.Y.B.A. Geography (S1), Syllabus for Semester IV
Name of Subject: Population Geography, Subject Code: Gg.220 (B)

Objectives:

1. To introduce students to the Population Policy of India and China.
2. To understand the Health indicator in India.
3. To acquaint students with the concept of urbanization in population geography.
4. To understand population theories.

Sr. No.	Topic	Sub Topics	Teaching Hours	Total Credits
1	Concept and theories of Population	1. Population and space: over Population, Optimum Population, Under Population 2. Malthusian Theory 3. Marxian Theory	12	03
2	Problems of Population and Population Polices	1. Population Problems in India. 2. Population Problems in developed countries 3. Population Policies in India and China	12	
3	Population as a Resources Contemporary Issues	1. Health Indicator in India 2. Population as Social Capital 3. Human Development Index.	12	
4	Urbanization	1. Concept of urbanization 2. History of urbanization in India, Trends of World urbanization. 3. Problems of Urbanization in India	12	

Reference Books:

1. Barrett H. R., 1995, Population Geography, Oliver and Boyd Publication,

2. Bhende A. and Kanitkar T., 2000, Principles of Population Studies, Himalaya Publishing

House.
3. Chandna R. C. and Sidhu M. S., 1980, An Introduction to Population Geography, Kalyani Publishers.
4. Clarke J. I., 1965, Population Geography, Pergamon Press, Oxford.
5. Jones, H. R., 2000, Population Geography, 3rd ed., Paul Chapman, London.
6. Lutz W., Warren C. S. and Scherbov S.,2004, The End of the World Population Growth in the 21st Century, Earth scan
7. New bold K. B.,2009, Population Geography Tools and Issues, Rowman and Littlefield Publishers.
8. Pacione M., 1986, Population Geography-Progress and Prospect, Taylor and Francis.
9. Wilson M. G. A., 1968, Population Geography, Nelson Publishers.
10. Panda B P , 1988, Population Geography, Granth Academy, Bhopal (Hindi)
11. Maurya S D, 2009, Population Geography, Sharda Putak Bhawan, Allahabad (Hindi)
12. Chandna, R C, 2006, Population Geography, Kalyani Publishers, Delhi. (Hindi)
13. Sawant, Athavale, Musmade, Population Geography, Mehta Pubication, Pune. (Marathi)
14. More J. C.,2014, Geography & Agriculture For MPSC Examination, Atharv Publication, Pune (Marathi)
15. Musmade A.H., Sonawane A.E., More J.C., 2015, Population & Settlement Geography, Diamond Publication Pune. (Marathi)

S.Y.B.A. Geography (S1), Syllabus for Semester III

Name of Subject: Geography of Maharashtra, Subject Code: Gg.220 (A)

Objectives:

1. To acquaint students with Geography of our State.
2. To make students aware of the magnitude of problems and prospects in Maharashtra.
3. To help students understand the inter relationship between the subject and the society.
4. To help students understand the recent trends in regional studies

.

Sr. No.	Topic	Sub Topics	Teaching Hours	Total Credits
1	Administrative Set up of Maharashtra	1. Historical and Political Background of the state 2. Geographical location of State 3. Adjoining States 4. Administrative Divisions	12	

2	Physical settings	1. Geological Structure of Maharashtra. 2. Physical Structure (Mountain, plateau, Plains) 3. Drainage Pattern (East and West flowing rivers) 4. Major Soil types and Distribution.	12	03
3	Climate	1. Climatic Regions of Maharashtra 2. Distribution of Rainfall 3. Draught prone areas- Problems and Management 4. Flood areas - Problems and Management	12	
4	Resources	1. Water :Problems in Utilization and conservation 2. Forest : Types and Conservation 3. Mineral; Iron ore, Manganese and Bauxite 4. Power : Hydro, Thermal, Atomic	12	

Reference Book:

1. Dikshit K.R ., Maharashtra in Maps,
2. Deshpande C. D. , Maharashtra
3. Sadhu Arun, Maharashtra, National Book Trust
4. Savadi A. B., Geography of Maharashtra: Nirali Prakashan, Pune.
5. Dastane S., Maharashtra, Ramchandra and company, Pune
6. Sawadi A. B., The Mega State Series : Nirali Publication, Pune.
7. Maharashtra state Agricultural Atlas
8. Karve I., Maharashtra its Land and people,
9. More J. C., 2014, Geography & Agriculture For MPSC Examination, Atharv Publication, Pune (Marathi)

S.Y.B.A. Geography (S1), Syllabus for Semester IV

Name of Subject: Geography of Maharashtra, Subject Code: Gg.220

(B)Objective :

1. To make students aware about the Agriculture problems and prospects of Maharashtra.
2. To understand the population distribution and settlement pattern in Maharashtra.
3. To understand the concept of rural development.
4. To understand the prospectus in Tourism activity in Maharashtra and the role of MTDC and Role of MIDC in industrial development in rural area of Maharashtra

Sr. No.	Topic	Sub Topic & Learning Point	Hours	Credits
1	Agriculture	1. Importance of Agriculture in Economy of Maharashtra 2. Major Crops - Wheat, Rice, Jawar, Bajra. 3. Cash Crops and Horticulture - Cotton, Sugarcane, Pomegranate, Grapes. 4. Problems of agriculture in Maharashtra.	12	03
2	Population and Settlement	1. Population distribution of Maharashtra 2. Population composition - Sex Ratio, Literacy, Occupational structure, Migration 3. Rural and Urban Settlements 4. Potential of Major Cities in Maharashtra – Mumbai, Pune, Nagpur	12	
3	Rural Development of Maharashtra	1. Concept of Rural Development 2. Parameters of Rural Development 3. Schemes For Rural Development 4. Case Studies – Hivare Bazar and Ralegan Siddhi (Ahmednagar), Patoda (Aurangabad)	12	
4	Tourism	1. Growth and development of tourism in Maharashtra 2. Tourism Potential of Maharashtra 3. Agro-Tourism 4. Role of MTDC	12	

Reference Book:

1. Dikshit K.R ., Maharashtra in Maps,
2. Deshpande C. D. , Maharashtra
3. Sadhu Arun, Maharashtra, National Book Trust
4. Savadi A. B., Geography of Maharashtra: NiraliPrakashan, Pune.
5. Dastane S., Maharashtra, Ramchandra and company, Pune
6. Sawadi A. B., The Mega State Series : Nirali Publication, Pune.
7. Maharashtra state Agricultural Atlas
8. Karve I., Maharashtra its Land and people,
9. More J. C., 2014, Geography & Agriculture For MPSC Examination, Atharv Publication, Pune (Marathi)

S.Y.B.A. Geography (S2), Syllabus for Semester III
Name of the Subject: Scale and Map Projection, subject Code: Gg. 201 (A)
Practical Geography-I No. of Credits: 04

Workload: Six Periods per week per batch consisting of 12 Students; however the last batch needs to have more than six students.

(Examination for the course will be conducted at the end of the semester)

Objectives of Course:

1. To introduce the basic concepts in Practical Geography
2. To enable students to use various Scales and Projection Techniques in Geography.
3. To acquaint students with the utility of various Projections in Geographical knowledge.
4. To explain the elementary and essential principles of practical work in Geography.

Course Outcome:

After the successful completion of the course, the students will be able to:

1. Develop practical skill and use of map scale and projection.
2. To make students aware of the new techniques, accuracy and skills of map making.

Note:

1. Use of Map stencils, Log tables, Calculator, computer, Statistical Tables is allowed at the time of Examination.
2. Students must check the practical's regularly and Journal should be certified by practical in-charge and Head of the Department before the examination.
3. Students without a certified journal should not be allowed for the practical examination.
4. Each of the practical batches needs a separate question paper.

Sr. No.	Topic	Sub Topic & Learning Point	No of Practical	Credits
1.	**Introduction of Maps**	1. Definition of Map 2. Elements of Map 3. Classification of Map: a. On the basis of scale: i) Small scale ii) Large Scale b. On the basis of function: i) Physical ii) Cultural 4. Use of map	**03**	**04**
2.	**Map Scale**	1. Definition of Map Scale. 2. Types of Map Scale a. Verbal Scale b. Numerical Scale c. Graphical Scale 3. Conversion Scale (British and Metric System) a. Verbal scale to Representative fraction b. Representative fraction into Verbal scale 4. Construction of Simple Graphical scale (At least two examples from each)	**06**	
3.	**Basic of map projection**	1. Definition and types of map projection 2. Basic Concepts of Projection: Latitude, Longitude, Parallel of latitude, Meridian of longitude, Prime meridian, Equator, Direction 3. Calculation of time basis on meridian and GMT (Calculation of minimum two examples)	**04**	
4.	**Construction, properties and use of map projections**	1. Zenithal Projection a. Zenithal Polar Gnomonic Projection 2. Conical Projection a. Conical projection with one standard parallel/Simple conical projection 3. Cylindrical Projection a. Cylindrical equal area projection 4. Mercator projection (At least two examples from each projection)	**07**	

Reference Books:

1. Sharma J. P., 2010, Prayogic Bhugol, Rastogi Publishers, Meerut.
2. Singh R. L. and Singh R. P. B., 1999, Elements of Practical Geography, Kalyani Publishers.
3. Slocum T. A., Mcmaster R. B. and Kessler F. C., 2008, Thematic Cartography and Geovisualization (3rd Edition), Prentice Hall.
4. Tyner J. A., 2010, Principles of Map Design, The Guilford Press.
5. Sarkar A., 2015, Practical Geography: A Systematic Approach, Orient Black Swan Private Ltd., New Delhi
6. Singh R. L. and Duttta P. K., 2012, Prayogatama Bhugol, Central Book Depot, Allahabad
7. Ahirrao Y., Karanjkhele E. K., 2002, Practical Geography, Sudarshan Publication, Nashik
8. Saptarshi P. G., Jog S. R., Statistical Methods ,
9. Karlekar S. N., 2008, Statistical Methods, Diamond Publication, Pune
10. Kanetkar T. P., Kulkarni S. V., 1986, Surveying and Leveling, Pune Vidyrthi Griha Publication, Pune
11. Kumbhare A., Practical Geography,
12. Saha P., Basu P., 2007, Advanced Practical Geography, Books and Allied (P) Ltd, Kolkata

S.Y.B.A. Geography (S2), Syllabus for Semester IV
Name of the Subject: Cartographic Techniques, Surveying and Excursion / Village / Project Report subject Code: Gg. 201 (B)

Practical Geography-II No. of Credits: 04

Workload: Six Periods per week per batch consisting of 12 Students; however the last batch needs to have more than six students.

(Examination for the course will be conducted at the end of the semester)

Objectives of Course:

1. To introduce the students to the basic and contemporary concepts in Cartography.
2. To acquaint the students with the utility and applications of various Cartographic Techniques.
3. To introduce the latest concepts regarding the modern cartography in the field of Geography.
4. To explain the elementary and essential principles of practical work in Geography.

Course Outcome:

After the successful completion of the course, the students will be able to:

1. Develop practical knowledge and application of cartographical techniques.
2. To make students aware of the new techniques, accuracy and skills of Map Making.

Note :

1. Use of Map stencils, Log tables, Calculators, Statistical Tables is allowed at the time of Examination.
2. Journal completion by the students and the certified by practical in-charge and Head of the Department is compulsory.
3. Students without a certified journal should not be allowed for the practical examination.
4. Each of the practical batches needs a separate question paper.

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Sr. No.	Topic	Sub Topic & Learning Point	No of Practical	Credits
1.	**Introduction to Cartography**	1. Definition of Cartography 2. Development of cartography a. Traditional b. Modern 3. Use of Cartography	**02**	**04**
2.	**Cartographic techniques**	1. Techniques of representation of data (Use and limitations) a. Simple line graph b. Simple bar Graph c. Pie diagram d. Choropleth Map e. Isopleth Method (Isoheight or Isothermal) f. Flow diagram (At least 01 example of each manually and using computer)	**06**	
3.	**Surveying**	1. Definition of Surveying 2. Types of North Direction (True, Magnetic and Grid North) 3. Types of Survey (Any three) a. Plane Table Survey : (Radiation Method and Intersection Method) b. GPS Survey and plotting c. Dumpy level / Auto level survey i) Rise and Fall Method ii) Collimation Method d. Demonstration of Total Station 4. Measurement of land: i) Measurement of survey field ii) Example on measurement of area (Circle, Square, Rectangle, Triangle, Uneven shape) iii) Conversion of area (hector into Acer, Square km into square meter, Square meter to Square feet)	**08**	
4.	**Excursion / village/city survey and report writing**	Study tour to places of geographical interest anywhere in the country Or Socio- economic survey of village/city	**04**	

Reference Books:

1. Sharma J. P., 2010, Prayogic Bhugol, Rastogi Publishers, Meerut.
2. Singh R. L. and Singh R. P. B., 1999, Elements of Practical Geography, Kalyani Publishers.
3. Slocum T. A., Mcmaster R. B. and Kessler F. C., 2008, Thematic Cartography and Geovisualization (3rd Edition), Prentice Hall.
4. Tyner J. A., 2010, Principles of Map Design, The Guilford Press.
5. Sarkar A., 2015, Practical Geography: A Systematic Approach, Orient Black Swan Private Ltd., New Delhi
6. Singh R. L. and Duttta P. K., 2012, Prayogatama Bhugol, Central Book Depot, Allahabad
7. Ahirrao Y., Karanjkhele E. K., 2002, Practical Geography, Sudarshan Publication, Nashik
8. Saptarshi P. G., Jog S. R., Statistical Methods ,
9. Karlekar S. N., 2008, Statistical Methods, Diamond Publication, Pune
10. Kanetkar T. P., Kulkarni S. V., 1986, Surveying and Leveling, Pune Vidyrthi Griha Publication, Pune
11. Kumbhare A., Practical Geography,
12. Saha P., Basu P., 2007, Advanced Practical Geography, Books and Allied (P) Ltd, Kolkata
13. Advanced Practical Geography: 2007, Saha P., Basu P.,Books and Allied (P) Ltd, Kolkata

S.Y.B.A. Geography Syllabus

Name of Subject: Introduction to Geographic Information System

Subject Code: SEC – A, Semester – III

Total Credit:02, Total Periods: 30

Objectives:

1. To introduce the students about the basic concepts of GIS.
2. To acquaint the students with the utility and applications of GIS Technique.
3. To create the awareness about Geospatial technology among the students.
4. To inculcate skill of map making among the students by using GIS Technique.

Sr. No.	Topic	Sub Topics	Teaching Hours	Total Credits
1	Introduction to GIS	1. Definition of GIS 2. Stages of GIS Development 3. Objectives of GIS 4. Components GIS 5. GIS Applications	06	2
2	Data Types & Models	1. Spatial Data – Concept, Sources; Data Models – Raster & Vector 2. Non-spatial Data – Concept, Sources; Data Models – Relational, Network, Hierarchical & Object-orientated	06	
3	Software based Practical	1. Geo-referencing of Toposheet/Map 2. Digitization of Point, Line & Polygon (at least one layer of each) 3. Data Attachment 4. Creation of Layout and Map	18	

Course Outcomes:

On successfully completion of this course, the students will able to -

- Comprehend knowledge about the concepts in GIS.
- Acquire skills of map making using GIS.

Reference Books:

- Burrough, P. A. and McDonnell, R. A. (2000): Principles of Geographical Information Systems, Oxford University Press, New York.
- Chang, K. T. (2008): Introduction to Geographic Information Systems, Avenue of the Americas, McGraw-Hill, New York.
- Debashis, C. and Sahoo, R. N. (2015): Fundamentals of Geographic Information System, Viva Books Private Limited.
- DeMers, M. N. (2008): Fundamentals of Geographic Information Systems, John Wiley and Sons, New Delhi.
- Heywood, I., Cornelius, S. and Carver, S. (2011): An Introduction to Geographical Information Systems, Pearson Education, New Delhi.
- Karlekar, S. (2007): Bhaugolik Mahiti Pranali (GIS), Diamond Publications, Pune.
- Korte, G. B. (2001): The GIS Book, Onward Press, Bangalore.
- Longley, P. A., Goodchild, M. F., Maguire, D. J. and Rhind, D. W. (2002): Geographical Information Systems and Science, John Wiley & Sons, Chichester.
- Lo Albert, C. P., Yeung and Albert K. W. (2002): Concepts and Techniques of Geographical Information Systems, Prentice Hall of India, New Delhi.

- Pandey, J. and Pathak D. (2015): Geographic Information System, TERI Press, The Energy and Resources Institute, New Delhi.
- Paul, A. L., Michel, F. G., Maguire, D. J. and Rhind, D.W. (2002): Introduction to Geographic Information Systems and Science, John Wiley and Sons Ltd.

S.Y.B.A. Geography Syllabus

Name of Subject: APPLIED COURSE OF DISASTER MANAGEMENT

Subject Code: SEC – A Semester - III

Total Credit:02, Total Periods: 30

Objectives:

The objectives of the course are to develop following Skills among the students
1.To introduce basic concepts and fundamental structure of Disaster Management (DM).
2.To inculcate critical thinking and problem-solving abilities on disaster management.
3.To enable students to assess the situation and design plan for Disaster management

Unit no.	Topic	Sub Topics	Teaching Hours	Total Credits
1	Fundamental Concepts, Measurement / Parameter and Types of Disasters	a) Disaster, Hazard, Risk, Vulnerability, Resilient b) Magnitude, Intensity, Frequency, Duration, Spatial dispersion	06	02
2	Phases of Disaster Management Role of Geographers and organizations	a) Concept: Mitigation, Preparedness, Response, Recovery, Rehabilitation. b) Role of Geographers	08	
3	Comparative Assessment of Disaster Management- I	a) Earthquake: - India and Japan b) Flood:- India and Netherland	08	
4	Assessment of Disaster Management- II	Assignment based on Primary or secondary data on any one Geographical scale- local/ regional/national/ global	08	

1. Disaster Management Guidelines, GOI-UND Disaster Risk Program (2009-2012)

2. Damon, P. Copola, (2006) Introduction to International Disaster Management, Butterworth Heineman.

3. Gupta A.K., Niar S.S and Chatterjee S. (2013) Disaster management and Risk Reduction, Role of Environmental Knowledge, Narosa Publishing House, Delhi.

4. Murthy D.B.N. (2012) Disaster Management, Deep and Deep Publication PVT. Ltd. New Delhi.

5. Modh S. (2010) Managing Natural Disasters, Mac Millan publishers India LTD.

6. Dr. Mrinalini Pandey (2017) Disaster Management, Wiley India Pvt. Ltd.

7. Tushar Bhattacharya (2018) Disaster Science and Management, McGraw Hill Education (India) Pvt. Ltd.

9. Arjun Musmade, Jyotiram More (2014) Geography of Disaster Management, Diamond Publication, Pune. (Marathi)

10. P. P. Marathe (2010), Disaster Management Concepts & Practices Diamond Publication, Pune. (Marathi)

S.Y.B.A. Geography Syllabus

Name of Subject: Introduction to Remote Sensing

Subject Code: SEC-B Semester – IV

Total Credit:02, Total Periods: 30

Objectives:

1. To introduce the students about the basic concepts of Remote Sensing.
2. To acquaint the students with the utility of RS and its applications.
3. To inculcate the skill of satellite image interpretation among the students.

Sr. No.	Topic	Sub Topics	Teaching Hours	Total Credits
1	Introduction to Remote Sensing	1. Concept, Definition and Types of RS 2. Development of RS in India 3. Stages in RS 4. Electromagnetic Spectrum 5. Applications of RS	07	2
2	Image Interpretation	1. Elements of Visual Image Interpretation 2. Visual Image Interpretation of Satellite Images i.e. IRS or LANDSAT	07	
3	Software based Practical	1. Image Downloading through Bhuvan/USGS 2. Layer Stacking 3. Image Enhancement 4. Image Classification - Unsupervised	16	

Course Outcomes:

On successfully completion of this course, the students will able to -

- Obtain knowledge about the concepts of remote sensing.
- Acquire skills in visual interpretation of satellite images.

Reference Books:

- Anji Reddy, M. (2008): Textbook of Remote Sensing and Geographic Information System, B.S. Publication, Hyderabad.
- Bhatta B., (2011): Remote Sensing and GIS, Oxford University Press, India.
- Campbell, J. (2002): Introduction to Remote Sensing, Taylor & Francis, London.
- Cracknell, A.P. (1991): Introduction to Remote Sensing, Tylor & Francis, London.
- Gupta, R.P. (1990): Remote Sensing Geology. Springer Verlag.
- Heywood, I., Steve, C. and Cornelius, S. (2003): An Introduction to Geographical Information Systems, Pearson Education.
- Jensen, J. R. (2000): Remote Sensing of the Environment: An Earth resource Perspective, Prentice Hall.
- Jensen, J. R. (2005): Introductory Digital Image Processing, Prentice Hall, New Jersey.
- Joseph, G. (2004): Fundamentals of Remote Sensing, Universities Press, Hyderabad, India.
- Karlekar, S. (2006): Doorsamvedan - Remote Sensing (Marathi), Diamond Publications, Pune.
- Karlekar, S. (2017): Dursamvedan Aani Bhougolik Mahiti Pranali (Marathi), Diamond Publications, Pune.
- Lillesand, T. M., Kiefer, R. W. and Chipman, J. W. (2016): Remote Sensing and Image Interpretation, 6th Edition, Wiley India.
- Rao R. M. (2002): Geographical Information Systems, Rawat Publication.
- Sabins, F. F. (1996): Remote Sensing: Principles and Interpretation, W.H. Freeman and Company, San Francisco.

S.Y.B.A. Geography Syllabus

Name of Subject: APPLIED COURSE OF Travel & Tourism

Subject Code: SEC – B Semester -IV

Total Credit:02, Total Periods: 30

Objectives

1. To develop basic framework to understand the various elements of tourism management.
2. To evaluate the role of transport in travel and tourism industry.
3. To develop the skills to arrange, manage and implement various types of tours.

Skills to be developed:

1. Students will be able to perform online as well as offline booking and cancellation procedures for different available modes of travel and tourism.
2. Students will be able to acquire earning skills in tourism industry.

Introduction to Tourism			
Unit No.	**Topic**	**Learning Point**	**Periods**
1	**Introduction to Travel and Tourism**	1.1 Basic concepts: Travel & Tourism 1.2 Types of Tourist and Tourism 1.3 Types of transportation	**05**
2	**Local Tourism**	2.1 Concept and need of local tourism 2.2 Introduction to local tourist places	**05**
3	**Tour planning and Skill development**	3.1 Basic skills: Communication, Time Management, Computer operating, online booking, Net banking, Cancellation of booking and ticket, etc. 3.2 Framing the tour plan (Itinerary): Budget (Costing), Duration, Insurance, Route and other requirements for individual, family, group and mass level tours 3.3 Promotion of tourism	**10**
4	**Project work and Visit to tourist place**	4.1 One short tour (Not more than two days duration) and Preparation of tour report.	**10**

Text Books:

1. Bhatia. Tourism Development (New Delhi, Sterling)
2. Seth: Tourism Management (New Delhi, Sterling)
3. Kaul: Dynamics of Tourism (New Delhi, Sterling)
4. Mill and Morrison – The Tourism system an Introductory Text (1992) Prentice Hall
5. Cooper, Fletcher, Tourism, Principles and practices (1993) Pitman
6. Burkart and Medlik Tourism, Past, Present and Future (1981) Heinemenn, ELBS.
7. P.S. Gill, Dynamices of Tourism (4 Vols) Anmol Publication.
8. P.C. Sinha, Tourism Management. Anmol Publication.

References:

1. Travel Industry : Chunky Gee et-al
2. Tourism Systems - Mill and Morisson
3. Tourism Management Vol - 4 - P.C. Sinha
4. Tourism Development - R. Gartner
5. Studies in Tourism - Sagar Singh
6. Tourism: Principles and Practices - Cooper C., Fletcher J., Gilbert D and Wanhil.
7. Tourism: Principles and Practices - McIntosh , R.W.
8. Tourism : Past, Present and Future - Burkart & Medli

Savitribai Phule Pune University

(Formerly University of Pune)

M.A./M.Sc.-II (Geography)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2020-2021

Title of the Course: M.A./M.Sc. (Geography)

Preamble

Introduction:

Savitribai Phule Pune University has decided to change the syllabi of various faculties from June 2020. Taking into consideration the rapid changes in science and technology and new approaches in different areas of Geography and related subjects, Board of Studies in Geography after a thorough discussion with the teachers of Geography from different colleges affiliated to the Savitribai Phule Pune University, Pune has prepared the syllabus of M.Sc. /M. A. Semester - III and Semester- IV (w.e.f. 2020-21) Geography course under the Choice Based Credit System (CBCS). The model curriculum as developed by U.G.C. is used as a guideline for the present syllabi.

Aims and Objectives of the new curriculum:

i) To maintain updated curriculum.
ii) To take care of fast development in the knowledge of Geography.
iii) To enhance the quality and standards of Geography Education.
iv) To provide a broad common frame work, for exchange, mobility and free dialogue across the Indian Geography and associated community.
v) To create and aptitude for Geography in those students who show a promise for higher studies and creative work in Geography.
vi) To create confidence in others, for equipping themselves with that part of Geography which is needed for various branches of Sciences or Humanities in which they have aptitude for higher studies and original work

Savitribai Phule Pune University

Faculty of Science and Technology
Geography MA/MSc – II
Semester – III

Course Code	Core Compulsory Theory Paper (CCTP)	Choice Based Optional Paper (CBOP)	Theory / Practical	Credit	Core Compulsory Practical Paper (CCPP)	Credit
GGUT-235	Geoinformatics-II	-	-	04	-	04
GGUT-236	Geographical Thoughts	-	-	04	-	04
One of the following according to specialization from CCTP						
GGUT-237	Tropical Geomorphology	-	-	04	-	04
GGUT-238	Applied Climatology	-	-	04	-	
GGUT-239	Geography of Rural Development	-	-	04	-	
GGUT-240	Urban Geography	-	-	04	-	
Choice Based Optional Paper (CBOP) (1 Theory + 1 Practical)						
		GGDP-241	Practical in Geoinformatics	02	-	04
		GGUT-242	Hydrology	02		
		GGUT-243	Watershed Management	02	-	
		GGDP-244	Practical in Multivariate Statistics	02	-	
One of the following according to specialization from CCPP						
				GGUP-245	Practical in Geomorphology	04
				GGUP-246	Practical in Climatology	
				GGUP-247	Practical in Economic Geography	
				GGUP-248	Practical in Population and Settlement Geography	
Total Credits of Semester - III						**20**

Savitribai Phule Pune University
Faculty of Science and Technology
Geography MA/MSc – II
Semester - IV

	Core Compulsory Theory Paper (CCTP)	**Choice Based Optional Paper (CBOP)**	**Theory / Practical**	**Credit**	**Core Compulsory Practical Paper (CCPP)**	**Credit**
GGUT-249	Geography of India	-	-	-	-	04
GGUT-250	Oceanography	-	-	-	-	04
GGUT-251	Research Methodology	-	-	-	-	04
Choice Based Optional Paper (CBOP) (1Theory + 1Practical)						
		GGUT-252	Geography of Soils	02		04
		GGDP-253	Practical in Geostatistics	02		
		GGUT-254	Political Geography	02		
		GGUT-255	Regional Planning	02		
		GGDP-256	Practical in Watershed Analysis	02		
		GGDP-257	Interpretation of Topographical Maps and GPS Survey	02		
Core Compulsory Practical Paper (CCPP)						
				GGUT-258	Geography of World	04
				GGUP-259	Dissertation/ Research Project	04
					Total Credits of Semester - IV	**20**

Savitribai Phule Pune University, Pune

MA/MSc - II Syllabus in Geography (Credit System)
Revised Syllabus (from June, 2020)

Course: GGUT-235 Geoinformatics II

No. of Credits: 04 **No. of Periods: 60**

Topic No.	Topic	Subtopics	No. of Periods
1	Introduction to Remote Sensing	i. Remote Sensing: definition, concept and principles ii. History and development of Remote Sensing in India	05
2	EMR and EMS	i. EM Radiation and EM Spectrum ii. Interaction of EMR with atmosphere iii. Interaction of EMR with Earth's surface iv. Black body radiation, Laws of radiation	10
3	Platforms and Satellites	i. Platform: Types and characteristics ii. Satellites: Geo-stationary and Sun synchronous iii. Earth Resources Satellites: LANDSAT, SPOT, IRS, IKONOS satellite series iv. Meteorological satellites: INSAT, NOAA, GOES	15
4	Sensors	i. Sensors: Across track (whiskbroom) and Along track (pushbroom) scanning ii. Optical mechanical scanners: MSS, TM, LISS, WiFS, PAN	08
5	Resolution	i. Spatial Resolution ii. Spectral Resolution iii. Temporal Resolution iv. Radiometric Resolution	05
6	Image Interpretation Techniques	i. Basic principles, types, steps and elements of image interpretation ii. Techniques of visual interpretation and interpretation keys	05
7	Aerial Photography	i. Aerial camera: Components ii. Aerial Photography: Definition and characteristics iii. Types of aerial photographsTypes of Aerial Photographs Based on the Position of the Cameral Axis iv. Types of Aerial Photographs Based on Scale v. Geometry of an aerial photograph	12

Reference Books:

1. Anji Reddy, M. (2004): Geoinformatics for environmental management.B.S. Publications
2. Campbell, J.B. (2002): Introduction to Remote sensing. Taylor Publications.
3. Chang.T.K. (2002): Geographic Information Systems. Tata McGrawHill
4. Drury, S.A. (1987): Image Interpretation in Geology. Allen and Unwin.
5. Francis Tar Bernhardsen. Geographical Information Systems. John Wiley.
6. Gupta, R.P. (1990): Remote Sensing Geology. Springer Verlag.
7. Heywood.I, Cornelius S, CrverSteve. (2003): An Introduction to Geographical Information Systems. Pearson Education
8. Jensen, J.R. (2000): Remote Sensing of the Environment: An Earth resource Perspective Prentice Hall.
9. Joseph George (2003): Fundamentals of remote sensing. Universities Press.
10. Lillesand, T.M., and Kieffer, R.M. (1987): Remote Sensing and Image Interpretation, John Wiley.
11. Ram Mohan Rao. (2002): Geographical Information Systems. Rawat Publication.
12. Sabbins, F.F. (1985): Remote sensing Principles and interpretation. W.H.Freeman and company
13. Skidmore A., (2002): Environmental modeling with GIS and Remote Sensing. Taylor and
14. Wise S., (2002): GIS Basics. Taylor Publications

Savitribai Phule Pune University, Pune

MA/MSc - II Syllabus in Geography (Credit System)
Revised Syllabus (from June, 2020)

Course: GGUT-236 Geographical Thoughts

No. of Credits: 04 **No. of Periods: 60**

Topic No.	Topic	Subtopics	No. of Periods
1	Historical Development of Geographical Thought	i. A brief account of Greek, Roman, and Indian Schools of thoughts ii. Contributions of Herodotus, Eratosthenes, Strabo, Ptolemy iii. brief account of Arab School iv. Contributions of Marco Polo, Columbus, Vasco-Da-Gama and Captain Cook v. A brief account of different schools of thought – German, French, British and American vi. Contributions of Kant, Humboldt, Ritter, W. M. Davis.	20
2	Dualism in Geography	i. Determinism and Possibilism ii. Systematic versus Regional Geography iii. Physical versus Human Geography	10
	Paradigms,	i. Hypothesis, Theories and Laws ii. Paradigms in Geography	10

3	System approaches and Models in Geography	iii. System approaches in Geography iv. Types of Models used in Geographical Studies	
4	Recent Trends in Geography	i. Field survey process studies and experimental studies ii. Quantification and application of statistical techniques in Geography iii. Computer based Cartography, Remote Sensing, GIS and Geo-informatics	10
5	Applied Geography	i. Definition, Need and Significance ii. Application in land-use planning, regional planning and urban planning, resource management, environmental management, natural hazards, scenic evaluation	10

Reference Books:

1. Cooke, R. U. and Doornkamp, J. C. (1974): Geomorphology in Environmental Management, Clarendon Press, Oxford.
2. Coffey, W. J. (1981): Geography : Towards a general spatial systems approach, Mathuen, London
3. Dikshit, R. D. (1997): Geographical Thought: A Contextual History of Ideas, Pub. By A. K. Ghosh, Prentice – Hall of India Pvt. M 97, New Delhi.
4. Frazire, J. W. (1982): Applied Geography, Prentice Hall, Englewood Cliffs.
5. Hertshone, R. (1959): Perspectives of Nature of Geography, Rand Mac Nally and Co.
6. Hussain, M. (1995) : Evolution of Geographical Thought, Rawat Pub., Jaipur
7. Singh I. (2006): Diverse aspect of Geographical Thought, ALFA Publications, New Delhi

Savitribai Phule Pune University, Pune

MA/MSc - II Syllabus in Geography (Credit System)
Revised Syllabus (from June, 2020)

Course: GGUT-237 Tropical Geomorphology

No. of Credits: 04 **No. of Periods: 60**

Topic No.	Topic	Subtopics	No. of Periods
1	Introduction to Tropics	i. Tropical Environment – Definition ii. Peculiarities of tropical climate iii. Classification of Tropics iv. Morphogenetic regions - Temperature, rainfall, humidity, vegetation	06
2	Tropical Weathering	i. Factors influencing the weathering - climatic, geomorphic, biotic, geologic, chronological and site factors ii. Solubility and Mobility of minerals in Tropics iii. Weathering profile: Deep weathering profiles -	12

		nature, development and distribution iv. Tropical Soils: Process of soil formation in Tropics, Clay minerals	
3	Duricursts and Laterites	i. Duricursts and Laterites – Definition ii. Indurated laterites - Properties and world distribution iii. Classification by site, Morphology and chronology iv. A complete account of various division of Lateritic Profile v. Landform development on laterites vi. Distribution of laterites in India vii. Theories of origin of iron in laterites	10
4	Denudation in Tropics	i. Mass movement: Types & Processes ii. Slope wash iii. Process of chemical denudation iv. Tropical rivers - process of erosion and deposition	08
5	Tropical Landscape	i. Tropical Terrain – Relief characteristics ii. Slope and valley forms iii. Domed and boulder inselbergs iv. Hillslopes and Pediments v. Tropical coasts	08
6	Tropical Planation	i. Formation and Types of planation surfaces ii. Morphology of planation surfaces iii. Peneplains, Pediplains, Etchplains iv. double surface of planation	08
7	Landform development in the tropics	i. Role of tectonics and climatic change ii. Nature of changes during Quaternary changes in climate and vegetation	08

Reference Books:

1. Andrew Goudie, (1985): Duricrusts in tropical and subtropical landscapes, Allen Unwin, London.
2. Andrew Goudie, (1987): Environmental change.
3. Budel J. (1982) Climatic geomorphology, Princeton University Press.
4. Douglas j. & Spencer, (1985): Environmental change & Tropical geomorphology, George Allen & Unwin.
5. Feniran A. 7 Jeje L.K. (1983): Humid tropical geomorphology
6. Thomas, M. F. (1994): Geomorphology in the Tropics, John Wiley and Sons, Chichester
7. Thomas M.F. (1974): Tropical geomorphology, McMillan, London.
8. Tricart J. (1972): Landforms of the humid tropics, forests and Savanna, Longman, London.

Savitribai Phule Pune University, Pune

MA/MSc - II Syllabus in Geography (Credit System)

Revised Syllabus (from June, 2020)

Course: GGUT-238 Applied Climatology

No. of Credits: 04 **No. of Periods: 60**

Topic No.	Topic	Subtopics	No. of Periods
1	Introduction	i. Nature and scope ii. Development of applied climatology iii. Atmospheric concern and awareness iv. Climate impact assessment	06
2	Basic climatic elements	i. Radiation - Basic relations, Radiation laws, distribution, instruments to measure radiation ii. Temperature - Basic relations, distribution, soil temperature, instruments to measure temperature iii. Moisture - Basic relations, humidity, clouds, precipitation, rain, snow, sleet, hail, rime, dew, distribution and instruments to measure Precipitation iv. Evaporation and evapo-transpiration – Basic relations, soil plant relationship, empirical methods to estimate evapo-transpiration, distribution and Instruments v. Pressure – Basic relation, distribution and instruments to measure pressure vi. Wind - Basic relations, turbulence, gustiness Instruments	10
3	Agro-climatology	i. Climate and soil ii. Climate and soil management iii. Climate pests and diseases iv. Micro-meteorological changes and behaviour of pests and diseases v. Climate and livestock vi. Climate and crops vii. Artificial control of plant environment	10
4	Climate and Human behaviour	i. Human bio-meteorology ii. Climate, clothing and human control iii. Climate and health	07
5	Urban Climate	i. Nature of global environmental change ii. Nature of urban climates iii. Impact of urban climate on GEC iv. Urban heat Island v. 5. Urban air Pollution problems	08
6	Climate industry, commerce and engineering	i. Significant climate variables ii. Industrial and commercial activities iii. Construction operations	05

7	Engineering applications	i. Heating degree-days. cooling towers ii. Traction ability	03
8	Climate and Transportation	i. Effect of climate on land transport ii. Effect of climate on water transport iii. Effect of climate on air transport – clear air turbulence	06
9	Use of Remote sensing in agroclimatology	i. Satellite programming for crop condition ii. Meteorological study monitoring iii. Detection of plant stress iv. Canopy transpiration and crop stress	05

Reference Books:

1. Geiger, Rudolf (1966): The Climate near the Ground, Hardward University Press.
2. Hobbs, John E. (1980): Applied Climatology, Dawson West View Press.
3. Lal, M. (ed.) (1993): Global Warming, Tata McGraw Hill, New York.
4. Mather, J.R. (1974): Climatology: Fundamentals and Applications, McGraw Hill, New York.
5. Oliver, John E. (1973): Climate and Man's Environment, John Wiley and Sons, New York.
6. Oliver, John E. (1981): Climatology, Selected Applications, V.H. Winston and Sons, London.

Savitribai Phule Pune University, Pune

MA/MSc - II Syllabus in Geography (Credit System)

Revised Syllabus (from June, 2020)

Course: GGUT-239 Geography of Rural Development

Credit: 04 **Periods: 60**

Topic No.	Topic	Subtopics	Periods
1	Introduction to Rural Development	i. Concept of Rural Development ii. Geography and Rural Development iii. Nature and Scope of Rural Development iv. Amis and Objectives of Rural Development	06
2	Factors affecting on Rural Development	i. Geographical factors ii. Social Factors iii. Economic Factors iv. Rural Demography	04

3	Rural Basic Services and Infrastructures	i. Rural housing and Rural health ii. Drinking water and Sanitation iii. Rural electrification and Energy iv. Rural Education v. Rural Connectivity (Transportation and Communication)	08
4	Rural Development Planning	i. Planning for Rural Development ii. Planning Process- Level and Types of planning iii. Multilevel planning, District Planning, Grassroots Planning iv. Rural Development Planning in India v. Integrated Rural Development Programme (IRDP), MGNREGA & NRLM	10
5	Government Policies and Rural Development	i. Role of Government in Rural Development ii. Major Issues and Challenges in context to India iii. Green Revolution and Rural Development	06
6	Role of Rural Institutions in Development	i. Definition, Types, Structure and Characteristics of Rural Institutions ii. Panchayati Raj Institutions : Structure, Functions and Problems iii. Cooperatives, NABARD, Regional Rural Bank, Primary Agricultural Credit Societies and SHGs: Structure and Functions iv. Non-Govt. Organizations (NGOs) & Rural Development	10
7	Application of computer and information technology in Rural Development	i. E-Governance, e-agriculture, Generation of Resource data Sources acquisition, structure, transformation into map/diagram/visual presentation for better comprehension. Application of Cartographic techniques ii. Application IT and GIS in rural development like smart village	08
8	Rural Management	i. Smart Village Concept and structure ii. Watershed Management and Rural Development iii. Problems and Prospects of Rural development in India iv. Management of Tribal Village v. Case study of Rural Development (Ralegan Shiddi or Hiware Bazar)	08

Reference Books:

1. Chamola, S. D. and Bharati Anirudh, “Agriculture and Rural Development in India”, Global Vision Publishing House.
2. Desai V. (1991): “Fundamentals of Rural Development”, New Delhi: Rawat Publications

3. Economic Survey of India: 2019
4. Katar Singh "Rural Development: Principles, Policies and Management", (Sage Texts) 3rd Edition
5. Khullar, R.D. (2019): "India: A Comprehensive Geography" Kalyani Publishers
6. Lekhi , R.K.: "The Economics of Development and Planning", Kalyani Publishers, New Delhi
7. Manual on municipal solid waste management – Govt. of India Publication
8. Meier, Gerald (1987): Leading Issues in Economic Development New Delhi: Oxford Uni. Press
9. Nelson Nemerow: "Theories and Practices of Industrial waste treatment"
10. Prasad, B.K. (2003): "Rural Development: Concept, Approach and Strategy", New Delhi: Sarup & Sons
11. Rau, S.K. (2001): Global Search for Rural Development Hyderabad: NIRD
12. Satya Sundaram, I. (2002): "Rural Development" Mumbai: Himalaya, 2002

Savitribai Phule Pune University, Pune

MA/MSc - II Syllabus in Geography (Credit System)
Revised Syllabus (from June, 2020)

Course: GGUT-240 Urban Geography
No. of Credits: 04 **No. of Periods: 60**

Topic No.	Topic	Subtopics	No. of Periods
1	Introduction to Urban Geography	i. Nature of Urban Geography ii. Scope of Urban Geography iii. Significance of Urban Geography iv. Relation to other disciplines	07
2	Urbanization	i. Meaning of Urban settlement and urbanization. ii. Brief review of spatial- temporal variations in urbanization in the world iii. Urbanization curve iv. Contemporary factors of urbanization	07
3	Urban Morphology	Models of urban structure: i. Park and Burgess Model ii. Homer Hoyet Model iii. Harris and Ullman Model iv. Characteristics and demarcation of CBD	07
4	Urban Classification	i. Criteria used for classification ii. Functional classification of towns and cities	04

5	Urban Demography	Characteristics of urban population: i. Growth of Urban population ii. Density of population in cities iii. Age, sex and occupational structure	08
6	City and its Region	i. Concepts of city region and various synonymous terms used ii. Criteria used to demarcate the city region	04
7	Central Place	i. Christaller's Central Place Theory ii. Rank-size relationship and rank- size rule iii. Hierarchy of urban settlements	08
8	Contemporary Urban issues	i. Price of land and vertical and horizontal growth of cities ii. Scarcity of housing and growth of slums iii. Problems of civic amenities iv. Urban transport problem v. Urban Environmental pollution vi. Urban floods, health and hygiene	08
9	Urban policy and planning	i. Urban development policy in India ii. Need &Element of city plan iii. Use of GIS in Urban Planning	07

Reference Books:

1. Bhattacharya: Urban Development in India, Shree publication
2. Brian, R.K. (1996): Landscape of Settlement Prehistory to present, Routledge, London
3. Careter (1972): Fourth edition: The study of Urban Geography, Arnold, London
4. Gadakh B.L. and Jaybhaye R. G. (2017): Urban Sprawal Analysis of Nashik City. Scholar press
5. Hall P. (1992): Urban and Regional Planning, Routedge, London
6. K. Siddharth and S. Mukherji : Cities, Urbanization and Urban Systems
7. Kundu, A. (1992): Urban Development and Urban Research in India, Khanna Publication
8. Mayer and Kohan: Readings in Geography
9. Northam: Urban Geography
10. Roy Turner: Indian's Urban Future
11. R.B Mandal-V.G A Textbook (Concept publishing Company
12. Shah Manzooor Alam: Urbanization in Developing Countries
13. Singh.K.and Steinberg.F. (eds)(1998): Urban India in Crisis. New Age Interns
14. Urban Geography: Tim Hall
15. Verma: Urban Geography, Rawat, Jaipur

Savitribai Phule Pune University, Pune

MA/MSc - II Syllabus in Geography (Credit System)
Revised Syllabus (from June, 2020)

Course: GGDP-241 Practical in Geoinformatics

No. of Credits: 02 **No. of Periods: 30**

Topic No.	Topic	Subtopics	Practical (3 Hours)
1	Aerial Photography	Measurements and Interpretation i. Scale and height (using parallax bar) ii. Visual Interpretation of single aerial photograph iii. Interpretation of stereo pair using Stereoscope	02
2	Satellite Images	i. Visual interpretation of LISS, PAN, WiFS ii. Cartosat Data, IKONOS and Quick Bird	02
3	Spatial Database	Layer Generation i. Raster: Full Grid, Chain Codes and Run Length Codes ii. Vector: Manual Digitization, Digitization Errors and Topology Building	04
4	GIS operations	i. Raster and vector overlay, map algebra (AND, OR) from a toposheet quadrant ii. Spatial interpolation from a toposheet quadrant iii. GIS operations using open source GIS softwares	02

Reference Books:

1. Burrough, P.A. and R.A. McDonnell (2000): Principles of Geographical Information System, Oxford University Press.
2. Chang Kang-tsung. (2002): Introduction to GIS, Tata McGraw Hill, New Delhi.
3. C. P. Lo and Albert, K. W. Yeung (2002): Concepts and Techniques of Geographic Information System, 2002Prentice –Hall, India.
4. George Joseph (2003): Fundamentals of Remote Sensing, Universities Press, Hyderabad
5. Kang – Tsung – Chang, (2002): Introduction to Geographical Information System, McGraw Hill.
6. J. R. Jensen, (2003) : Remote Sensing of Environment, An Earth Resource Perspective, Pearson Education Pvt. Ltd., New Delhi
7. P. A. Burrough and R. A. McDonnell, (2000): Principles of Geographical Information System, Oxford University Press.

8. Paul A. Lonfley, Michel F. Goodchild, D J. Maguire and D.W. Rhind (2002): Introduction to Geographic Information Systems and Science, John Wiley and Sons Ltd.
9. Vaidyanadhan, R. (1973): Index to a set of 70 aerial stereopairs, UGC, New Delhi.

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MA/MSc - II Syllabus in Geography (Credit System)
Revised Syllabus (from June, 2020)

Course: GGUT-242 Hydrology

No. of Credits: 02 **No. of Periods: 30**

Topic No.	Topic	Subtopics	No. of Periods
1	Introduction to Hydrology	i. Meaning and definition of Hydrology ii. The hydrologic cycle iii. The hydrologic budget iv. Applications of Hydrology	06
2	Hydrologic Measurements and Data Sources	i. Units of measurement ii. Sources of hydrologic data iii. Measurements hydrologic variables	06
3	Precipitation	i. Water vapor: Measures of atmospheric moisture ii. Precipitation: Forms and Types iii. Global distribution of precipitation iv. Probable Maximum Precipitation (PMP) v. Gross and net precipitation	06
4	Interception and Depression Storage	i. Interception ii. Throughfall iii. Depression storage	06
5	Evaporation and Transpiration	i. Evaporation ii. Method of evaporation control iii. Transpiration iv. Methods of transpiration control v. Evapotranspiration	06

Reference Books:

8. Baker, V.R., Kochel, R.C. and Patton, P.C., (1988): Flood Geomorphology, Wiley, New York.
9. Bedient, P.B. and Huber, W.C., (1989): Hydrology and floodplain analysis, Addison-Wesley Publication Company, New York.
10. Chow, V.T., (1964): Handbook of Applied Hydrology. McGraw-Hill, New York.
11. Eagleson, P.S., (1970): Dynamic Hydrology, McGraw-Hill Book Company, New York.
12. Hamblin, W.K., (1989): The Earth's Dynamic Systems, MacMillan Publishing Company, New York.

13. Kale, V.S. and Gupta, A., (2001): Introduction to Geomorphology, Orient Longman, Calcutta.
14. Kazmann, R.G., (1972): Modern Hydrology, Harper and Row Publishers, New York.
15. Linsley, R.K. (Jr), Kohler, M. A. P. and Joseph L. H., (1975): Applied Hydrology, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
16. Mutreja, K.N., (1995): Applied Hydrology. Tata McGraw-Hill Publishing Company Ltd. New Delhi.
17. Raghunath, H.M., (1985): Hydrology: Principles, Analysis and Design. Wiley Eastern Ltd, New Delhi.
18. Rodda, J.C., Downing, R. A. and Law, F.M., (1976): Systematic Hydrology, Newnes-Butterworths, London.
19. Shaw, E.M., (1988): Hydrology in Practice. Van Nostrand Reibhold Int. Co. Ltd, London.
20. Strahler, A.A. and Strahler, A. N., (2002): Physical Geography: Science and Systems of the Human Environment, John Wiley & Sons, INC.
21. Strahler, A.H. and Strahler, A. N., (1992): Modern Physical Geography, John Wiley & Sons, INC.
22. Strahler, A.N., (1965): Introduction to Physical Geography, John Wiley & Sons, INC.
23. Viessman, W. and Lewis, G., (2003): Introduction to Hydrology, Pearson Education, Singapore.
24. Ward, R., (1978): Floods. A Geographical Perspective. The Mac Millan Press Ltd, London.
25. Wilfried, B., (2005): Hydrology: An Introduction. Cambridge University Press, Cambridge.
26. Wisler, C.O. and Brater, E. F., (1959): Hydrology, John Wiley and Sons, Tokyo.

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MA/MSc - II Syllabus in Geography (Credit System)
Revised Syllabus (from June, 2020)

Course: GGUT-243 Watershed Management
No. of Credits: 02 **No. of Periods: 30**

Topic No.	Topic	Sub topics	Periods
1	Concept of watershed management	i. Definition, concepts of watershed; watershed management, Principle of watershed management ii. Necessity of watershed management iii. Problems in watershed management	06
2	Characteristics of watershed	i. Delineation of Watershed ii. Characteristics: Size , Shape , Physiography , Climate, Drainage, Land use, Vegetation, Geology and Soils, Hydrology, Socioeconomics	06

3	Hydrological process in watershed	i. Precipitation, interception, infiltration, evaporation, evapo-transpiration, surface runoff, ground water-flow, water budget ii. Hydrological cycle	06
4	Water and soil conservation in watershed	i. Water conservation: Nala Bunding, Check dams, Farm ponds, Percolation tanks, Artificial recharge ii. Soil conservation- Contour Bunding, Gully plugging, Trench cum mound, Levelling	06
5	Watershed development	i. Application of Remote Sensing and GIS in watershed management ii. Integrated watershed development plans iii. Importance of watershed management in national development.	06

Reference Books

1. Dhruvanarayana, V.V., Sastry, G., Patnaik, U.S.: Watershed Management
2. Kakde, B.K.: Watershed Manual – A Guide for Watershed Development Practitioners and Trainers, BAIF Development Research Foundation, Pune.
3. Murthy, JVS: Watershed Management, New age International Publishers.
4. Rajesh Rajora: Integrated Watershed Management- A Field Manual for Equitable, Productive and Sustainable Development, Rawat Publication, Jaipur.
5. Singh Rajvir: Watershed Planning and Management, 2nd Edition, Yash Publishing House, Bikaner, India.
6. Suresh,R.: Soil and Watershed Conversation Engineering, 2nd Edition, Standard Publication Distributors, Delhi.
7. Schwab,G.O. et al: Soil and Water Conservation Engineering, 4th Edition, John Wiley & Sons.

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MA/MSc - II Syllabus in Geography (Credit System)
Revised Syllabus (from June, 2020)

Course: GGDP-244 Practical in Multivariate Statistics

No. of Credits: 02 **No. of Periods: 30**

Topic No.	Topic	Subtopics	Practical (3 hours)
1	Introduction	i. Bivariate & Multivariate Analysis ii. Objectives of Multivariate Analysis a. Data reduction or simplification b. Sorting and Grouping c. Prediction d. Hypothesis Testing	01
2	Matrix Algebra	i. Matrix : a. Definition, Elements, Order and Types b. Determinant of a matrix c. Addition, subtraction and multiplication of matrices	02

		d. Transpose, adjoint and inverse of matrix e. Determination of unknowns in a simultaneous equation by matrix solution using (i) – Crammer's rule and (ii) Inverse method	
3	Curvilinear bivariate Relationships	i. Computation, plotting and interpretation of a. Second Degree (Quadratic) equation, $Y= a + b_1 X^1 + b_2 X^2$ b. Third Degree (Cubic) equation $Y= a + b_1 X^1 + b_2 X^2 + b_3 X^3$	02
4	Multivariate Analysis	i. Computation of multiple regression equations involving two and three independent variables (by using variance – covariance matrix) Calculation of Co-efficient of multiple determination (R^2) and Explained Variance (EV) a. Second order multiple regression equation, $Y= a + b_1 X_1 + b_2 X_2$ b. Third order multiple regression equation, $Y= a + b_1 X_1 + b_2 X_2 + b_3 X_3$	03
5	Trend Surface Analysis	i. Importance of Trend surface analysis in the study of spatially distributed data. Examples of TSA ii. Computation, application and plotting of linear trend surface, Interpolation of trends. iii. Ideas of quadratic and cubic trend surfaces.	02

Reference Books:

1. Clark W. A. V. and Hosking P. L. (1986): Statistical methods of geographers.
2. Collins (1984): Introduction to multivariate analysis, Edward Arnold.
3. Fortheringham, A.S., Brunsdon, G., and Charlton, M., (2000): Quantitative Geography, Perspectives on Spatial Data Analysis, SAGE.
4. Jonston, R. J. (1979): Multivariate statistics in Geography, Longman, London.
5. Karlekar S. N. and Kale M. (2005): Statistical Analysis of Geographical Data, Diamond Publication, Pune.
6. Shaw G. and Wheller D. (1985): Statistical techniques in geographical analysis. John Wiley and Sons, New York.
7. Sumner G. J. (1978): Mathematics of Physical Geographers, Edward Arnold.

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MA/MSc Syllabus in Geography (Credit System)
Revised Syllabus (from June, 2020)

Code No: GGUP-245 Practical in Geomorphology
No. of Credits: 04 **Total Periods:60**

Topic No	Topics	Subtopics	Practical (3 Hours)	No. of Sheets (Minimum)
1.	Geomorphological mapping	Use of symbols (Hert, 1986) i. Chart showing symbols ii. Preparing a geographic map of a small area / basin –toposheets / field iii. Interpretation of the map in terms of forms and processes	04	02
2.	Hill slope Analysis	Direct and indirect measurements i. Using clinometers / profiles from toposheets, ii. Identification of segments iii. Dalrymple et al's nine- unit landsurface model- Understanding nature of processes	04	02
3.	Field Survey	Channel cross sections/ Beach/Hill slope profile Soil/sediment sample collection i. Surveying and plotting of stream or gully channel cross–section or beach profile or slope profile. ii. Quadrat or Traverse survey of sediment size on river bed /beach. iii. Analysis of shape and size of coarse sediment(Zingg's classification) GPS survey Preparation of beach, river channel maps etc. using GPS	07	04
4	Laboratory work	Soil/Sediment analysis i. Analysis of 1 sandy and 1 Clayey sample ii. Plotting of data on probability graph paper and iii. Estimation of grain size parameters iv. Interpretation of results	05	02

(Note : Fieldwork / Field Visit for a duration of not more than 5 days should be undertaken for the course selected)

Reference Books:

1. Aackombe, R. V. and Gardiner, V. (1983): Geomorphological Field Manual
2. Chorley, R. J., Schumm, S. A. and Sugden, D.E. (1984) : Geomorphology, Methuen, London
3. Goudie, A. (1990): Geomorphological Techniques, Unwin Hyman, London
4. Hart, M. G. (1986): Geomorphology, Pune and Applied George Allen andUnwin
5. Kale, V. S. and Gupta, A. (2001): Introduction to Geomorphology, Orient Longman, Culcutta
6. King, C.A.M. (1966): Techniques in Geomorphology, Edward Arnold,London George Allen andUnwin, London

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MA/MSc Syllabus in Geography (Credit System)
Revised Syllabus (from June, 2020)

Code No: GGUP-246 Practical in Climatology
No. of Credits: 04 **Total Periods: 60**

Topic No	Topics	Subtopics	Practical (3 Hours)	No. of Sheets (Minimum)
1.	Weather Elements	i. Instrumentation and measurement techniques of weather elements and processing of weather data (5-10 years data)	05	04
2.	Station Model	i. Synoptic data: Coding, decoding and plotting of synoptic data	03	03
3.	Indian Daily Weather Report (IDWR)	i. Study and Analysis of IDWR Study of IDWR and analysis of Temperature, Air Pressure, etc. for various stations. Charting of Systems (4 years)	05	04
4	Water Balance	i. Computation of water balance for 4 stations in different rainfall zones and irrigation scheduling	05	04

5	Climate Architecture Analysis	**i.** Sketch design recommendations: The Mahoney tables: Air temperature, humidity, Rain and Wind, Diagnosis of climatic stress	02	03

Reference Books:

1. Indian Daily Weather Report, IMD, Pune.
2. Oliver, John E. (1973): Climate and Man's Environment, John Wiley and Sons, New York.
3. Thornthwaite, C. W. and Mather, J. R. (1957): Instructions and Tables for computing potential evapo-transpiration and water balance, Drexel Institute of Technology, Laboratory of Climatology.
4. WMO No. 8 (1983): Guide to meteorological instruments and methods of observations

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MA/MSc - II Syllabus in Geography (Credit System)
Revised Syllabus (from June, 2020)

Course: GGUP- 247 Practical in Economic Geography
Credit: 04 **Periods: 60**

Topic No.	Topic	Subtopics	Practical (3 Hours)
1	Techniques in Agricultural Geography	i. Crop Combination: Thomas Method ii. Crop Diversification: Bhatia method iii. Crop Concentration : Jasbir Singh method iv. Measurement of Agriculture Efficiency : Kendall method v. Productivity Index: Enyedi Method vi. Cropping Intensity and Irrigation Intensity	05
2	Techniques in Industrial Geography	i. Lorenz Curve: Calculation and Plotting ii. Location Quotient: Calculation and Plotting iii. Gini's Co-efficient	04
3	Techniques in Trade and Transportation Geography	**i.** Measures in Network Structure: Ratio Measure, Alpha, Beta, Gamma, Associate Number and Cyclomatric numbers ii. Gravity Potential Population Surface iii. Breaking Point Theory iv. Law of Retail Trade Gravitation	05

4	Cartographic Techniques in Economic Geography	i. Use of Thematic Maps in Economic Geography ii. Use of Choropleth Maps in Economic Geography iii. Use of GIS in Economic Geography	03
5	Industrial Visit	i. Visit to one Agro-based Unit (Industry) and report writing	03

Reference Books:

1. C. P. Lo and Albert, K. W. Yeung (2002): Concepts and Techniques of Geographic Information System, 2002Prentice –Hall, India.
2. Kansky, N. T. (1965): Structure of Transport Network
3. Liendsor, J. M. (1997): Techniques in Human Geography, Routledge
4. Lloyd, P. and B. Dicken (1972): Location in Space - A theoretical approach to economic geography. Harper and Row, New York.
5. Majid Hussein, " Agricultural Geography", Rawat Publication.
6. Monkhouse, F. J. and Wilkison, H. R. (1976): Map and Diagrams, Methuen and Co.
7. P. A. Burrough and R. A. McDonnell, (2000): Principles of Geographical Information System, Oxford University Press.
8. Paul A. Lonfley, Michel F. Goodchild, D J. Maguire and D.W. Rhind (2002): Introduction to Geographic Information Systems and Science, John Wiley and Sons Ltd.
9. Singh & Kanujia : Map work and Practical Geography
10. Singh. J. and Dhillon S.S. (1994): Agricultural Geography. Tata McGraw Hill, Publishing Co. Ltd.
11. Yeats, M. H. (1974): An introduction to Quantitative Analysis in Human Geography

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MA/MSc - II Syllabus in Geography (Credit System)
Revised Syllabus (from June, 2020)

Course: GGUP-248 Practical in Population and Settlement Geography
No. of Credits: 04 **No. of Periods: 60**

Topic No.	Topic	Subtopics	Practical (3 Hours)
1	Population Geography	Demographic indices: i. Mean age at marriage and fertility ii. Measures of mortality ,IMR & A.S.D.R Dependency ratio Determinants of Demographic transition: i. Demographic transition: Determinants of demographic transition compared with underdeveloped/developing/developed countries/state ii. Pull-push factors affecting volume of migration- simple correlation matrix iii. Rural urban composition of population	06

		iv. Age-sex and literacy	
2	Settlement Geography	i. Gravity model by W.J.Reilly and Zipf, its application (potential population surfaces) Indices of C.B.D ii. Stages according to urbanization curve iii. Rank size rule iv. Gini's Coefficient concentration index	06
3	Village Survey/ Urban Survey	i. Preparation of questionnaire ii. Collection of Population and settlement data iii. Data analysis and preparation of report	08

Reference Books:

1. Economic and Political weekly-Special issue of population survey
2. Liendzore J.M Techniques in Human Geography
3. Martin Cad: Analytical Urban Geography
4. Siddharth,K and Mukherjee,S (1999): Cities urbanization and urban systems
5. Chandana, R,.C.Population,Geography
6. Yeats,M.H.(1978): An introduction to quantitative analysis in human Geography.
7. Carter Harold: Urban Geography
8. John R.Weeks: Population – an introduction to concepts and issues.

SAVITRIBAI PHULE PUNE UNIVERSITY

Geography MA/MSc-II (Credit System)

Revised Syllabus (From June-2020)

Semi -IV

Course: GGUT-249 Geography of India

No. of Credits: 04 **Total Periods: 60**

Topic No.	Topic	Sub-Topic	Periods
1	Introduction	i. Geographical and relative location of India ii. Frontiers of India iii. Strategic Significance iv. Geological Structure	06
2	Physiography	Main physiographic divisions & their importance i. The northern mountains ii. The north Indian Plain iii. The peninsular plateau iv. The coastal lowlands v. The islands	06

3	Drainage Systems	A) Himalayan drainage systems: i. Ganga ii. Brahmaputra iii. Indus B) Peninsular drainage system 1. East Flowing Rivers: i. Godavari ii. Krishna iii. Mahanadi 2. West Flowing Rivers: i. Narmada ii. Tapi iii. Mahi	06
4	Climate	A) Main Seasons & Associated weather conditions: i. The winter ii. The summer iii. The rainy/monsoon iv. The retreat monsoon B) Origin and mechanism of monsoon: i. Traditional concept: Halley's view ii. Recent Concept: a. Role of Tibet plateau b. ITCZ c. Jet Stream d. El-Nino	06
5	Soils	A) Major soil types and their distribution in India: i. Alluvial soil ii. Black soil iii. Red soil iv. Laterite and Lateritic soils v. Forest and Mountain soils vi. Arid and Desert soils vii. Saline and Alkaline soils viii. Peaty and Marshy soils B) Soil degradation and soil conservation	06
6	Forest	A) Main forest types and their distribution in India: i. Moist Tropical forests ii. Dry Tropical forests iii. Montane Sub-tropical forests iv. Montane Temperate forests v. Alpine forests B) Deforestation and conservation of forest	06
7	Minerals and Energy Resources	A) Distribution and Utilization of Minerals: i. Iron Ore ii. Manganese iii. Bauxite B) Distribution and Utilization of Energy Resources: i. Coal ii. Petroleum iii. Natural gas	06

		C) Major power projects in India: i. Hydro electric ii. Thermal Power iii. Atomic power	
8	Agriculture	A) Distribution and Production of Major Crops: i. Rice ii. Wheat iii. Cotton iv. Sugarcane B) Agriculture revolution in India: i. Components of the Green Revolution ii. Merits and demerits of Green Revolution in India C) Factors affecting Indian Agriculture: i. Environmental Factors ii. Technological Factors iii. Institutional Factors	06
9	Industries	A) Major Industries in India: i. Cotton Textile ii. Sugar iii. Iron and Steel B) Major Industrial Regions in India C) Problems of Industrial development	06
10	Population	A) Growth and distribution of population in India B) Composition and structure of Population: i. Rural-Urban ii. Age-sex iii. Religious iv. Marital status v. Occupational structure	06

N.B.: According need of topics, maps are expected.

Reference Books:

1. Agrawal A. N. (2019): "Indian economy, Developmental Problems and policies" New Age International Pvt. Ltd.
2. Bhende, Asha A and Kanitkar Tara (2015): "Principles of Population Studies", Himalaya Pub. House, New Delhi.
3. Chandana R. C. (2016): "Geography of population", Kalyani Publishers, New Delhi.
4. Chopra S. N. - India, an Area Study.
5. Deshpande C. D. (1992): "India: A Regional Interpretation", Indian Council of Social Science Research and National Book Centre, New Delhi
6. Dubey and Negi - Economic Geography of India.
7. Gopal Singh (1976): Geography of India" Atma Ram Pub., Delhi
8. Khullar D. R. (2018) : "India: a Comprehensive Geography" Kalyani Publishers
9. Majid Husain (2008): "Geography of India", Tata McGraw Hill, New Delhi
10. Mathur, S. M. (1994): Physical Geology of India, National Book Trust, New Delhi, India.
11. Memoria, I. B. - Geography of India.
12. Singh R. L. (1971): "India-A Regional Geography". NGSI, Varanasi.

13. Randhawa, M. S. (1947): The Birth of the Himalayas.
14. Saigal, Umesh (1994): Lakshadweep, National Book Trust, New Delhi, India.
15. Sharma and Continuo - Economic and Commercial Geography of India.
16. Singh, R. L. et. al. (1971): India: A Regional Geography, National Geographical Society of India, Varanasi.
17. Tamta, B. R. (1994): Andaman and Nicobar Islands, National Book Trust, New Delhi, India.
18. Wadia D. N. (1993): Geology of India, Tata McGraw Hill, New Delhi
19. Census of India Report – website- http://censusindia.gov.in/
20. Earth Science India- www.earthscienceindia.info

SAVITRIBAI PHULE PUNE UNIVERSITY

Geography MA/MSc-II (Credit System)

Revised Syllabus (From June-2020)

Course: GGUT–250 Oceanography

No. of Credits: 04 **Total Periods: 60**

S.N.	Topic	Sub-Topic	Periods
1	Introduction to Oceanography	i. Definition and Meaning of Oceanography ii. Foundation of Modern Oceanography iii. Contribution of Oceanographers in the subject iv. Post-war Oceanography v. Modern Trends	08
2	Origin of the Ocean Basins	i. Continental Drift ii. Seafloor Spreading iii. Plate Tectonics iv. World Oceans, their origin and distribution	08
3	The Ocean Floor	Relief of the Ocean Bottom i. Continental Margin: Continental shelves and slopes ii. Oceanic Ridges and Rises iii. Abyssal Plains iv. Oceanic Trenches v. Volcanoes on ocean floor vi. Coral Reefs and Atolls vii. Offshore Islands	08
4	Properties of Sea Water	i. Factors affect temperature on water and distribution ii. Factors affecting density iii. Origin and composition of sea salt and residence time iv. Carbon dioxide and carbonate cycles v. Viscosity vi. Surface tension	12
5	Marine Sediments	i. Lithogenous particles (Derived from Rocks) ii. Biogenous particles (derived from organisms) iii. Hydrogenous particles (derived from Water iv. Distribution of sediment deposits v. Oceanic ooze vi. Correlation and age determination	08

6	Ocean resources	i. Natural resources- gaseous, liquefied and solid chemical parameters ii. Available resources iii. Exploited resources iv. Unexploited resources v. Account of known but unexploited oceanic reserves	08
7	Oceanic Pollution	Causes and measures i. Etiology of marine & oceanic pollution ii. Possible natural disturbances causing pollution in oceans iii. Anthropogenic activities resulting in oceanic pollution iv. Oceanic pollutants and their characteristics for human benefits v. Known remedial measures for pollution at sea & oceanic level	08

Reference Books:

1. Basu S.K. (2003) (ed): Handbook of Oceanography, Global Vision, Delhi.
2. Davis Richard A. (1972): Oceanography, Addition Wesley Publishing Co.
3. Garrison Tom (1999): Oceanography, Brooks/ Cole Wadsworth, New York.
4. Garrison Tom (2004): Essentials of Oceanography. Thompson, Australia.
5. Grant Gross M. (1982): Oceanography, Prentice hall, Ince, New Jersey.
6. King Cuchlain A. M (1962): Oceanography for Geographers (ED) Edward Arnold.
7. Sharma & Vatal (1962): Oceanography for Geographers. Chaitanya Publishing House, Allahabad
8. Thurman Harold V. (1985): Introductory Oceanography. Bell & Howell Co. London.
9. Weisberg J. and Howard P. (1974): Introductory Oceanography. McGraw Hill, Kogakusha, Tokyo

SAVITRIBAI PHULE PUNE UNIVERSITY

Geography MA/MSc-II (Credit System)

Revised Syllabus (From June-2020)

Course: GGUT – 251 Research Methodology

No. of Credits: 04 **Total Periods: 60**

Topic No.	Topic	Sub-Topic	Periods
1	Introduction to Research Methodology	i. Meaning and objectives of research ii. Characteristics of Research iii. Types of Research iv. Various steps in Research Process v. Research Methods versus Methodology	10
2	Research Design	i. Research Design - definition ii. Purpose of a Research Design iii. Characteristics of Good Research Design	06
3	Research Problem	i. Definitions of the Research Problem ii. Identification of a Research Problem iii. Technique involved in defining a problem	06

4	Sampling Design	i. Sampling Design – Definition of Population, Sample and Sampling Design ii. Advantages and disadvantages of Sampling iii. Characteristics of a good sample iv. Types or method of sampling	08
5	Methods of Data Collection	A) Primary Data Questionnaire Method i. Questionnaire – definition ii. Characteristics of a good questionnaire iii. Merits and demerits Questionnaire Method Interview Method i. Interview – definition ii. Characteristics of an interview iii. Merits and demerits of Interview iv. Difference between Interview and Questionnaire Observation Method/Field Work Method B) Secondary Data	06
6	Data Analysis	i. Variables and their types ii. Hypothesis- definition and types iii. Measure for Central Tendency and Dispersion iv. Correlation and Regression Analysis v. Time series analysis vi. T test, Z test, Chi-square test	12
7	Technical writing and reporting of research	Types of research report i. Dissertation and thesis, research paper, review article, short communication, conference presentation, meeting report, etc. ii. Structure and organization of research reports- Title, abstract, key words, introduction, methodology, results, discussion, conclusion, acknowledgements, references, footnotes, tables and illustration iii. Literature Review	06
8	Research ethics, plagiarism and funding agencies	i. Research ethics ii. Plagiarism iii. Use of plagiarism detection softwares iv. Research opportunities and funding agencies	06

Reference Books:

1. Gaum, Carl G., Graves, Harod F., and Hoffman, Lyne, S.S., (1950): Report Writing, 3rd ed., New York: Prentice-Hall.
2. Kothari, C.R. (2004): Research Methodology: Methods and Techniques, New Age International (P) Ltd.,New Delhi – 110002.
3. Kothari, C.R., (1984): Quantitative Techniques, 2nd ed., New Delhi: Vikas Publishing House Pvt. Ltd.
4. Mishra Shanti Bhushan and Shashi A. (2011): Handbook of Research Methodology,Educreation Publishing, New Delhi – 110075.
5. Pandey, P. and Pandey, M.M. (2015): Research Methodology: Tools and Techniques,Bridge Center, Romania, European Union.

6. Tandon, B.C., (1979): Research Methodology in Social Sciences. Allahabad, Chaitanya Publishing House.
7. Ullman, Neil R. (1978): Elementary Statistics, New York: John Wiley & Sons, Inc.
8. Yamane, T., Statistics (1973): An Introductory Analysis, 3rd ed., New York: Harper and Row.

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Geography MA/MSc-II (Credit System)
Revised Syllabus (From June-2020)

Course: GGUT- 252: Geography of Soil

Credit: 02 **Periods: 30**

Topic No.	Topic	Subtopics	Periods
1	Introduction to Geography of Soil	i. Definition ii. Nature and Scopeof Soil Geography iii. Development of Geography of Soil iv. Soil as a Natural Resource	4
2	Soil Formation and Soil Profile	i. Factors of Soil formation: Parent Material, Climate, Biota, Time, Topography. ii. Soil Profile : Definition and Structure	6
3	Components and Characteristics of Soil	i. Soil component: Minerals, Organic Matter, Air and Water. ii. Physical, Chemical and Biological characteristics of soil. iii. Nutrients in Soils: Primary, Secondary and Micronutrients	6
4	Classification and types of Soil	i. Land Capability Classification ii. Land Suitability Classification iii. Types of Soil with reference to India	6
5	Problems related to soil and Soil Conservation	i. Soil Problems: Soil Pollution, Acidification, salinization and Soil health ii. Soil Conservation: Definition and various methods of Soil Conservation, iii. Soil Conservation in India iv. Role of RS and GIS in Soil Conservation	8

References Books:

1. A.S. Gustafson, (2007): “Soils and Management” Published by Agrobios (India).
2. Brady, N. C., and Weil, R. R. (2008): The Nature and Properties of Soils, Prentice Hall, New Jersey
3. Bridges, E. M. and Davidson, D. A. (1982): Principles and Applications of Soil Geography, Longman Group, London.
4. Birkeland, P. W (1999): Soils and Geomorphology, Oxford University Press, New York.
5. C. E. Miller, L.M. Turk, (2001): “Fundamental of soil Science” Biotech Books Delhi.

6. Daji, J. A. (1970): A Textbook of Soil Science, Asia Publication House, New York.
7. Lal, R. (ed.), (2002): Encyclopedia of soil science. Marcel Dekker, New York.
8. Miller, R. W. and Donahue, R. L. (1992): Soils: An Introduction to Soils and Plant Growth, Prentice-Hall of India, New Delhi.
9. Pitty, A. F. (1978): Geography and Soil Properties, Methuen and Co., London.
10. S. C. Panda, (2007): "Soil water conservation and dry farming" Published by Agrobios (India).
11. V. B. Kale (2020): Soil Geography, Himalaya Publishing House, Mumbai.

Savitribai Phule Pune University, Pune

MA/MSc - II Syllabus in Geography (Credit System)
Revised Syllabus (from June, 2020)

Course: GGDP-253 Practical in Geostatistics

No. of Credits: 02 **No. of Periods: 30**

Topic No.	Topic	Subtopics	Practical (3 hours)
1	Exploratory spatial data analysis	i. Univariate descriptors: Frequency tables, Histogram, Cumulative frequency table, Normal probability plots, Summary / Descriptive Statistics ii. Bivariate descriptors: Scatter plot, correlation, covariance, correlation-coefficient, linear regression *(Attempt at least two discrete problems plotting/obtaining the univariate and bivariate descriptors and interpreting them.)*	2
2	Structural analysis	Variogram: Definition and concept i. Plotting of variogram using GIS software	2
3	Spatial interpolation	Local Interpolation Thiessen polygon (Vornoii plots) (manual and software) i. Inverse Distance Weighting (IDW)* ii. Spline* iii. Kriging* (*use of software)	2
4	Cluster Analysis	Problems and interpretation of results	2
5	Markov Chain Analysis	Problems and interpretation of results	2

Reference Books:

1. Cressie, N.A.C. (1993): Statistics for Spatial Data, New York: John Wiley & Sons, Inc.
2. Duetsch, C.V. and Journel, A.G. (1992): GSLIB: Geostatistical Software Library and User's Guide, New York: Oxford University Press.
3. Hohn, M.E. (1988): Geostatistics and Petroleum Geology, New York: Van Nostrand Reinhold.
4. Simon W. Houlding (2000): Geostatistics: Modeling and Spatial Analysis, Springer; Har/Cdr edition (8 June 2000), CD-ROM: 161 pages

SAVITRIBAI PHULE PUNE UNIVERSITY
Geography MA/MSc-II (Choice Based Credit System)

Semester: IV

Revised Syllabus (From June-2020)

Course: GGUT – 254 Political Geography

No. of Credits: 02

Total Periods: 30

Sr. No.	Topic	Sub-Topic	Periods
1	Introduction to PoliticalGeography	i. Definition, nature and scope ii. Historical Development of Political Geography iii. Recent trends inPolitical Geography iv. Importance of Political Geography	6
2	Concepts of Nations and State	i. Definition of Nation and State ii. Origin of state and Elements of state iii. Nation building/Nationalism iv. Difference between Nation and State	6
3	Frontiers & Boundaries	i. Definition of Frontiers & Boundaries ii. Difference between frontiers & boundaries iii. Genetic, functional & Morphological classification of boundaries	4
4	Geopolitics	i. Concept of Geopolitics ii. Heartland Theory of Mackinder iii. Concept of Modern Geopolitics iv. Geopolitical importance of Indian ocean	6
5	Contemporary Issues related to India	i. Changing political map of India. ii. Interstate water dispute in India iii. Problems of border states of India iv. Dispute of India boarder with neighbouring countries	8

REFERENCES:

1. Alexander L.M (1963): World Political Patterns, Ram McNally, Chicago.
2. Adhikari (2008) Political Geography of India, Sharda Pustak Bhavan Allahabad
3. Adhikari S., 1997: Political Geography, Rawat Publication, Jaipur.
4. Blij De H.J., 1972: Systematic Political Geography. Wiley, New York.
5. Cohen S.B., 1973: Geography and Politics in a divided world. Oxford, New York.
6. Cox Kevin: Political geography: Territory, State and Society, Blackwell Publishers ltd, 108, Cowely Road, Oxford, UK.

7. Dixit R. D., 1982: Political Geography. Tata McGraw Hill New Delhi.
8. Dikshit R.D. (2000) Political Geography: The Spatiality of Politics ,Tata McGraw New Delhi
9. Dwivedi R.L., 1996: Political Geography. Chaitanya Prakashan Allahabad.
10. Moor R., 1981: Modern Political Geography. McMillan, London.
11. Pounds N.G., 1972: Political Geography. McGraw Hill, London.
12. Painter J and Jeffery A (2009) Political Geography, Sage Publication
13. Taylor P. (2001): Political Geography, New Delhi, Pearson
14. Valkenberg S.U. & Stoz C., 1963: Elements of Political Geography. Prentice Hall of India, New Delhi.
15. K Siddhartha (1998) Nation Sate theory and Geopolitics: An introductory Political Geography, Kisalaya Publication, Patana
16. Vitthal Gharpure (2013) Rajkiy Bhugol (Marathi) Pimpalapure Publishers Nagpur.
17. Jay Kumar Magar (1994), Rajkiy Bhugol (Marathi) Vidhya Prakashan Nagpur

SAVITRIBAI PHULE PUNE UNIVERSITY

Geography MA/MSc-II (Credit System)

Revised Syllabus (From June-2020)

Course: GGUT – 255 Regional Planning

No. of Credits: 02Total Periods: 30

Topic No	Topic	Sub-Topic	Periods
1	Introduction to Regional Planning	i. Concept and Need of Regional Planning ii. Role of Geography in Regional Planning iii. Hierarchy of Planning iv. Types of Planning v. Levels of Planning	7
2	Region	i. Concept of a Region ii. Type of a Region iii. Concept of Planning Region iv. Indicators of Developments v. Measurement of Regional Development	7
3	Surveys of Regional Planning	i. Regional Survey ii. Techno-Economic Survey iii. Diagnostic surveys Survey	4
4	Regional Policies	i. Regional disparities in India ii. Regional Policies in India's Five Year Plans iii. Experience of Regional Planning in India iv. Multilevel planning (State, District and Block Level Planning).	7
5	Regionalisation	i. Concept of Regionalisation ii. Planning of Metropolitan regions iii. Planning of tribal, command areas and river basins iv. National Capital Region.	5

Reference Books:

1. Bhat, L.S. (1973): Regional Planning in India, Statistical Publishing Society, Kolkata.
2. Chandana, R.C. (2000): Regional Planning - A Comprehensive Text, Kalyani Publishers,Ludhiana.
3. Dube K.N. (ed) (1990): Planning and Development in India, Asia Publishing House, New Delhi.
4. Friedmann, J., Alanso, W. (1967): Regional Development and planning - A Reader, MITPress Mass.
5. Govt. of India (1986): Regional Plan 2001 - National Capital Region, NCRPB, Ministry of Urban Development, New Delhi.
6. Mishra R.P. (Ed.) (1992): Regional Planning, Concepts, Techniques, Policies and Case Studies, Concept Pub. New Delhi.

SAVITRIBAI PHULE PUNE UNIVERSITY

Geography MA/MSc-II (Credit System)

Revised Syllabus (From June-2020)

Course: GGDP – 256 Practical in Watershed Analysis

No. of Credits: 02 **Total Periods: 30**

S.N.	Topic	Sub-Topic	Practical (3 Hours/practical)
1	Delineation of Watershed/Drainage Basin	i. Delineation of Watershed/Drainage basin from toposheets (3 to 5 th order) ii. Calculation of Basin perimeter, shape and area	02
2	Linear Aspects of Drainage Basin	i. Stream ordering (Strahler's method) ii. Bifurcation ratio iii. Measurement and calculation of Stream length iv. Mean stream length, v. Stream length ratio	02
3	Relief Aspects of Drainage Basin	i. Calculation of Relief ratio ii. Relative relief iii. Ruggedness number iv. absolute relief map v. Relative relief map	02
4	Software based	i. Delineation of watershed (DEM based) ii. Physiographic map iii. Watershed map iv. Drainage network map v. Contour map vi. Slope map	04

Reference Books:

1. King, C. A. M (1966): Techniques in Geomorphology, Edward Arnold, London
2. Savindra Singh (2002): Geomorphology, Prayag Pustak Bhawan, Allahabad
3. Miller, Austin (1953): The skin of the Earth, Methuen & Co. Ltd. London
4. Strahler: Physical Geography

5. Wilson, J., Gallant, J., (2000): Terrain Analysis: Principles and Applications. New York: JohnWiley and Sons.
6. Rajvir Singh, (2008): Watershed Planning and Management, 2nd Edition, Yash PublishingHouse, Bikaner, India.
7. B. K. Kakde, (2004) Watershed Manual – A Guide for Watershed Development Practitionersand Trainers, BAIF Development Research Foundation, Pune.
8. R. Suresh (2006) Soil and Watershed Conversation Engineering, 2nd Edition, – StandardPublication Distributors, Delhi.

Savitribai Phule Pune University, Pune

MA/MSc - II Syllabus in Geography (Credit System)
Revised Syllabus (from June, 2020)

Course: GGDP-257 Interpretation of Topographical Maps and GPS Survey
No. of Credits: 02 **No. of Periods: 30**

Topic No.	Topic	Sub topics	Practical (3 hours)
1	Study of Topographical Maps	i. Indexing systems and conventional signs and symbols of S.O.I. toposheets ii. Grid references: 4-figure grid, 6-figure grid and International grid reference iii. Introduction to US and OS sheets	02
2	Interpretation of S.O.I toposheets.	i. Relief: Distribution of Spot heights, bench marks, Trigonometrical Points etc., Types of Slopes (convex, concave, uniform etc.) and Major landforms from contour patterns ii. Drainage network: Types-trellis, dendritic, radial, etc., Streams with water, without water and Influence of relief on drainage iii. Natural Vegetation: Types of vegetation, Association of relief and drainage, Reserved Forest and Protected Forest iv. Land Use: Agriculture, mining etc, areal distribution and impact of Physical landscape. v. Settlements: Types settlements, amenities, etc, Distribution, relative size, relative distance (dispersed, nucleated etc) vi. Transport and Communication: Types of roads, railway lines, facilities of communication **(3 sheets of S.O.I. toposheets)**	04

3	GPS Survey of Village	i. Introduction of GPS : Space segment, Control segment and user segment ii. GPS Survey (GPS Reading and Area Measurement): One day field visit and excursion report	04

Reference Books

1. Archer J. E and Dalton T. H. (1968), Field work in Geography B.T. Batsford Limited London
2. Dury G.H. (1960): Map Interpretation. Sir Isaac Pitman and Sons Limited, Pitman House, Bath.
3. Gupta, K. K. and Tyagi, V. C. (1992): Working with maps, Survey of India Publication, Dehradun.
4. Jones P. A. (1968): Field work in Geography. Longmans, Green and Company Limited.
5. Meux A. H. (1960): Reading Topographical Maps. University of London Press Limited.
6. Petrie N. (1992): Analysis and Interpretation of Topographical Maps. Orient Longman Limited Calcutta.
7. Ramamurthy, K. (1982): Map interpretation, Madras.
8. Tamaskar B.G. and Deshmukh V.M. (1974): Geographical Interpretation of Indian Topographical Maps. Orient Longman Limited, Bombay.
9. Vaidyanadhan. R. (1968): Index to a set of 60 topographical maps, CSIR, New Delhi.
10. Wheeler K.S. Ed (1970): Geography in the field. Blond Educational, London.

Savitribai Phule Pune University, Pune

MA/MSc - II Syllabus in Geography (Credit System)
Revised Syllabus (from June, 2020)

Course: GGUT-258 Geography of World
No. of Credits: 04 **No. of Periods: 60**

Topic No.	Topic	Subtopics	Practical (3 hours)
1	The Earth	i. Introduction (Earth and solar system) ii. Origin and Evolution of the Earth- Big-bang theory iii. Geological Time scale iv. Continents and Oceans, Major natural regions	08
2	Regional geography of : 1. Europe 2. North America 3. South America 4. Africa 5. Australia	i. Location ii. Physical features – (Physical Division and main rivers) iii. Climate iv. Agriculture v. Natural vegetation and wild life vi. Mineral resources vii. Population	30

	6. Asia 7. Antarctica	viii. Important countries	
3	World contemporary issues	i. Major political issues (Border and Water) ii. Health issues – (COVID-19) iii. Environmental issues – (Global warming) iv. Population issues – (Growth, Religious conflict, Poverty, Migration) v. Role of WTO and IMF	12
4	21st century challenges and opportunities in the world	Challenges i. Food security ii. Climate change iii. Global Public Health (Pandemics) iv. Terrorism Opportunities i. Globalization ii. Tourism	10

Reference Books:

1. Ashworth, L. M. (2013). Mapping a new world: Geography and the interwar study of international relations. International Studies Quarterly, 57(1), 138-149.
2. Baerwald, T. J., Fraser, C., & Bednarz, S. (2003). World geography: Building a global perspective. Prentice-Hall.
3. Berglee, R. (2012). *World regional geography: People, places and globalization*.
4. Bradshaw, M. J. (2000). World Regional geography: The new global order. McGraw Hill.
5. Cole, J. P. (1996). Geography of the world's major regions. Psychology Press.
6. George, B. P., & Nedelea, A. (2007). International Tourism: World Geography and Developmental Perspectives. Abhijeet Publications.
7. Haggett, P. (Ed.). (2002). Encyclopedia of World Geography (Vol. 24). Marshall Cavendish.
8. Jackson, R. H., & Hudman, L. E. (1990). *World regional geography: issues for today*. Wiley.
9. Krätke, S., & Taylor, P. J. (2004). A world geography of global media cities. *European Planning Studies*, *12*(4), 459-477.
10. Majid Husain (2013) World Geography, Rawat Publications.
11. McColl, R. W. (2014). *Encyclopedia of world geography* (Vol. 1). Infobase Publishing.
12. Sager, R. J., Helgren, D. M., & Israel, S. (1989). World geography today. Holt, Rinehart and Winston.
13. Schmidt, B. (2015). Inventing exoticism: geography, globalism, and Europe's early modern world. University of Pennsylvania Press.

SAVITRIBAI PHULE PUNE UNIVERSITY

Geography MA/MSc-II (Credit System)

Revised Syllabus (From June-2020)

Course: GGUP – 259 Dissertations

No. of Credits: 04 **Total Periods: 60**

1 The students shall declare the option of dissertation at the beginning of the 3rd semester.

2 A Post Graduate recognized teacher in the department is eligible to guide maximum two students per year.

3 **General Guide Lines :-**

i. Introduction to the problem
ii. Aims and objectives of the study
iii. Data and Methodology
iv. Analysis, description and interpretation
v. Results and Conclusions
vi. References/Bibliography

(Fieldwork/data collection/field visits wherever necessary)

4 Every table, figure, photograph should have a caption and with references.

5 The list of references should be given at the end and all the references should be complete in all respects (author(s)) name, year, title of the article or book, name of the journal, name of the publisher of the book and place of publication, volume of journal and page numbers)

6 The minimum page limit for the dissertation is 50, including text, figures, tables, photographs, references, and appendices.

7 At the time of viva-voce, presentation must be given with the help of power point.

सावित्रीबाई फुले पुणे विश्वविद्यालय, पुणे
Savitribai Phule Pune University, Pune

एम. ए. हिंदी पाठ्यक्रम
M.A. Hindi Syllabus

संबंद्ध महाविद्यालयों के लिए
For Affiliated colleges

एम. ए. द्वितीय वर्ष
(तृतीय एवं चतुर्थ अयन)
Third & Fourth Semester

शैक्षिक वर्ष
Academic year

2020-2021

अनुक्रम

कोर्स नं.	एम. ए. हिंदी द्वितीय वर्ष (तृतीय अयन)		क्रेडिट	पृष्ठ क्रमांक
9	आधुनिक काव्य (आदर्शवादी, छायावादी तथा अन्य काव्य)		4	03
10	भाषाविज्ञान		4	05
11	हिंदी साहित्य का इतिहास (आदिकाल, भक्तिकाल, रीतिकाल)		4	07
12	वैकल्पिक			
	क)	हिंदी आलोचना	4	09
	ख)	संचार माध्यम : सिद्धांत और स्वरूप	4	11
कोर्स नं.	एम. ए. हिंदी द्वितीय वर्ष (चतुर्थ अयन)		क्रेडिट	पृष्ठ क्रमांक
13	आधुनिक कविता		4	14
14	हिंदी भाषा का विकास		4	16
15	हिंदी साहित्य का इतिहास (आधुनिककाल)		4	18
16	वैकल्पिक			
	क)	भारतीय लोकसाहित्य	4	20
	ख)	भारतीय साहित्य	4	22

एम. ए. हिंदी साहित्य द्वितीय वर्ष

तृतीय अयन (Third Semester)

पाठ्यचर्या : 9 आधुनिक काव्य (आदर्शवादी, छायावादी तथा अन्य काव्य)

4 कर्मांक (Credit)

उद्देश्य :

1. छात्रों को आधुनिक काव्य से अवगत कराना।
2. छात्रों में आधुनिक काव्य–अध्ययन की दृष्टि विकसित करना।
3. काव्य मूल्यांकन–दृष्टि विकसित करना।
4. काव्य–संवेदना एवं शिल्पगत अध्ययन से छात्रों को अवगत करना।
5. छात्रों में काव्य–सर्जन कला का विकास करना।

इकाई	पाठ्यविषय	तासिकाएँ
इकाई– I	साकेत (नवम् सर्ग) – मैथिलीशरण गुप्त संवदेना एवं शिल्पगत अध्ययन	15 तासिकाएँ
इकाई– II	कामायनी (लज्जा सर्ग) – जयशंकर प्रसाद संवदेना एवं शिल्पगत अध्ययन	15 तासिकाएँ
इकाई– III	1) बीन भी हूँ मैं तुम्हारी रागिनी भी हूँ – महादेवी वर्मा 2) पहाडी बच्चा – निर्मल पुतुल 3) कूडा बीनते बच्चे – अनामिका 4) जिंदगी का नमक – निर्मला गर्ग 5) अंधेरे में बुद्ध – गगन गिल उक्त रचनाओं का, संवदेना एवं शिल्पगत अध्ययन।	15 तासिकाएँ
इकाई– IV	1) बात बोलेगी – शमशेर बहादुर सिंह 2) एक पीली शाम – शमशेर बहादुर सिंह 3) भारत की आरती – शमशेर बहादुर सिंह 4) रोटी और संसद – धूमिल 5) मोचीराम – धूमिल उक्त रचनाओं का, संवदेना एवं शिल्पगत अध्ययन।	15 तासिकाएँ

अंक विभाजन – पूर्णांक : 100

आंतरिक मूल्यांकन –50 (लघुत्तरी परीक्षा–20, शोध परियोजना–20, प्रस्तुतिकरण–10)

सत्रांत परीक्षा – 50

सत्रांत परीक्षा – प्रश्नपत्र का प्रारूप :

(शैक्षिक वर्ष 2020–21 से आगे)

समय : 3 घंटे **अंक 50**

प्रश्न : 1 इकाई एक पर दीर्घोत्तरी प्रश्न (दो में से एक)।	10 अंक
प्रश्न : 2 इकाई दो पर दीर्घोत्तरी प्रश्न (दो में से एक)।	10 अंक
प्रश्न : 3 इकाई तीन पर दीर्घोत्तरी प्रश्न (दो में से एक)।	10 अंक
प्रश्न : 4 इकाई चार पर दीर्घोत्तरी प्रश्न (दो में से एक)।	10 अंक
प्रश्न : 5 बहुविकल्पि प्रश्न – 12 में से 10 (चार में से एक सही विकल्प का चयन कीजिए।)।	10 अंक

संदर्भ ग्रंथ :

1. काव्य प्रसून – संपादक हिंदी अध्ययन मंडल, सावित्रीबाई फुले पुणे विश्वविद्यालय, पुणे, राजकमल प्रकाशन, नई दिल्ली।
2. कामायनी का पुनर्मूल्यांकन – डॉ. रामस्वरूप चतुर्वेदी
3. कामायनी : एक पुनर्विचार – ग. मा. मुक्तिबोध
4. साकेत – मैथिलीशरण गुप्त
5. कामायनी – जयशंकर प्रसाद
6. नये कविता के प्रतिमान – डॉ. नामवर सिंह
6. अनामिका का काव्य : आधुनिक स्त्री विमर्श – मंजु रस्तोगी
7. साकेत में पुनर्जागरण का आंदोलन – डॉ. जालिंदर इंगले।

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एम. ए. हिंदी साहित्य द्वितीय वर्ष

तृतीय अयन : (Third Semester)

पाठ्यचर्या : 10 भाषा विज्ञान

4 कर्मांक (Credit)

उद्देश्य :

1. भाषाविज्ञान के स्वरूप का परिचय देना।
2. छात्रों को भाषाविज्ञान की व्याप्ति समझाना।
3. भाषाविज्ञान के अध्ययन की दिशाओं का परिचय देना।
4. भाषाविज्ञान के अनुप्रयोगात्मक पक्ष को समझाना।
5. साहित्य–अध्ययन में भाषाविज्ञान की उपयोगिता समझाना।

इकाई	पाठ्यविषय	तासिकाएँ
इकाई– I	भाषाविज्ञान : परिभाषा, स्वरूप और व्याप्ति, अध्ययन की दिशाएँ।	15 तासिकाएँ
इकाई– II	स्वनिम विज्ञान : स्वन की परिभाषा, वागावयव और कार्य, स्वन वर्गीकरण, स्वनगुण, स्वनिम परिवर्तन।	15 तासिकाएँ
इकाई– III	रूपिम विज्ञान : रूप प्रक्रिया का स्वरूप और शाखाएँ, रूपिम की परिभाषा, रूपिम के भेद और प्रकार्य। पदबंध और उपवाक्य : पदबंध का स्वरूप, पदबंध के भेद, उपवाक्य का स्वरूप, उपवाक्य के भेद।	15 तासिकाएँ
इकाई– IV	वाक्य विज्ञान : वाक्य की परिभाषा और स्वरूप, वाक्य के भेद, वाक्य विश्लेषण। अर्थ विज्ञान : अर्थ की परिभाषा और स्वरूप, शब्द और अर्थ का संबंध, अर्थ परिवर्तन की दिशाएँ और कारण।	15 तासिकाएँ

अंक विभाजन – पूर्णांक : 100

आंतरिक मूल्यांकन –50 (लघुत्तरी परीक्षा–20, शोध परियोजना–20, प्रस्तुतिकरण–10)

सत्रांत परीक्षा – 50

सत्रांत परीक्षा – प्रश्नपत्र का प्रारूप :

(शैक्षिक वर्ष 2020–21 से आगे)

समय : 3 घंटे **अंक 50**

प्रश्न : 1 इकाई एक पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 2 इकाई दो पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 3 इकाई तीन पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 4 इकाई चार पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 5 बहुविकल्पि प्रश्न – 12 में से 10 (चार में से एक सही विकल्प का चयन कीजिए।) 10 अंक

संदर्भ ग्रंथ :

1. भाषा और समाज – रामविलास शर्मा
2. आधुनिक भाषा विज्ञान – राजमणि शर्मा
3. सांस्कृतिक भाषा विज्ञान – डॉ. रामानंद तिवारी
4. भाषा विज्ञान – सं. डॉ. राजमल बोरा
5. भाषा शास्त्र तथा हिंदी भाषा की रूपरेखा – डॉ. देवेंद्रकुमार शास्त्री
6. भाषाविज्ञान – भोलानाथ तिवारी
7. भाषा विज्ञान एवं भाषाशास्त्र – डॉ. कपिलदेव द्विवेदी
8. हिंदी भाषा संरचना – डॉ. भोलानाथ तिवारी
9. आधुनिक भाषाविज्ञान – डॉ. कृपाशंकर सिंह, डॉ. चतुर्भुज सहाय
10. हिंदी का वाक्यात्मक कारण – प्रो. सूरजभान सिंह
11. भाषाविज्ञान के आधुनातन आयाम – डॉ. अंबादास देशमुख
12. ऐतिहासिक भाषा विज्ञान और हिंदी – राजेंद्र प्रसाद सिंह
13. भाषा विज्ञान : सैद्धांतिक चिंतन – रवींद्रनाथ श्रीवास्तव
14. भाषाशास्त्र के सूत्रधार – रवींद्रनाथ श्रीवास्तव
15. भाषा विज्ञान एवं हिंदी भाषा – लक्ष्मीकांत पाण्डेय/प्रमिला अवस्थी
16. भाषा विज्ञान एवं हिंदी भाषा – मुकेश अग्रवाल
17. भाषा विज्ञान, हिंदी भाषा और लिपि – राम किशोर शर्मा
18. भाषा विज्ञान की भूमिका – देवेंद्रनाथ शर्मा/दीप्ति शर्मा
19. अद्यतन भाषा विज्ञान – पाण्डेय शशिभूषण 'शीतांशु'
20. हिंदी भाषा विज्ञान – डॉ. बाबूराम
21. सामान्य भाषिकी – आर. एच. रोबिन्स
22. भाषिकी और संस्कृत भाषा – डॉ. देवीदत्त शर्मा

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एम. ए. हिंदी साहित्य द्वितीय वर्ष

तृतीय अयन : (Third Semester)

पाठ्यचर्या : 11 हिंदी साहित्य का इतिहास (आदिकाल, भक्तिकाल, रीतिकाल)

4 कर्मांक (Credit)

उद्देश्य :

1. हिंदी साहित्येतिहास लेखन का परिचय देना।
2. हिंदी साहित्येतिहास के कालविभाजन तथा नामकरण का परिचय देना।
3. आदिकालीन, भक्तिकालीन, रीतिकालीन प्रमुख साहित्यिक प्रवृत्तियों, रचनाकारों और रचनाओं से परिचित कराना।

इकाई	पाठ्यविषय	तासिकाएँ
इकाई– I	हिंदी साहित्येतिहास दर्शन, हिंदी साहित्येतिहास लेखन की पद्धतियाँ, हिंदी साहित्य का इतिहास : काल विभाजन और नामकरण।	15 तासिकाएँ
इकाई– II	आदिकाल की विशेषताएँ एवं साहित्यिक प्रवृत्तियाँ, रासो साहित्य, जैन साहित्य, सिद्ध और नाथ साहित्य। अमीर खुसरो की हिंदी कविता।	15 तासिकाएँ
इकाई– III	भक्ति आंदोलन का अखिल भारतीय स्वरूप, आलवार संत, भक्तिकाल का प्रमुख संप्रदाय और उनका वैचारिक आधार। निर्गुण–सगुण कवि और उनका काव्य। निर्गुण धारा के कवि : कबीर, रैदास, दादू, नामदेव, जायसी, कुतुबन, मंझन। सगुण धारा के कवि : सूरदास, मीराबाई, रसखान, नंददास, तुलसीदास, नाभादास।	15 तासिकाएँ
इकाई– IV	रीतिकाल की सामाजिक–सांस्कृतिक पृष्ठभूमि, रीतिकाल की प्रमुख प्रवृत्तियाँ– रीतिबद्ध, रीतिसिद्ध और रीतिमुक्त। रीतिकाल के प्रमुख कवि और उनका काव्य। बिहारी, केशव, घनानंद, देवा, भूषण, बोधा, आलम, ठाकुर।	15 तासिकाएँ

अंक विभाजन – पूर्णांक : 100

आंतरिक मूल्यांकन –50 (लघुत्तरी परीक्षा–20, शोध परियोजना–20, प्रस्तुतिकरण–10)

सत्रांत परीक्षा – 50

सत्रांत परीक्षा – प्रश्नपत्र का प्रारूप :

(शैक्षिक वर्ष 2020–21 से आगे)

समय 3 घंटे **अंक 50**

प्रश्न : 1 इकाई एक पर दीर्घोत्तरी प्रश्न (दो में से एक)।	10 अंक
प्रश्न : 2 इकाई दो पर दीर्घोत्तरी प्रश्न (दो में से एक)।	10 अंक
प्रश्न : 3 इकाई तीन पर दीर्घोत्तरी प्रश्न (दो में से एक)।	10 अंक
प्रश्न : 4 इकाई चार पर दीर्घोत्तरी प्रश्न (दो में से एक)।	10 अंक
प्रश्न : 5 बहुविकल्पि प्रश्न – 12 में से 10 (चार में से एक सही विकल्प का चयन कीजिए।)।	10 अंक

संदर्भ ग्रंथ :

1. हिंदी साहित्य का इतिहास – आ. रामचंद्र शुक्ल
2. हिंदी साहित्य की भूमिका – आ. हजारीप्रसाद द्विवेदी
3. हिंदी साहित्य का आदिकाल – आ. हजारीप्रसाद द्विवेदी
4. हिंदी साहित्य का वैज्ञानिक इतिहास – डॉ. गणपतिचंद्र गुप्त
5. हिंदी साहित्य का आलोचनात्मक इतिहास – डॉ. रामकुमार वर्मा
6. हिंदी साहित्य और संवेदना का विकास – रामस्वरूप चतुर्वेदी
7. हिंदी साहित्य का इतिहास – डॉ. नगेंद्र
8. हिंदी साहित्य का अतीत – विश्वनाथ प्रसाद मिश्र
9. हिंदी साहित्य का दूसरा इतिहास – बच्चन सिंह
10. हिंदी साहित्य का इतिहास – प्रो. माधव सोनटक्के

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एम. ए. हिंदी साहित्य द्वितीय वर्ष

तृतीय अयन : (Third Semester) वैकल्पिक

पाठ्यचर्या : 12 (क) हिंदी आलोचना

4 कर्मांक (Credit)

उद्देश्य :

1. आलोचना के स्वरूप एवं विविध प्रकारों से अवगत कराना।
2. हिंदी के प्रमुख आलोचकों के आलोचनात्मक प्रतीमानों का परिचय देना।
3. साहित्यालोचन एवं व्यावहारिक समीक्षा दृष्टि विकसित करना।

इकाई	पाठ्यविषय	तासिकाएँ
इकाई– I	आलोचना : स्वरूप एवं उद्देश्य। आलोचक के गुण। आलोचना और अनुसंधान।	15 तासिकाएँ
इकाई– II	आलोचना दृष्टियाँ एवं पद्धतियाँ। मार्क्सवादी, मनोवैज्ञानिक, शैलीवैज्ञानिक, प्रकृतिवादी।	15 तासिकाएँ
इकाई– III	हिंदी आलोचना का संक्षिप्त इतिहास, भारतेंदुकालीन आलोचना, द्विवेदीयुगीन आलोचना, आ. शुक्ल युगीन आलोचना, शुक्लोतर आलोचना, समकालीन आलोचना।	15 तासिकाएँ
इकाई– IV	हिंदी के प्रमुख आलोचक आ. रामचंद्र शुक्ल, आ. नंददुलारे वाजपेयी, आ. हजारीप्रसाद द्विवेदी, डॉ. रामविलास शर्मा, डॉ. नामवर सिंह।	15 तासिकाएँ

अंक विभाजन – पूर्णांक : 100

आंतरिक मूल्यांकन –50 (लघुत्तरी परीक्षा–20, शोध परियोजना–20, प्रस्तुतिकरण–10)

सत्रांत परीक्षा – 50

सत्रांत परीक्षा – प्रश्नपत्र का प्रारूप :

(शैक्षिक वर्ष 2020–21 से आगे)

समय : 3 घंटे **अंक 50**

प्रश्न : 1 इकाई एक पर दीर्घोत्तरी प्रश्न (दो में से एक)।	10 अंक
प्रश्न : 2 इकाई दो पर दीर्घोत्तरी प्रश्न (दो में से एक)।	10 अंक
प्रश्न : 3 इकाई तीन पर दीर्घोत्तरी प्रश्न (दो में से एक)।	10 अंक
प्रश्न : 4 इकाई चार पर दीर्घोत्तरी प्रश्न (दो में से एक)।	10 अंक
प्रश्न : 5 बहुविकल्पि प्रश्न – 12 में से 10 (चार में से एक सही विकल्प का चयन कीजिए।)।	10 अंक

संदर्भ ग्रंथ :

1. समीक्षा शास्त्र – डॉ. दशरथ ओझा
2. हिंदी आलोचना के आधार स्तंभ – डॉ. रामेश्वरलाल खंडेलवाल
3. आलोचनाःप्रकृति और परिवेश – डॉ. तारकानाथ बाली
4. आ. शुक्ल के समीक्षा सिद्धांत – डॉ. रामलाल सिंह
5. इतिहास और आलोचना – डॉ. नामवर सिंह
6. आधुनिक आलोचना के बीज शब्द – बच्चन सिंह
7. हिंदी आलोचना – विश्वनाथ त्रिपाठी
8. समकालीन आलोचक और आलोचना – रामबक्ष
9. हिंदी आलोचना के सैद्धांतिक आधार – कृष्णदत्त पालीवाल
10. साहित्यशास्त्र तथा आलोचना – डॉ. माधव सोनटक्के
11. हिंदी आलोचना की पहचान – डॉ. राजमल बोरा
12. हिंदी आलोचना का बदलता परिप्रेक्ष्य – सं. डॉ. माधव सोनटक्के

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एम. ए. हिंदी साहित्य द्वितीय वर्ष

तृतीय अयन : (Third Semester) वैकल्पिक

पाठ्यचर्या : 12 (ख) संचार माध्यम : सिद्धांत और स्वरूप

4 कर्मांक (Credit)

उद्देश्य :

1. संचार माध्यम और संप्रेषण अवधारणाओं का परिचय देना।
2. संचार माध्यम की अवधारणा और स्वरूप का परिचय देना।
3. संचार माध्यम की बहुआयामी भूमिका का परिचय देना।
4. संचार माध्यम कौशल विकसित करना।

इकाई	पाठ्यविषय	तासिकाएँ
इकाई– I	संचार, जनसंचार तथा संप्रेषण : अवधारणा और स्वरूप। संचार माध्यम : सिद्धांत और स्वरूप। संचार के संघटक तत्व। संचार–माध्यमों से लाभ–हानि।	15 तासिकाएँ
इकाई– II	सूचना क्रांति बनाम सूचना–उद्योग। संचार माध्यम के प्रकार : 1) परंपरागत, 2) मौखिक, 3) लिखित, 4) आधुनिक।	15 तासिकाएँ
इकाई– III	आधुनिक संचार माध्यम : 1) मुद्रित, 2) रेडियो, 3) चलचित्र, 4) विद्युतीय, 5) बहुमाध्यम, 6) हाइपर मीडिया संचार माध्यमों द्वारा संप्रेषित संदेश की भाषिक प्रकृति।	15 तासिकाएँ
इकाई– IV	संचार माध्यमों की बहुआयामी भूमिका : 1) जन संपर्क, 2) जन शिक्षण, 3) जन प्रबोधन, 4) जन निर्माण, 5) जन समस्या का समाधान, 6) जन रंजन। वर्तमान सूचना क्रांति के विविध आयाम।	15 तासिकाएँ

अंक विभाजन – पूर्णांक : 100

आंतरिक मूल्यांकन –50 (लघुत्तरी परीक्षा–20, शोध परियोजना–20, प्रस्तुतिकरण–10)

सत्रांत परीक्षा – 50

सत्रांत परीक्षा – प्रश्नपत्र का प्रारूप :

(शैक्षिक वर्ष 2020–21 से आगे)

समय : 3 घंटे **अंक 50**

प्रश्न : 1 इकाई एक पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 2 इकाई दो पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 3 इकाई तीन पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 4 इकाई चार पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 5 बहुविकल्पि प्रश्न – 12 में से 10 (चार में से एक सही विकल्प का चयन कीजिए।)। 10 अंक

संदर्भ ग्रंथ :

1. जनसंचार के विविध आयाम – ब्रजमोहन गुप्त
2. जनमाध्यम और मासकल्चर – जगदीश्वर चतुर्वेदी
3. जनमाध्यम और पत्रकारिता (भाग : 1, 2) – प्रवीण दीक्षित
4. रेडियो और दूरदर्शन और हिंदी – डॉ. हरिमोहन
5. जनमाध्यम : संप्रेषण और विकास – देवेंद्र इस्सर
6. सिनेमाई भाषा और हिंदी संवादों का विश्लेषण – डॉ. किशोर वासवानी
7. जनसंचार – राधेश्याम शर्मा
8. जनसंचार सिद्धांत और अनुप्रयोग – विष्णु राजगढ़िया
9. जनसंचार माध्यम और पत्रकारिता सर्वांग – डॉ. जितेंद्र वत्स, डॉ. किरण बाल
10. जनसंचार और हिंदी पत्रकारिता – डॉ. अर्जुन तिवारी
11. आधुनिक पत्रकारिता और इलेक्ट्रनिक मीडिया – डॉ. जालिंदर इंगले।

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एम. ए. हिंदी द्वितीय वर्ष
चतुर्थ अयन **(Fourth Semester)**

कोर्स नं.	एम. ए. हिंदी द्वितीय वर्ष (चतुर्थ अयन)		क्रेडिट	पृष्ठ क्रमांक
13	आधुनिक कविता		4	14
14	हिंदी भाषा का विकास		4	16
15	हिंदी साहित्य का इतिहास (आधुनिककाल)		4	18
16	वैकल्पिक			
	क)	भारतीय लोकसाहित्य	4	20
	ख)	भारतीय साहित्य	4	22

एम. ए. हिंदी साहित्य द्वितीय वर्ष

चतुर्थ अयन : (Fourth Semester)

पाठ्यचर्या : 13 आधुनिक कविता

4 कर्मांक (Credit)

उद्देश्य :

1. छात्रों को आधुनिक काव्य से अवगत कराना।
2. छात्रों में आधुनिक काव्य–अध्ययन की दृष्टि विकसित करना।
3. सर्जनात्मक कौशल से अवगत करना।
4. आलोचानात्मक दृष्टि विकासित करना।

इकाई	पाठ्यविषय	तासिकाएँ
इकाई– I	1) बादल को घिरते देखा – नागार्जुन 2) शासन की बंदूक – नागार्जुन 3) मेरी आभा है इसी में – नागार्जुन 4) जन जन का चेहरा एक – मुक्तिबोध 5) भूल गलती – मुक्तिबोध उक्त रचनाओं का, संवदेना एवं शिल्पगत अध्ययन।	15 तासिकाएँ
इकाई– II	1) असाध्य वीणा – अज्ञेय 2) हीरोसिमा – अज्ञेय 3) कनुप्रिया अंश – धर्मवीर भारती 4) ठंडा लोहा – धर्मवीर भारती 5) फिरोजी होंठ – धर्मवीर भारती उक्त रचनाओं का, संवदेना एवं शिल्पगत अध्ययन।	15 तासिकाएँ
इकाई– III	1) आदिवासी स्त्रियाँ – निर्मला पुतुल 2) बूढी पृथ्वी का दुख – निर्मला पुतुल 3) दरवाजा – अनामिका 4) जनम ले रहा है नया पुरुष – अनामिका 5) नमक – अनामिका उक्त रचनाओं का, संवदेना एवं शिल्पगत अध्ययन।	15 तासिकाएँ
इकाई– IV	1) पेड़ का नाच – लीलाधर मंडलोई 2) जानती है सिर्फ नदी – लीलाधर मंडलोई 3) गुंगा नहीं था मैं – जयप्रकाश कर्दम 4) बेमानी है आजादी – जयप्रकाश कर्दम	15 तासिकाएँ

	5) शुक्र है तू नहीं है – जयप्रकाश कर्दम उक्त रचनाओं का, संवदेना एवं शिल्पगत अध्ययन।	

अंक विभाजन – पूर्णांक : 100

आंतरिक मूल्यांकन –50 (लघुत्तरी परीक्षा–20, शोध परियोजना–20, प्रस्तुतिकरण–10)

सत्रांत परीक्षा – 50

सत्रांत परीक्षा – प्रश्नपत्र का प्रारूप :

(शैक्षिक वर्ष 2020–21 से आगे)

समय : 3 घंटे **50 अंक**

प्रश्न : 1 इकाई एक पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 2 इकाई दो पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 3 इकाई तीन पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 4 इकाई चार पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 5 बहुविकल्पि प्रश्न – 12 में से 10 (चार में से एक सही विकल्प का चयन कीजिए।)। 10 अंक

संदर्भ ग्रंथ :

1. 'काव्य सारंग' – संपादक हिंदी अध्ययन मंडल, सावित्रीबाई फुले पुणे विश्वविद्यालय, पुणे, राजकमल प्रकाशन, नई दिल्ली।

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एम. ए. हिंदी साहित्य द्वितीय वर्ष

चतुर्थ अयन : (Fourth Semester)

पाठ्यचर्या : 14 हिंदी भाषा का विकास

4 कर्मांक (Credit)

उद्देश्य :

1. हिंदी भाषा की ऐतिहासिक पृष्ठभूमि से अवगत कराना।
2. आधुनिक आर्य भाषाओं का परिचय देना।
3. हिंदी के स्वनिम व्यवस्था का परिचय देना।
4. हिंदी की रूप रचना से अवगत अवगत करना।
5. हिंदी भाषा के योगदान से अवगत करना।

इकाई	पाठ्यविषय	तासिकाएँ
इकाई– I	हिंदी भाषा की ऐतिहासिक पृष्ठभूमि प्राचीन भारतीय आर्य भाषाएँ : वैदिक संस्कृत, लौकिक संस्कृत। मध्यकालीन आर्य भाषाएँ : पालि, प्राकृत, शौरसेनी, पैशाची, महाराष्ट्री, अर्धमागधी, मागधी।	15 तासिकाएँ
इकाई– II	आधुनिक भारतीय आर्य भाषाएँ : बंगाली, असमिया, उडिया, हिंदी, गुजराती, पंजाबी, सिंधी, गढ़वाली, मराठी।	15 तासिकाएँ
इकाई– III	हिंदी की स्वनिम व्यवस्था : खंडय और खंडेयत्तर, हिंदी ध्वनियों के वर्गीकरण का आधार, हिंदी शब्द रचना – उपसर्ग, प्रत्यय, समास।	15 तासिकाएँ
इकाई– IV	हिंदी की रूप रचना : संज्ञा, सर्वनाम, विशेषण, क्रिया रूप, लिंग, वचन, कारक व्यवस्था।	15 तासिकाएँ

अंक विभाजन – पूर्णांक : 100

आंतरिक मूल्यांकन –50 (लघुत्तरी परीक्षा–20, शोध परियोजना–20, प्रस्तुतिकरण–10)

सत्रांत परीक्षा – 50

सत्रांत परीक्षा – प्रश्नपत्र का प्रारूप :

(शैक्षिक वर्ष 2020–21 से आगे)

समय : 3 घंटे **अंक 50**

प्रश्न : 1 इकाई एक पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 2 इकाई दो पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 3 इकाई तीन पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 4 इकाई चार पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 5 बहुविकल्पि प्रश्न – 12 में से 10 (चार में से एक सही विकल्प का चयन कीजिए।)। 10 अंक

संदर्भ ग्रंथ :

1. भाषाविज्ञान – डॉ. भोलानाथ तिवारी
2. भाषाशास्त्र तथा हिंदी भाषा की रूपरेखा – डॉ. देवेंद्रकुमार शास्त्री
3. भाषाविज्ञान एवं भाषाशास्त्र – डॉ. कपिलदेव द्विवेदी
4. हिंदी भाषा संरचना – डॉ. भोलानाथ तिवारी
5. आधुनिक भाषाविज्ञान – डॉ. कृपाशंकर सिंह, डॉ. चतुर्भुज सहाय
6. हिंदी का वाक्यात्मक कारण – प्रो. सूरजभान सिंह
7. भाषाविज्ञान के आधुनातन आयाम – डॉ. अंबादास देशमुख
8. ऐतिहासिक भाषा विज्ञान और हिंदी – राजेंद्र प्रसाद सिंह
9. भाषाविज्ञान : सैद्धांतिक चिंतन – रवींद्रनाथ श्रीवास्तव
10. भाषाशास्त्र के सूत्रधार – रवींद्रनाथ श्रीवास्तव
11. भाषाविज्ञान एवं हिंदी भाषा – लक्ष्मीकांत पाण्डेय/प्रमिला अवस्थी
12. भाषाविज्ञान एवं हिंदी भाषा – मुकेश अग्रवाल

13 भाषाविज्ञान, हिंदी भाषा और लिपि – राम किशोर शर्मा

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एम. ए. हिंदी साहित्य द्वितीय वर्ष

चतुर्थ अयन : (Fourth Semester)

पाठ्यचर्या : 15 हिंदी साहित्य का इतिहास (आधुनिक काल)

4 कर्मांक (Credit)

उद्देश्य :

1. हिंदी गद्य के उद्भव और विकास से छात्रों को अवगत कराना।
2. द्विवेदी युग, छायावाद, प्रगतिवाद, प्रयोगवाद और नई कविता के प्रमुख साहित्यिक प्रवृत्तियों, रचनाकारों और रचनाओं से परिचित कराना।
3. ऐतिहासिक दृष्टि विकसित करना।

इकाई	पाठ्यविषय	तासिकाएँ
इकाई– I	हिंदी गद्य का उद्भव और विकास : भारतेंदु पूर्व हिंदी गद्य : 1957 की क्रांति और सांस्कृतिक पुनर्जागरण : भारतेंदु युग, 19 वीं शताब्दी की हिंदी पत्रकारिता।	15 तासिकाएँ
इकाई– II	द्विवेदी युग : महावीरप्रसाद द्विवेदी और उनका युग, हिंदी नवजागरण और स्वरस्वती पत्रिका, राष्ट्रीय काव्यधारा के प्रमुख कवि, स्वच्छंदतावाद और उसके प्रमुख कवि।	15 तासिकाएँ
इकाई– III	छायावाद, प्रगतिवाद : छायावादी काव्य की प्रमुख विशेषताएँ, छायावाद के प्रमुख कवि। प्रगतिवादी काव्य और प्रमख कवि, प्रगतिवादी काव्य की विशेषताएँ।	15 तासिकाएँ
इकाई– IV	प्रयोगवाद, नई कविता : प्रयोगवाद के प्रमुख कवि, प्रयोगवाद की विशेषताएँ, नई कविता की विशेषताएँ, नई कविता के प्रमुख कवि।	15 तासिकाएँ

अंक विभाजन – पूर्णांक : 100

आंतरिक मूल्यांकन –50 (लघुत्तरी परीक्षा–20, शोध परियोजना–20, प्रस्तुतिकरण–10)

सत्रांत परीक्षा – 50

सत्रांत परीक्षा – प्रश्नपत्र का प्रारूप :

(शैक्षिक वर्ष 2020–21 से आगे)

समय : 3 घंटे **अंक 50**

प्रश्न : 1 इकाई एक पर दीर्घोत्तरी प्रश्न (दो में से एक)।	10 अंक
प्रश्न : 2 इकाई दो पर दीर्घोत्तरी प्रश्न (दो में से एक)।	10 अंक
प्रश्न : 3 इकाई तीन पर दीर्घोत्तरी प्रश्न (दो में से एक)।	10 अंक
प्रश्न : 4 इकाई चार पर दीर्घोत्तरी प्रश्न (दो में से एक)।	10 अंक
प्रश्न : 5 बहुविकल्पि प्रश्न – 12 में से 10 (चार में से एक सही विकल्प का चयन कीजिए।)।	10 अंक

संदर्भ ग्रंथ :

1. हिंदी साहित्य का इतिहास – आ. रामचंद्र शुक्ल
2. हिंदी साहित्य की भूमिका – आ. हजारीप्रसाद द्विवेदी
3. हिंदी साहित्य का आदिकाल – आ. हजारीप्रसाद द्विवेदी
4. हिंदी साहित्य का वैज्ञानिक इतिहास – डॉ. गणपतिचंद्र गुप्त
5. हिंदी साहित्य का आलोचनात्मक इतिहास – डॉ. रामकुमार वर्मा
6. हिंदी साहित्य और संवेदना का विकास – रामस्वरूप चतुर्वेदी
7. हिंदी साहित्य का इतिहास – डॉ. नगेंद्र
8. हिंदी साहित्य का अतीत – विश्वनाथ प्रसाद मिश्र
9. हिंदी साहित्य का दूसरा इतिहास – बच्चन सिंह
10. हिंदी साहित्य का इतिहास – प्रो. माधव सोनटक्के
11. हिंदी साहित्य का नया इतिहास – डॉ. राजेंद्र मिश्र

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एम. ए. हिंदी साहित्य द्वितीय वर्ष

चतुर्थ अयन : (Fourth Semester) वैकल्पिक

पाठ्यचर्या : 16 (क) भारतीय लोकसाहित्य

4 कर्मांक (Credit)

उद्देश्य :

1. लोकसाहित्य के स्वरूप एवं महत्व से परिचित कराना।
2. लोकसाहित्य के विविध प्रकारों से परिचित कराना।
3. लोक साहित्य की व्यापकता से परिचित कराना।
4. महाराष्ट्र के लोक साहित्य का परिचय देना।

इकाई	पाठ्यविषय	तासिकाएँ
इकाई– I	लोकसाहित्य की परिभाषा, स्वरूप एवं विशेषताएँ, लोक संस्कृति और साहित्य, भारत में लोकसाहित्य के अध्ययन का इतिहास।	15 तासिकाएँ
इकाई– II	लोक–साहित्य संकलन : उद्देश्य, संकलन की पद्धतियाँ, संकलन कर्ता की समस्याएँ तथा समाधान।	15 तासिकाएँ
इकाई– III	लोक–गीत : संस्कार, व्रत, श्रम, ऋतु, जाति। लोकनाट्य : रामलीला, रासलीला, कीर्तनिया, स्वांग, यक्षगान, भवाई, जात्रा। महाराष्ट्र का लोकनाट्य : तमाशा, गोंधळ, लावणी, पोतराज, सुंबरन, वासुदेव, भारुड, लळित, दशावतार, पोवाडा, कीर्तन।	15 तासिकाएँ
इकाई– IV	लोक–कथा : व्रत कथा, परी कथा, नाग कथा, बोध कथा, कथानक रूढ़ियाँ। लोक संगीत : लोकवाद्य तथा विशिष्ट लोक धुनें। लोकभाषा : लोक सुभाषित, मुहावरे, कहावतें, पहेलियाँ।	15 तासिकाएँ

अंक विभाजन – पूर्णांक : 100

आंतरिक मूल्यांकन –50 (लघुत्तरी परीक्षा–20, शोध परियोजना–20, प्रस्तुतिकरण–10)

सत्रांत परीक्षा – 50

सत्रांत परीक्षा – प्रश्नपत्र का प्रारूप :

(शैक्षिक वर्ष 2020–21 से आगे)

समय : 3 घंटे अंक 50

प्रश्न : 1 इकाई एक पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 2 इकाई दो पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 3 इकाई तीन पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 4 इकाई चार पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 5 बहुविकल्पि प्रश्न – 12 में से 10 (चार में से एक सही विकल्प का चयन कीजिए।)। 10 अंक

संदर्भ ग्रंथ :

1. भारतीय लोकसाहित्य – डॉ. श्याम परमार
2. लोकसाहित्य की भूमिका – डॉ. कृष्णदेव उपाध्याय
3. लोकसाहित्य की भूमिका – पं. रामनरेश त्रिपाठी
4. महाराष्ट्र की हिंदी लोककला – कृ. ग. दिवाकर
5. लोकसाहित्य और लोकसंस्कृति – दिनेश्वर प्रसाद
6. पारंपरिक भारतीय रंगमंच – कपिला वात्स्यायन, अनु. बरीउज्जया
7. लोकसाहित्य विज्ञान – डॉ. सत्येंद्र
8. लोकसाहित्य एवं लोक संस्कृति : परंपरा की प्रासंगिकता एवं सामाजिक परिप्रेक्ष्य – सं. वीरेंद्रसिंह यादव

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एम. ए. हिंदी साहित्य द्वितीय वर्ष

चतुर्थ अयन : (Fourth Semester) वैकल्पिक

पाठ्यचर्या : 16 (ख) भारतीय साहित्य

4 कर्मांक (Credit)

उद्देश्य :

1. भारतीय साहित्य से छात्रों को अवगत कराना।
2. भारतीय साहित्य का स्वरूप समझाना।
3. भारतीय साहित्य के अध्ययन की समस्याएँ सुलझाना।
4. भारतीयता का समाजशास्त्र समझाना।

इकाई	पाठ्यविषय	तासिकाएँ
इकाई– I	भारतीय साहित्य की अवधारणा, भारतीय साहित्य का स्वरूप, भारतीय साहित्य के अध्ययन की समस्याएँ।	15 तासिकाएँ
इकाई– II	भारतीय साहित्य में आज के भारत का बिंब, भारतीयता का समाजशास्त्र, हिंदी साहित्य में भारतीय मूल्यों की अभिव्यक्ति।	15 तासिकाएँ
इकाई– III	कन्नड साहित्य का इतिहास 1) पंपपूर्व युग 2) पंप युग 3) बसवा युग 4) कुमाराव्यास युग 5) आधुनिक युग	15 तासिकाएँ
इकाई– IV	रसीदी तिकट – अमृता प्रीतम। रचनाकार का व्यक्तित्व एवं कृतित्व, संवेदना एवं शिल्पगत अध्ययन।	15 तासिकाएँ

अंक विभाजन – पूर्णांक : 100

आंतरिक मूल्यांकन –50 (लघुत्तरी परीक्षा–20, शोध परियोजना–20, प्रस्तुतिकरण–10)

सत्रांत परीक्षा – 50

सत्रांत परीक्षा – प्रश्नपत्र का प्रारूप :

(शैक्षिक वर्ष 2020–21 से आगे)

समय : 3 घंटे **50 अंक**

प्रश्न : 1 इकाई एक पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 2 इकाई दो पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 3 इकाई तीन पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 4 इकाई चार पर दीर्घोत्तरी प्रश्न (दो में से एक)। 10 अंक

प्रश्न : 5 बहुविकल्पि प्रश्न – 12 में से 10 (चार में से एक सही विकल्प का चयन कीजिए।) 10 अंक

संदर्भ ग्रंथ :

1. रसीदी तिकट – अमृता प्रीतम, पराग प्रकाशन, दिल्ली
2. भारतीय साहित्य – डॉ. छबिला त्रिपाठी
3. भारतीय साहित्य – डॉ. ब्रजकिशोर प्रसाद सिंह।

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Savitribai Phule Pune University

(Formerly University of Pune)

M.A. ECONOMICS SYLLABUS

(CREDIT & SEMESTER SYSTEM)

Revised syllabus will be implemented with effect from the academic year 2020-2021 at College & P.G. Centers

M.A. ECONOMICS - PART II

(CREDIT & SEMESTER SYSTEM)

SYLLABUS: FROM JUNE 2020

Information:

The M.A. degree will be awarded to students who complete a total of 64 credits in a minimum of two years taking four courses per Semester (4X4=16 credits). Each course will be of 4 credits.

- A Student may take three courses (twelve credits) per semester from the parent department and therefore one course of four credits from any other department per semester. In case a student wishes to take all courses from the parent department he/she may also do so.
- All courses are open to all students from outside the department. Eligibility for registering for each course will be decided by the departmental committee.
- For the students doing M.A. degree in Economics the courses for divided into compulsory and Elective. Every student has to take three core courses and one elective course each semester.

Evaluation

- Each course will have 50% marks as End of Semester Examination and 50% marks for Continuous Assessment.
- The student has to pass in the combined total of Continuous Assessment and End of Semester Examination.
- In order to pass a student shall have to get minimum 40% marks (E and above on grade point scale) in each course. Any student getting less than16 marks in each component will be declared as failed, even if the combined total is over 40%.
- If a student misses a Continuous Assessment examination, he/she will have a second chance with the permission of the teacher concerned. Students who have failed for the entire course may reappear at the semester-end exam. Their internal marks will not change. They can also repeat during the 5th /the 6th semester whichever is applicable

Revised Syllabus To Be Implemented From Academic Year JUNE 2020-2021
at College & P.G. Centers

M.A. Part- II, Semester- III		**M.A. Part- II, Semester- IV**	
Core Papers Compulsory Paper		**Core Papers Compulsory Paper**	
EC-3001	Macro Economics Analysis-I	EC-4001	Macro I Economics Analysis II
EC-3002	Growth & Development -I	EC-4002	Growth & Development II
EC-3003	Research Methodology- I	EC-4003	**Research Project(Only Regular Students)** Research Methodology - II (Only External Students)

(Any ONE to be selected)

Elective Papers		**Elective Papers**	
EC-3004	Economics of Finance	EC-4004	Econometrics
EC-3004	Demography	EC-4004	Public Policy
EC-3004	Capital Market	EC-4004	Economics of Environment
EC-3004	Industrial Economics	EC-4004	Foreign Exchange Market

M.A. ECONOMICS PART- II

SEMESTER III

CORE PAPERS (COMPULSORY PAPER)
01 - MACRO ECONOMICS ANALYSIS - I
02 - GROWTH AND DEVELOPMENT- I
03 - RESEARCH METHODOLOGY- I

CORE COURSE
SEMESTER III
EC-3001
MACRO ECONOMICS ANALYSIS - I
(This course will have *FOUR* credits)

PREAMBLE

Macroeconomics or aggregative economics analysis establishes the functional relationship between various aggregates of the economy. Aggregative analysis assumed such a great significance in recent times that a prior understanding of macroeconomic theoretical structure is considered essential for proper comprehension of different issues and policies. Macroeconomics now is not only a scientific method of analysis but also a body of empirical economic knowledge. The course equips the students at the postgraduate level to understand systematic facts and theoretical developments for empirical analysis,

Course Objectives:

- To provide a thorough understanding of the principles of macroeconomics and the application of macroeconomic concepts in real-life situations.
- To discuss the modern developments in macroeconomics.

Programme Outcome:

- Ability to analyze and demonstrate knowledge of the basic theories/laws in macroeconomics.
- At the end of the course, the student should be able to evaluate macroeconomic concepts, models and its use in real life situations.

1. Traditional Approaches to Macroeconomics 12

1.1 Classical Approach-Introduction and main features
1.2 Keynesian Approach-Introduction and main features
1.3 Neoclassical Approach-Introduction and main features

2. **National Income and Social Accounting 12**

2.1 Circular Flow Income in two-three and four sector economy
2.2 Different forms of national income accounting-
2.2.1 Social accounting
2.2.2 Input-output accounting
2.2.3 Flow of funds Accounting
2.2.4 Balance of payments Accounting
2.2.5 Matrix presentation of Social Accounting

3. Demand and Supply of Money 12

3.1 Definition of Money, Debates relating to definition of Money
3.2 The Liquidity Theory, Gurley and Shaw Hypothesis, Demand for Money-Classical and Keynesian
3.4 Cash Balance Approach- Post Keynesian Theories of Demand for Money, Tobins Approach, Baumol's Inventory Theoretic Approach, Friedman’s Theory of Demand for Money.

4. Supply of Money **12**

4.1 Financial Intermediation
4.2 A Mechanistic Model of Bank Deposit Determination.
4.3 A Behavior Model of Money Supply Determination,
4.4 A Demand-determined Money Supply process,
4.5 RBI approach to Money Supply-High Powered Money and Money Multiplier; Budget Deficit and Money Supply, Money Supply and Open Economy.
4.7 Control of Money Supply.

BASIC READING LIST:

1. August Swanenberg (2005) 'Macroeconomics Demystified' A Self Teaching Guide, Mcgraw Hill Education
2. Ackley,G.(1978), Macro Economics : Theory and Policy, Macmillan, New York.
3. Agrawal Vanita, Macroeconomics: Theory and Policy, Pearson Publication, New Delhi.
4. Ahuja H.L., Macroeconomics: Theory and Practice, S.Chand & Co. New Delhi.
5. Blackhouse, R. and A. Salansi (Eds.) (2000) Macroeconomics and the Real World (2 Vols.), Oxford University Press, London. Dornbusch,
6. Campbell R. McConnell, Stanley L. Brue, (2001) Macroeconomics: Principples, Problems and Policies', McGraw Hill, Inc, New York.
7. Froyen Richard T (2006) 'Macroeconomics– Theories and Policies' Pearson Education; 8th edition
8. Gupta S.B. (1997) 'Monetary planning for India' OUP
9. Jha, R. (1991), Contemporary Macroeconomic Theory and Policy, Wiley Eastern Ltd., New Delhi.
10. Mankiw Gregory (2007) 'Macroeconomics' Worth, New York
11. Rao, V.K.R.V. (1983) India's National Income : 1950 to 1980, Saqe Publications, New Delhi
12. Gupta, S.B. (1995), Monetary Planning in India, OUP, New Delhi.
13. Sampat Mukherjee (2013), 'A Global Text-Macroeconomics', New Central Book Agency
14. Soumyen Sikdar (2006) 'Principles of Macroeconomics' Oxford University Press

Recommended Readings:

1. Branson, W.A. (1989), Macroeconomic Theory and Policy, (3rd Edition), Harper and Row, New York.
2. Culbertson, J.M. (1968), Macroeconomic Theory and Stabilization Policy, McGraw Hill, Kogenkosh, Tokyo.
3. Duesenberry, J.S. (1949), Income Saving and the Theory of Consumer Behaviour. Harvard University Press, Harvard.
4. Edey, M. and A.T. Peacock (1967), National Income and Social Accounts, Hutchinson University Library, London
5. Fisher, Dornbusch, Schamalensee (1988) 'Economics' McGraw Hill International Edition ; 2nd edition
6. Friedman, M. (1957), The Theory of Consumption Function, Princeton University Press Princeton.
7. Friedman, M. (1956), Studies in the Quantity Theory of Money, The University of Chicago Press, Chicago
8. Glahe, Fred, R.(1973), Macroeconomics: Theory and Policy, Harcourt Brace Javanovich, Inc, New York.
9. Harris Lawrrence (1980) 'Monetary Theory' McGraw Hill Inc.
10. Keynes, J.M. (1936), 'The General Theory of Employment Interest and Money',

Macmillan, London.
11. Ruggles, R. and N. Ruggles (1956), National Income Accounts and Income Analysis, McGraw Hill New York.
12. Shapiro, E.(1996) Macroeconomic Analysis, Galgotia Publications, New Delhi.
13. D.Wrightsman 'An Introduction to Monetary Theory and Policy' The Free Press New York 1983
14. Bhise V.B , Khandare V.B & Babar , (2014) Macro Economics ,Chinmay Publication Aurangabad.
15. Kute S & Rithe M ,Macro Economics , Prashant Publication Jalgaon, MS ,India.

Recommended Journals:

Applied Economics- Taylor & Francis Online
Journal of Macroeconomics-Elsevier
Macroeconomics and Finance in Emerging Market Economies- Taylor & Francis Online
The Indian Economic Journal- Sage Journal

CORE COURSE
SEMESTER III
EC- 3002
GROWTH AND DEVELOPMENT- I
(This course will have *FOUR* credits)

PREAMBLE

The course makes an attempt to provide an introduction to the economics of Growth and Development and at the same time provide an understanding of the analytical rigour of the subject. Growth and Development-I is a core course that covers meaning and concept of Economic Growth and Development, measuring the economic growth and development, theories of economic growth and development, poverty, inequality and unemployment and role human capital in economic development . Growth and development-I will try to clear the concepts regarding the economic growth and development and provides basic knowledge to the students to get engaged in the activities.

Course Objectives:

- To enable learning and understanding of the basic concepts and process to measure the growth and economic development etc.
- To analyze and evaluate the obstacles in the process of economic growth and development

Programme Outcome:

- Ability to apply the concepts of economic growth and compare international comparison of economic development, etc.
- Ability to analyze and demonstrate knowledge of the economic growth and development theories of economic growth and development

1 Principles and Concepts of Growth and Development 12

1.1 Concepts of growth and Development
1.2 Measuring Economic Development: Income and Alternative Measures
1.3 International Comparison of Incomes: PPP and Exchange Rate Approaches
1.4 Developing / Emerging Economies – Concept
1.5 Barriers to Economic Development

2 Theories of Economic Development and Growth 12

2.1 Classical Theory of Economic Development: Adam Smith
2.2 The Harrod-Domar Model
2.3 Solow model of economic growth
2.4 The Cobb-Douglas Production Function
2.5 The Big push theory
2.6 The New (Endogenous) Growth Theory

3 Poverty, Inequality and Unemployment 12

3.1 Measurement of Poverty- Uni-dimensional & Multi-dimensional, Amartya Sen's Approach to Poverty measurement, Rural and Urban Poverty, Participatory Approach to Poverty, Women and Poverty
3.2 Measuring Inequality, Lorenz Curve, Gini Coefficient, Functional Distribution,
3.3 Challenge of Unemployment, Disguised Unemployment and Economic Development, Concept of Jobless Growth
3.4 Employment and Migration

4 Human Capital and Economic Development 12

4.1 Theory of Demographic Transition
4.2 Human Capital Approach of Development
4.3 Demographic Dividends
4.3 Education, Skill and Wages, Health and Efficiency to Work
4.5 Optimum Population

Basic Reading List:

1. Basu Kaushik (1998) Analytic Development Economics: The Less Developed Economy Revisited', OUP
2. Behrman, S. and T.N. Srinivasan (1995), Handbook of Development Economics, Vol. 3, Elsevier, Amsterdam.
3. Felix Raj, Sampat Mukherjee, Mallinath Mukherjee, Amitava Ghose, Ranjanendra N. Nag (2007) "Contemporary Development Economics From Adam Smith to Amartya Sen", New Central Book Agency Private Limited
4. Gillis, M., D.H. Perkins, M. Romer and D.R. Snodgrass (1992), Economics of Development,(3rd Edition), W.W. Norton, New York.
5. Kindleberger, C.P. (1977), Economic Development, (3rd Edition), McGraw Hill, New York
6. Meier Gerald M. and James E. Rauch, "Leading Issues in Economic Development" Oxford University Press, 2006
7. Ray Debraj (1998) "Development Economics", Oxford University Press
8. Solow Robert M. (2000) "Growth Theory An Exposition" Oxford University Press
9. Thirwal, A.P. (1999), (6th Edition), Growth and Development, Macmillan, U.K.
10. Todaro, M.P. (1996), (6th Edition), Economic Development, Longman, London.

Recommended Readings:

1. Banerjee Abhijit V, Esther Duflo (2013) 'Poor Economics: Rethinking Poverty & the Ways to End it' Penguin
2. Barro Robert J. and Xavier Sala-i-Martin (2004) "Economic Growth " Prentice Hall of India Brown, M. (1966), On the Theory and Measurement of Technical Change, Cambridge University Press, Cambridge, Mass.
3. Chenery, H. and T.N. Srinivasan (Eds.) (1989), Handbook of Development Economics, Vols.1 & 2, Elsevier, Amsterdam
4. Dasgupta, P. (1993), An Enquiry into Well-being and Destitution, Clarendon Press, Oxford.
5. Gillis, M., D.H. Perkins, M. Romer and D.R. Snodgrass (1992), Economics of Development,(3rd Edition), W.W. Norton, New York.
6. Meier, G.M. (1995), Leading Issues in Economic Development, (6th Edition), Oxford University Press, New Delhi.
7. Nayyar Deepak (2019) 'Resurgent Asia' OUP
8. Todaro Michael (1981) "Economics for A Developing World", Longman, London.
9. Wavre Anilkumar & Londhe M , Economics of Development and Planning , (2019) Educational Publishers , Jalgaon , MS, India**.**

Reports:

- Human Development Report, 1995-2009, UNDP, OUP Latest Reports
- RBI Bulletin (latest issues)
- World Development Report, Latest Reports
- World Development Indicators, World Bank, OUP, Latest Reports

Recommended Journals:
Economic Development and Cultural Change- Chicago Press
Journal of Development Economics-Elsevier
IMF Economic Review- Palgrave Macmilan
Oxford development Studies- Rouledge
Review of Development Economics-Wiley
Review of World Economics-Springer
Review of Economic Dynamics- Elsevier

CORE COURSE
SEMESTER III
EC- 3003
RESEARCH METHODOLOGY I
(This course will have *FOUR* credits)

PREAMBLE

The main objective of this paper is to make the students aware of the importance of Research Methodology. Today research is of importance in every field of life. Hence students need sound initiation in the world of research. Thus this syllabus is prepared to equip students with basics of research methodology and also provide them acquaintance with the main ingredients of major sources secondary data on Economics, some hands-on experience in conduct so survey including designing questionnaire and interview schedules, collection of data, analysis of data and preparation of report.

Course Objectives:

- To enable an understanding of Research and its methods under various areas of economics.
- To demonstrate the practical and the applied aspects of research in relation to Economics.

Programme Outcome:

- Ability to develop, demonstrate and examine topics under Economics to pursue research.
- Ability to evaluate and examine subject areas in economics and explore possibilities of research.

1 Introduction **08**

1.1 Research : Meaning ,Nature , Scoup. And Importance
1.2 Scientific Research : Methods - Stages /Steps
1.3 Social Science Research - Meaning ,Nature , Scoup. And Importance
1.4 Review of Literature- Need, Scope, Use and Precautions

2 Research Problem And Design **10**

2.1 Research Problem- Meaning, Identification and Selection of Research Problems
2.2 Research design ; Meaning , Objective ,
2.3 Need , Characteristics of Research design
2.4 Types of research Design – Descriptive, Diagnostic ,Exploratory, Experimental

3 Data Collection And Data Analysis **12**

3.1 Collection of Data – Meaning ,Importance
3.2 Sources of data – Primary Data And secondary data
3.3 Methods of Primary Data Collection- Questionnaire and Interview method, Schedule , Observation Method; ,
3.4 Secondary Data Sources
3.5 Sampling Method –Meaning and Types—(Probability and Non-probability)
3.6 Analysis of Data- Classification and Tabulation of Data
3.7 Computer Use Of Data Analysis

4 Testing of Hypothesis **12**

4.1 Hypothesis: Definitions, Characteristics and Importance
4.2 Types Of Hypothesis
4.3 Procedure of Hypothesis Testing

4.4 Basic Concepts: Level of Significance, Statistical Errors (Type --I and Type II Error)
4.3 Procedure of Testing of Hypothesis- Parametric and Non-Parametric tests

5 Report Writing **10**

5.1 Objective of Report Writing
5.2 Importance of Research Report,
5.3 Features of Research Report
5.4 Steps/ Element of Research Report
5.5 Report Writing: Considerations and Precautions,
Ordering References , Bibliography and Appendix in Research

Basic Reading List:

1. Banamati Mohanty (2015) 'Statistics for Behavioral and Social Sciences' Sage Texts
2. Bryman Alan (2018) 'Social research methods' OUP
3. Cooper Donald R. & Pamela S. Schindler (1999), "Business Research Methods", Tata McGraw-Hill Edition, New Delhi
4. Flick Uwe (2011) 'Introducing Research Methodology' Sage Publications
5. Kothari C. R, Gaurau Garg (2019) 'Research Methodology, Methods and Techniques", New Age International Publications, 4th Edition
6. Kumar Ranjit, (2012), "Research Methodology" 2nd Ed, Pearson Education
7. Wilkinson and Bhandarkar (2016) 'Methodology and Techniques of Social Science Research; HPH
8. Willson Jonathan (2017) 'Essentials of Business Research: A Guide to Doing Your Research Project' Sage Publications

Recommended Readings:

1. Basotia G.R. Sharma K.K. (1999) 'Research Methodology' Mangal Deeop Publications
2. Don E. Ehridge (2004) 'Research Methodology in Applied Economics: Organizing Planning and Conducting Economics Research', John Wiley and Sons
3. Gopal M.H. (1971) 'An Introduction to Research Procedure in Social Sciences', Asia Publishing House
4. Kothari S. R (2012) 'Research Methodology, Methods and Techniques", Pragun Publications.
5. Khandhare V.B., Yadav Y.,2016, Chinmay Publication ,Aurangabad.
6. Krishnaswamy, O.R. (1993) 'Methodology of Research In Social Sciences, HPH
7. Kurein C. T. (1973) A Guide to Research in Economics' Sangam Publishers for Madras Institute of Development Studies
8. Les Oakshott (2012) 'Essential Quantitative Methods for Business, Management and Finance', Palgrave Macmilan, 5th edition
9. Moser C.A., G. Kalton (1985) 'Survey Methods in Social Investigations' Routeledge
10. BAV Sharma D Ravindra Prasad and P. Satyanarayana (1983) Research Methods in Social Sciences' Sterling publishers, New Delhi
11. Sadhu AN, Amarjit Singh (2007) 'Research Methodology in Social Sciences' HPH
12. Thakur Devendra (2009) 'Research Methodology in Social Sciences' Deep and Deep Publiations
13. Young P.V. (1984) 'Scientific Social Survey and Research', Prentice Hall -India

Recommended Journals:
Journal of Mixed Methods Research- Sage
Journal of Applied Social Sciences- Sage
Research in Economics- Elsevier
Social Science Research- Elsevier
The Social Science Journal – Elsevier/ ScienceDirect

M.A. ECONOMICS PART- II

SEMESTER III

ELECTIVE PAPERS
EC-3004
(Choose Any ONE Paper)

01- ECONOMICS OF FINANCE
02- DEMOGRAPHY
03- CAPITAL MARKETS
04- INDUSTRIAL ECONOMICS

ELECTIVE COURSE
SEMESTER III
EC-3004
ECONOMICS OF FINANCE
(This course will have *FOUR* credits)

PREAMBLE

The positive and significant role of financial institutions in the process of growth and development has been very well recognized in the literature and indeed has become more important during the last two decades as the financial systems of different countries have become integrated in the process of globalization. It is, therefore, essential that the student of economics should be well conversant with the theory and practice of different financial institutions and markets; to understand and analyze the interconnection between the monetary forces and real forces, their developmental role and limitations in shaping and influencing the monetary and related policies both at the national and international levels.

Course Objectives:

- To provide an understanding of Finance and its application under various topics under economics.
- To demonstrate the practical and the applied aspects of Finance in relation to Economics.

Programme Outcome:

- Ability to develop, demonstrate and examine various topics under Finance with the help of Economics.
- Ability to evaluate and examine subject areas in economics bringing out the relation to finance.

1. Introduction **10**

1.1 Role of Finance in economic development.
1.2 Structure and functioning of the Financial system – Financial Intermediaries, Financial Markets and Financial Instruments
1.3 Markets and Aspects of Risk Sharing, The Problem of Agency

2. Basic Financial Calculations 1**0**

2.1 Types of Financial securities- Fixed Income Securities, Bonds, Index-linked securities
2.2 The time value of money, Future Value of Asset, Present Value of Asset; Future and present values of multiple cash flows.
2.3 Relation Between Inflation and Interest Rates, Real and Nominal Cash Flows, Valuing Real Cash Payments, Effective Annual Interest Rates
2.4 Bond valuation- Characteristics of Bonds.

3. Portfolio Theory 10

3.1 Asset Return- random variables and random returns
3.2 Capital Asset Pricing, Validity of CAPM (Capital Asset Pricing Model), the CAPM, Risk and Return
3.3 Arbitrage Pricing Theory
3.4 Measuring portfolio return and risks, effect of Diversification, Minimum Variance Portfolio, Perfectly Correlated Assets, Minimum Variance Opportunity Set, Optimal Portfolio Choice; Mean Variance Frontier Of Risky and Risk-Free Asset, Portfolio Weights

4. Efficient Market Hypothesis 10

4.1 Efficient Market Hypothesis

4.2 Valuing Stocks, Book Values, Liquidation Values and Market Values, Valuing Common Stocks, The Price-Earnings Ratio

4.3 The Dividend Discount Model -The Dividend Discount Model with No Growth, The Constant-Growth Dividend Discount Model

5. Risk, Return, and Capital Budgeting 08

5.1 Measuring Market Risk, Using the CAPM to Estimate Expected Returns, Capital Budgeting and Project Risk, Determinants of Project Risk

5.2 Introduction to risk, return and opportunity cost of capital, Estimating Expected Rates of Return,

5.3 Measuring Risk Variance and Standard Deviation Measuring the Variation in Stock Returns Risk and Diversification Asset versus Portfolio Risk

BASIC READING LIST

1. Bhole L.M. (2004) 'Financial Institutions and Markets', Tata McGraw Hill
2. Chandra P. (2017), ' Investment Analysis and Portfolio Management', McGraw Hill Education, Fifth Edition
3. Frederic Mishkin (2019) 'The Economics of Money, Banking and Financial Markets' Pearson Education India, 11th edition
4. Frederic Mishkin and Stanley Eakins (2006) "Financial Markets and Institutions", Pearson 5th Ed
5. Fabozzi Frank J. (2016) Bond Market Analysis and Strategies' Pearson, 8th edition
6. Hull John C (2018) "Fundamentals of Futures and Options Market", Pearson Education, 9th Edition
7. Hull John C, Sankarshan Basu (2018) "Options, Futures and Other Derivatives", Pearson Education, 10th Edition
8. Richard A Brealey, Stewart C Myers, and Alan J. Marcus (2003) 'Fundamentals of Corporate Finance', Third Edition; McGraw-Hill, Inc

Recommended Books

1. Ajay Shah Susan Thomas Michael Gorham (2008) "Indian Financial Markets: AN Insider's Guide to How the Market Works" Elsevier Science
2. Baye Micheal R, Dennis W Jansen (1996) " Money, Banking & Financial Markets An Economic Approach", A.I.T.B.S. Publishers & Distributors. Delhi
3. Chandra P. (1997), " Financial Markets", Tata McGraw Hill, 4th Edition
4. David G. Lueberger (2012) "Investment Science", OUP, 1st edition
5. Elton Edwin J, Martin J Gruber, Stephen J Brown & William Goetzmann (2002) "Modern Portfolio Theory and Investment Analysis" John Wiley & Sons
6. Fama E.F. (1997) "Foundations of Finance", Basil Blackwell, Oxford, Ch.5
7. Hauthkkar H.S., Williomson P.J., (1996) "The Economics of Financial Market", OUP
8. Hearth Douglas & Zaima J K (1998) "Contemporary Investment: Security and Portfolio Analysis" The Dryden Press
9. Hull John C (2018) "Risk Management and Financial Institutions", John Wiley & Co
10. LeRoy Stephen F, Jan Werner (2014) "Principles of Financial Economics" Cambridge University Press
11. Ross Stephen and Rudolph W.W., (1998) " Fundamentals of Corporate Finance", McGraw Hill

12. Smith, P.F., (1978), “Money and Financial Intermediation: The Theory and Structures of Financial System”, Prentice Hall
13. Susan Thomas, (ed) (2003) “Derivatives Market in India”, Invest India
14. Wavre A. & Dhonde S , Finance of Village Panchayat , Shubhan publication , Kanpur. UP, India
15. Zvi Bodie, Robert C. Merton, Devid L. Cleeton (2008) “ Financial Economics” Pearson

Recommended Journals:

Journal of Finance- Wiley Online
Journal of Applied Statistics- Francis & Taylor
Journal of Banking and Finance – Elsevier
Global Finance Journal – Elsevier

ELECTIVE COURSE
SEMESTER III
EC-3004
DEMOGRAPHY
(This course will have *FOUR* credits)

PREAMBLE

The main objective of this paper is to make the students aware of the importance of population in economic development and the various theories that explain the growth of population in a country. The paper also enlightens the students on the quantitative and the qualitative aspects and characteristics of the population through various demographic techniques. In recent times, the gender aspect of the population has acquired importance and these have also been included in the framework of study. Fertility and Aging are also vital characteristics of the undergoing structural change. Their study is essential to understand the dynamics of this change. The paper exposes the students to sources of population and related characteristics and also to the rationale, need and evolution of population policy.

Course Objectives:

- To provide an understanding of Demography and its application under various topics under economics.
- To demonstrate the practical and the applied aspects of Demography and the study of Population and its relation to Economics.

Programme Outcome:

- Ability to develop, demonstrate and examine various topics under Demography.
- Ability to evaluate and examine subject areas in economics bringing out the relation to population studies and demography.

1. **Demography** 10

1.1 Demography: Evolution, Nature and Scope
1.2 Development of Population Studies - relationship with other disciplines
1.3 History of Population Growth – Primitive, Pre-Industrial, Developed and Developing
1.4 Population Growth- Components, Interdependence, World Population Growth and Distribution, Growth in Developed and Developing Countries
1.5 Measures of Population Growth- Sources of Demographic Data

2. **Population theories** 14

2.1 The Malthusian theory
2.2 Post-Malthusian Theories
2.3 The Optimum Population Theory
2.4 The Theory of Demographic Transition
2.5 Population and Development (Meadows, Enke and Simon)

3. Population structure and characteristics 10

3.1 Structure of Population, Growth Rate and
3.2 Mortality- Meaning, Measurement of Mortality, Measures - causes of death.
3.3 Fertility- Meaning, Measurement of Fertility, Extent and Trends of Fertility, Factors affecting Fertility, Fertility Differentials in India
3.4 Pattern of Age and Sex Structure- Determinants, Impact and Implications; Age and Population

4. **Population and Development** **14**

4.1 Relation between Population and Development; Effects of Development on Population Growth and vice versa

4.2 Population and Natural Resources- Demographic and Socio-economic factors influencing Saving, Investment, Capital Formation and Technology

4.3 Population and Labour force- Population and Employment, Economically Active Population, Work Participation

4.4 Women and Development- Indicators of Status of Women, Inter-relation between Status of Women and Demographic Change

4.5 Population Policy in India- Shift from Population Control from Welfare and Empowerment; Strategies for Population Control and Human Development, Challenges to National Population Commission

Basic Reading List

1. Bogue, D.J. (1971), Principles of Demography, John Wiley, New York
2. Bhende, Asha A., Tara Kanitkar (2013) *Principles of Population Studies,* Himalaya Publishing House, Mumbai
3. Mujumdar P. K (2013) "Indian's Demography: Changing Demographic Scenario in India", Rawat Publications
4. Sinha V.C.,Easo Zacharia (1986) 'Principles of Demography' Allied Publishers, 2nd Edition
5. Srinivasan Krishnamurthy (2017) "Population Concerns in India: Shifting Trends, Policies and Programs" Sage Publications
6. Srinivasan, K. and A. Shariff (1998), India: Towards Population and Demographic Goals, Oxford University Press, New Delhi

Reports

1. Census of India, Census Commissioner and Registrar General of India, Government of India, New Delhi, Latest Census
2. Family Welfare Programme in India, Year Book 2012, Government of India
3. National Family Health Survey, Government of India & IIPS, Mumbai, Recent Reports
4. National Population Policy 2000, Government of India
5. United Nations (1973) " Determinants and Consequences of Population Trends"

Recommended Books

1. Agarwala S.N. (1972), " India's Population Problem", Tata McGraw-Hill Co
2. Bose, A. (1996), "India's Basic Demographic Statistics", B.R. Publishing, New Delhi
3. Chakraborti Rajagopal D (2004) "The Greying of India: Population Ageing in the Context of Asia" Sage Publications
4. Chenery H., T.N. Srinivasan (Eds.) (1989),"HandBook of Development" Economics, Vol.1 & 2 Elsevier, Amsterdam
5. Choubey, P.K. (2000), "Population Policy in India", Kanishka Publications, New Delhi
6. Dasgupta Sukti, Sher Singh Verick (2016) "Transformation of Women at Work in Asia: An Unfinished Development Agenda" Sage Publications
7. Easterlin Richard A (1987) "Population and Economic change in Develo0ping Countries", National Bureau of Economic Research, University of Chicago Press
8. G Giridar (Ed) (2014) "Population Aging In India" Cambridge University Press
9. Gulati, S.C. (1988), "Fertility in India: An Econometric Study of a Metropolis", Sage, New Delhi. Economics
10. Seth Mira (2001) "Women and Development: The Indian Experience", Sage

11. Simon,J.L.(1992), " Population and Development in Poor Countries", Princeton University Press.
12. Srinivasan, K. (1998), "Basic Demographic Techniques and Applications", Sage, New Delhi
13. Kute S & Rithe M , Demography , (2017) ,Prashant Publication , Jalgaon MS, India .

Recommended Journals:

Antyajaa – Indian Journal of Women and Social Change - Sage
Demography – Springer
Economic and Political Weekly
Journal of Population Research - Springer
Journal of Demographic Economics - Cambridge
Management and Labour Studies- Sage
Population and Development Review – Wiley Online
Population Studies – Taylor and Francis Online

ELECTIVE COURSE
SEMESTER III
EC-3004
CAPITAL MARKETS
(This course will have *FOUR* credits)

PREAMBLE

Finance Systems and Markets are specialized areas in Economics and Finance. Financial Markets discuss market structures, financial institutions, financial markets, financial instruments and services. The subject discusses the capital markets in the Indian as well as the international context with reference to the changing structure, role of regulatory bodies, self-regulation, development of various new instruments and institutions.

Course Objectives:

- To develop an understanding of the financial system in the theoretical context.
- To interpret the developments in the capital markets w.r.t. institutions and instruments and compare and contrast with International Capital Markets

Programme Outcome:

- Ability to interpret and analyze the scenario in Indian and Global markets.
- Ability to discuss and debate on the changing scenario in global market.

1 Introduction **12**

1.1 Structure of Capital Market-
- 1.1.1 Government Securities Market and Industrial Securities Market;
- 1.1.2 Primary and Secondary Markets,
- 1.1.3 Equity, Debt & Derivatives Market

1.2 Developed and Underdeveloped Capital Markets
1.3 Regulation of Capital Markets-Securities & Exchange Board of India (SEBI)-Objective & Role

2 Constituents & Instruments of Capital Market **12**

2.1 Government
2.2 Stock Exchanges- Meaning & Types
2.3 Financial Institutions
2.4 Commercial banks
2.5 Credit Rating Agencies- Purpose & Role
2.6 Other Institutions – Mutual Funds, Merchant Bankers, Underwriters, etc.
2.7 Portfolio Investors (Foreign Institutional Investors)
2.8 Instruments in the Capital Market- Equity, Debt & Derivatives- Types; Hybrid Instruments

3 Stock Exchanges **12**

3.1 Stock Exchanges- Meaning and Types
3.2 Stock Exchanges-Operations and Trading, Settlement
3.3 Stock Market Indices- Meaning & Calculation of Stock Indices (BSE/NSE)
3.4 Demutualization of Stock Exchanges
3.4 Dematerialization of Stocks/Shares

4 Indian Capital Market Changing Scenario 12

4.1 Changes in the Indian Capital Market Pre and Post Liberalization
4.2 Emergence of Financial Services- Venture Capital, Lease Finance, Angel Finance, Crowd Funding, Pension Funds
4.3 Globalization of Capital Markets – Instruments, Intermediaries and Risk Management
4.4 Risk Management and Financial Crisis in Emerging Market Economies

Basic Reading:

1. Brandl Micheal (2019) 'Money, Banking, Financial Markets and Institutions' Cengage Learning
2. Bhole, L. M., Jitendra Mahakud (2017) 'Financial Institutions and Markets' Tata McGraw Hill, ND
3. Fabozzi Frank J., Steven V. Mann, Moorad Choudhry (2002) 'The Global Money Markets' John Wiley & Sons
4. Frederic Mishkin and Stanley Eakins (2006) 'Financial Markets and Institutions', Pearson 5th Edition
5. Madura Jeff (2014) 'Financial Institutions and Markets' Cengage
6. Saunders Anthony and Cornett Marica Millon (2017) "Financial Markets and Institutions - An Introduction to the Risk Management Approach" McGraw Hill Education 3rd Edition

Recommended Readings:

1. Bhole, L. M. (2000) 'Indian Financial System' Chugh Publications, Allahabad
2. Batra G.S. "Financial Services and Markets", New Delhi: Deep and Deep Publications Pvt. Ltd., Latest Ed.
3. Das S. C. (2015) 'The Indian Financial System: Markets, Instruments, Institutions, Services and Regulations' PHI Learning
4. Kothari Rajesh. "Financial Services in India Concept and Application", New Delhi, Sage Publications. 2010.
5. Gurusamy S (2004) "Financial Services and Markets", Vijay Nicole Imprints
6. Meir Kohn (2013) 'Financial Institutions & Markets; OUP
7. Machiraju H.R. (2006) 'Indian Financial System, Vikas Publications, New Delhi
8. Pathak, Bharati (2009) 'The Indian Financial System, Pearson Education

Recommended Journals:

Indian Journal of Research in Capital Markets-
Journal of Capital Markets- Elsevier
Journal of Capital Market Studies- Emerald Insights

ELECTIVE COURSE
SEMESTER III
EC-3004
INDUSTRIAL ECONOMICS
(This course will have *FOUR* credits)

PREAMBLE

The main objective of this paper is to make the students aware of the importance of industrial sector in economic development. The paper explores the emergence of Industrial economics as a separate area of study; the theories of location are discussed and debated in the present context and analyzed with reference to the development of the industrial sector. The study is essential to understand the dynamics of the changes in the Industrial sector in India as well as around the world. The paper exposes the students to the current challenges to the industrial sector – growth, productivity, changing policy and performance.

Course Objectives:

- To provide an understanding of Industry, Industrial sector and growth and its relation to various economic issues and challenges.
- To demonstrate the practical and the applied aspects of Industrial economics and the study of Industry and its relation to Economics.

Programme Outcome:

- Ability to develop, demonstrate and examine various topics under Industrial Economics.
- Ability to evaluate and examine subject areas in economics bringing out the relation to industry and industrial development.

1 Introduction **10**

1.1 Industrial Economics – Emergence, Meaning and Definition
1.2 Scope and Importance of Industrial Economics
1.3 Classification of Industries
1.4 New Empirical Industrial Organization Approach

2 Theories of Industrial Location **14**

2.1 General Determinants of Industrial Location
2.2 Theories of Industrial Location
    2.2.1 Alfred Weber's Theory of Industrial Location
    2.2.2 Sergeant Florence's Theory of Industrial Location
2.3 Policy of Industrial Location in India
2.4 Need for Balanced Regional Development

3 Industrial Productivity and Growth **10**

3.1 Industrial Productivity - Norms and Measurement
3.2 Factors affecting Productivity and measures to improve Productivity,
3.3 Public Enterprises- Efficiency, Productivity and Performance
    (Case for/against India)
3.4 Skill Development and Industrial Productivity
3.5 Industrial Growth in India: Cause for Concern, Challenges to Private Sector
3.6 Policy Measures to enhance Industrial Growth

4 Industrial Policies in India 14

4.1 Industrial Policy in India – Progress since 1991
4.2 Developments in Industrial Policy – Special Economic Zones, 'Make in India', Public Private Partnership
4.3 Changing Role and Performance of Public and Private Sector in India
4.4 Developments in Policy for MSMEs since 1991
4.5 Development in FDI Policy, Emergence of Indian Multinational Companies
4.6 Globalization of Labour Markets and Impact of Emerging Economies

Basic Reading List:

1. Barthwal R.R. (2019), 'Industrial Economics,' New Age Publications
2. Das Keshab (2011) 'Micro and Small Enterprises in India: The Era of Reforms' Routledge India
3. Flanagan Robert J. (2006) 'Globalization and Labor Conditions: Working Conditions and Worker Rights in a Global Economy, OUP
4. Hajela, P.D. (1998), Labour Restructuring in India: A Critique of the New Economic Policies, Commonwealth Publishers, New Delhi
5. Jaya Prakash Pradhan (2008) 'Indian Multinational in the World Economy: Implications for Development', Bookwell Publications
6. Khanna Tarun (2008) 'Billions of Entrepreneurs: How India and China are Reshaping their Future and Yours' Penguin India
7. Gupta Parul (2019) 'Industrial Relations and Labour Laws for Managers' Sage Pub.
8. Sharma RC (2016) 'Industrial Relations and Labour Laws' PHI Learning
9. Sinha P.R.N., Indu Bala Sinha (2017) Industrial Relation Trade Unions and Labour Legislation Pearson Publication. New Delhi
10. Saumitra Mohan (2018) "Indian Policy and Development: A Manual for National Schemes and International Policies" McGraw Hill Education

Recommended Readings:

1. Agarwal Aradhana (2012) 'Social and Economic Impact of SEZs in India' Oxford University Press
2. Amit Kumar (2013) 'SMEs in India in post-1990s Era: Challenges and Opportunities, LAP Lambert Academic Publishing
3. Barthwal R.R. (1985), 'Industrial Economics,' Wiley Eastern Ltd., New Delhi.
4. Desai, B. [1999], 'Industrial Economics in India,' HPH
5. Divine, P.J. and R.M. Jones et.al. (1976), 'An Introduction to Industrial Economics,' George, Allen and Unwin Ltd., London.
6. Kumar V Pratap, rajesh Chakrabarti (2018) Public-Private Partnerships in Infrastructure: Managing the Challenges (India Studies in Business and Economics) Springer
7. Kuchhal, S.C. (1980), Industrial Economy of India, Chaitanya Publishing House, Allahabad.
8. Singh, A. A.N. Sandhu. [1988],'Industrial Economics,' HPH
9. Vepa R. K, (1988) Modern Small Industry in India, Sage Publication
10. Venkataratnam, C.S. (2001), Globalization and Labour- Management Relations: Dynamics of Changes, Sage Publications/Response Books, New Delhi.

Recommended Journals:

Applied Economics- taylor & Francis Online
International Journal of Economics and Business research- Inderscience
International Journal of Industrial Organization- Elsevier
The Journal of Industrial Economics- Wiley
The Journal of Industrial Economics- Scimago

M.A. ECONOMICS PART- II

SEMESTER IV

CORE PAPERS(COMPULSORY PAPER)

EC- 4001 - MACRO ECONOMIC ANALYSIS II
EC- 4002 - GROWTH & DEVELOPMENT II
EC- 4003 - RESEARCH PROJECT
(ONLY RGULAR STUDENTS)
EC- 4003 - RESEARCH METHODOLOGY
(ONLY EXTERNAL STUDENTS)

CORE COURSE
SEMESTER IV
EC- 4001
MACRO ECONOMIC ANALYSIS II
(This course will have *FOUR* credits)

PREAMBLE

Macroeconomics or aggregative economics analysis establishes the functional relationship between various aggregates of the economy. Aggregative analysis assumed such a great significance in recent times that a prior understanding of macroeconomic theoretical structure is considered essential for proper comprehension of different issues and policies. Macroeconomics now is not only a scientific method of analysis but also a body of empirical economic knowledge. The course equips the students at the postgraduate level to understand systematic facts and theoretical developments for empirical analysis,

Course Objectives:

- To provide a thorough understanding of the principles of macroeconomics and the application of macroeconomic concepts in various contexts.
- To discuss the modern developments in macroeconomics.

Programme Outcome:

- Ability to analyze and demonstrate knowledge of the basic theories/laws in economics- general equilibrium psychological law of consumption, etc.
- At the end of the course, the student should be able to evaluate macroeconomic concepts, models and its use in real life situations.

1. Aggregate Demand and Aggregate Supply Analysis 12

1.1 Aggregate Demand Curve (with price flexibility)-Derivation of aggregate demand curve-shift in aggregate demand curve and multiplier effect

1.2 Aggregate Supply curve (with variable prices)-shift in aggregate supply curve-long-run aggregate supply curve –Derivation of Aggregate supply curve-

1.3 Macroeconomic equilibrium: AS-AD Model-Friedman's Natural Rate Hypothesis-Economic Fluctuations

1.4 Three Models of the Upward Sloping SRAS (short-run aggregate supply curve) –The Sticky Wage Theory, The Sticky Price Theory and The Misperceptions (Fooling) Theory

2. The IS-LM Curves Model 12

2.1 Introduction-The Structure of the Model

2.2 Derivation of IS Curve and LM Curve –Shifts in IS Curve and LM curve, causes in shifts in IS and LM Curve.

2.3 Simultaneous Equilibrium in Goods Market and Money Market-Extension IS-LM model with government sector Fiscal policies.

2.4 Extension of IS-LM model with Labor Market and flexible prices.

3. Inflation-Unemployment Trade-Off: Phillips Curve and Rational Expectations Theory 12

3.1 Inflation and Unemployment-Phillips curve-Explanation of Phillips curve.

3.2 Causes of shifts in Phillips Curve- Long-run Phillips curve and adaptive expectations – Long-run Phillips curve: Rational expectations.

3.3 Relation between short-run Phillips curve and long-run Phillips curve.

3.4 Stagflation and Supply-side Economics-stagflation in India-1991-04, causes of stagflation
3.5 Supply-side economics-basic propositions of supply-side economics-Taxation and labour supply, Incentive to save and investment, the tax wedge-tax revenue and Laffer curve, a critical appraisal of supply side economics.

4. The New Classical Macro Economics & the Open Economy Issues 12

4.1 Introduction -Meaning of Rational Expectations- Barrow's view
4.2 The New Classical Model
4.3 The Role of the Monetary and Fiscal policy
4.4 Rational Expectations and the Real Business Cycles
4.5 Criticism of the Rational Expectations Hypothesis.
4.6 Open Economy-Balance of Trade-Balance of Payments-Mundel-Fleming Model, Exchange Rate Regimes.

BASIC READING LIST:

15. August Swanenberg (2005) 'Macroeconomics Demystified' A Self Teaching Guide, McGraw Hill Education
16. Ackley, G. (1978), Macro Economics: Theory and Policy, Macmillan, New York.
17. Agrawal Vanita, (2010) Macroeconomics: Theory and Policy, Pearson Publication, New Delhi.
18. Ahuja H.L., Macroeconomics: Theory and Practice, S.Chand & Co. New Delhi.
19. Blackhouse, R. and A. Salansi (Eds.) (2000) Macroeconomics and the Real World (2 Vols.), Oxford University Press, London. Dornbusch,
20. Campbell R. McConnell, Stanley L. Brue, (2001) Macroeconomics: Principles, Problems and Policies', McGraw Hill, Inc., New York.
21. Froyen Richard T (2006) 'Macroeconomics– Theories and Policies' Pearson Education; 8th edition
22. Gupta S.B. (1997) 'Monetary planning for India' OUP
23. Jha, R. (1991), Contemporary Macroeconomic Theory and Policy, Wiley Eastern Ltd., New Delhi.
24. Mankiw Gregory (2007) 'Macroeconomics' Worth, New York
25. Rao, V.K.R.V. (1983) India's National Income : 1950 to 1980, Sage Publications, New Delhi
26. Gupta, S.B. (1995), Monetary Planning in India, OUP, New Delhi.
27. Sampat Mukherjee (2013), 'A Global Text-Macroeconomics', New Central Book Agency
28. Soumyen Sikdar (2006) 'Principles of Macroeconomics' Oxford University Press

29 Bhise V.B , Khandare V.B & Babar , (2014) Macro Economics , Chinmay Publication Aurangabad.

Recommended Readings:

16. Branson, W.A. (1989), Macroeconomic Theory and Policy, (3rd Edition), Harper and Row, New York.
17. Culbertson, J.M. (1968), Macroeconomic Theory and Stabilization Policy, McGraw Hill, Kogenkosh, Tokyo.
18. Duesenberry, J.S. (1949), Income Saving and the Theory of Consumer Behaviour. Harvard University Press, Harvard.
19. Edey, M. and A.T. Peacock (1967), National Income and Social Accounts, Hutchinson University Library, London
20. Fisher, Dornbusch, Schamalensee (1988) 'Economics' McGraw Hill International Edition ; 2nd edition

21. Friedman, M. (1957), The Theory of Consumption Function, Princeton University Press Princeton.
22. Friedman, M. (1956), Studies in the Quantity Theory of Money, The University of Chicago Press, Chicago
23. Glahe, Fred, R. (1973), Macroeconomics: Theory and Policy, Harcourt Brace Javanovich, Inc., New York.
24. Harris Lawrence (1980) 'Monetary Theory' McGraw Hill Inc.
25. Keynes, J.M. (1936), 'The General Theory of Employment Interest and Money', Macmillan, London.
26. Ruggles, R. and N. Ruggles (1956), National Income Accounts and Income Analysis, McGraw Hill New York.
27. Shapiro, E. (1996) Macroeconomic Analysis, Galgotia Publications, New Delhi.
28. D.Wrightsman 'An Introduction to Monetary Theory and Policy' The Free Press New York 1983

Recommended Journals:

Applied Economics- Taylor & Francis Online
Journal of Macroeconomics-Elsevier
Macroeconomics and Finance in Emerging Market Economies- Taylor & Francis Online
The Indian Economic Journal- Sage Journal

CORE COURSE
SEMESTER IV
EC- 4002
GROWTH & DEVELOPMENT II
(This course will have *FOUR* credits)

PREAMBLE

The course makes an attempt to provide an introduction to the economics of Growth and Development and at the same time provide an understanding of the analytical rigour of the subject. Growth and Development-I is a core course that covers meaning and concept of Economic Growth and Development, measuring the economic growth and development, theories of economic growth and development, poverty, inequality and unemployment and role human capital in economic development . Growth and development-I will try to clear the concepts regarding the economic growth and development and provides basic knowledge to the students to get engaged in the activities.

Course Objectives:

- To enable learning and understanding of the basic concepts and process to measure the growth and economic development etc.
- To analyze and evaluate the obstacles in the process of economic growth and development

Programme Outcome:

- Ability to analyze and demonstrate knowledge of the economic growth and development theories of economic growth and development
- Ability analyze, evaluate and apply the growth and development concepts, role of human capital, etc. in real life situations

1. Sectoral Development: An Overview **12**

1.1 International agreements and Agriculture in India
1.2 Agriculture Productivity, Agriculture Price Policy, Land Holding and Cropping Pattern
1.3 Industrial Production Trends at National and International Level, Role Of MSMEs, Government Policies for Industrial Development
1.4 Growth of Services Sector in India, ICT and Services sector, International Comparison.

2. Technology and Development **12**

2.1 Role of Technology and Development
2.2 Capital Formation and Technical Progress as Sources of Growth
2.3 Technological Strategy of Development
2.5 Economics of R&D, Invention and Innovation, Relation to Development
2.6 Technology Centered Development

3. Environment and Development **12**

3.1 Sustainable Development, Sustainability Performance and Reporting
3.3 Environment and Rural-Urban Development
3.4 Industrialization and Environment Protection
3.5 Climate change and Agriculture

4. Development Strategies **12**

4.1The Role of the Government in the Developmental process
4.2 The Market versus Detailed Centralized Planning
4.3 Approaches to Poverty Alleviation and Employment Generation
4.4 Policy of Export Promotion & Import Substitution
4.5 Policy of Infrastructure Development

Basic Reading List:

1. Basu Kaushik (1998) Analytic Development Economics: The Less Developed Economy Revisited', OUP
2. Behrman, S. and T.N. Srinivasan (1995), Handbook of Development Economics, Vol. 3, Elsevier, Amsterdam.
3. Felix Raj, Sampat Mukherjee, Mallinath Mukherjee, Amitava Ghose, Ranjanendra N. Nag (2007) "Contemporary Development Economics From Adam Smith to Amartya Sen", New Central Book Agency Private Limited
4. Gillis, M., D.H. Perkins, M. Romer and D.R. Snodgrass (1992), Economics of Development, (3rd Edition), W.W. Norton, New York.
5. Kindleberger, C.P. (1977), Economic Development, (3rd Edition), McGraw Hill, New York. Economics
6. Meier Gerald M. and James E. Rauch, "Leading Issues in Economic Development" Oxford University Press, 2006
7. Ray Debraj (1998) "Development Economics", Oxford University Press
8. Solow Robert M. (2000) "Growth Theory An Exposition" Oxford University Press
9. Thirwal, A.P. (1999), (6th Edition), Growth and Development, Macmillan, U.K.
10. Todaro, M.P. (1996), (6th Edition), Economic Development, Longman, London.

Recommended Readings:

1. Barro Robert J. and Xavier Sala-i-Martin (2004) "Economic Growth" Prentice Hall of India Brown, M. (1966), On the Theory and Measurement of Technical Change, Cambridge University Press, Cambridge, Mass.
2. Dasgupta, P. (1993), 'An Enquiry into Well-being and Destitution', Clarendon Press, Oxford.
3. Gillis, M., D.H. Perkins, M. Romer and D.R. Snodgrass (1992), Economics of Development, (3rd Edition), W.W. Norton, New York.
4. Meier, G.M. (1995), Leading Issues in Economic Development, (6^{th} Edition), OUP
5. Nayyar Deepak (2019) 'Resurgent Asia' OUP
6. Todaro Michael P. (1981) "Economics for A Developing World", Longman, London.

Recommended Journals:

Economic Development and Cultural Change- Chicago Press
Journal of Development Economics-Elsevier
IMF Economic Review- Palgrave Macmillan
Oxford development Studies- Rutledge
Review of Development Economics-Wiley
Review of World Economics-Springer
Review of Economic Dynamics- Elsevier

CORE COURSE

SEMESTER IV

EC-4003

RESEARCH PROJECT

(This course will have *FOUR* credits)

(Only for Internal Students)

PREAMBLE:

Students who complete their post-graduation in Economics are mentally equipped to pursue research in the same discipline. It is generally accepted that research is nothing but extension and application of knowledge in a certain specialized field. Therefore regular students who do their post-graduation, as internal students will be given an opportunity to get exposed to a few elements of social research and also they are expected to complete a small research project under the expert guidance and supervision, Elementary knowledge of research methodology shall consolidate and deepen their understanding of various branches of Economics. Preparing a small dissertation is intended to train them in scientific thinking and art of systematic presentation. It is essentially a job-oriented exercise to enable them to take up the exciting field of social and economic research.

Part I: Internal IV Semester students shall submit a dissertation of minimum 8000 words & maximum 10,000 words in three copies to the Head of the Department on or before 30thApril. The dissertation shall be prepared under the guidance of an internal postgraduate recognized teacher.

Part II: An internal supervisor shall assess each dissertation for out of 50 marks, based on the methodology, analysis, contents and quality of the dissertation.

Part III: A viva voce examination of each candidate shall be held where he/she will have to make a presentation of the dissertation and defend the research. A panel of two referees shall be formed out of whom one shall be an internal examiner.

The viva voce shall carry 50 marks. Internal & external examiners shall give out of 25 marks each. The copies of dissertation and the record of the viva voce examination shall be maintained by the centre for two more academic years for inspection. The Marks obtained for project work shall be included in the statement of marks of all the regular internal students.

Scale of Remuneration will be as per the University Guidelines.

External examiner will be appointed by the University.

CORE COURSE
SEMESTER IV
EC-4003
RESEARCH METHODOLOGY
(ONLY EXTERNAL STUDENTS)
(This course will have *FOUR* credits)

PREAMBLE

The main objective of this paper is to make the students aware of the importance of Research Methodology. Today research is of importance in every field of life. Hence students need sound initiation in the world of research. Thus this syllabus is prepared to equip students with basics of research methodology and also provide them acquaintance with the main ingredients of major sources secondary data on Economics, some hands-on experience in conduct so survey including designing questionnaire and interview schedules, collection of data, analysis of data and preparation of report.

Course Objectives:

- To enable an understanding of Research and its methods under various areas of economics.
- To demonstrate the practical and the applied aspects of research in relation to Economics.

Programme Outcome:

- Ability to develop, demonstrate and examine topics under Economics to pursue research.
- Ability to evaluate and examine subject areas in economics and explore possibilities of research.

1 Data Collection **12**

1.1 Sources of Data- Primary, Secondary.
1.2 Surveys and Interviews Methods
1.3 Observation Method
1.4 Secondary Sources of Data

2 Sampling And Data Analysis **12**

2.1 Basic Concepts: Population, Sample, Sample Size
2.2 Sampling Methods: Probability and Non-probability Sampling Methods
2.3 Analysis of Data: Classification, Tabulation, Graph, Diagram and
2.4 Overview of Statistics in Data Analysis

3 Testing Hypothesis **12**

3.1 Hypothesis: Meaning, Types, Formulation, Criteria for a Good Hypothesis
3.2 Basic Concepts: Level of Significance, Critical error, Type I and Type II Error
3.3 Procedure of Testing Hypothesis
3.4 Parametric and Non Parametric Tests

4 Report Writing **12**

4.1 Goals of Report Writing
4.2 Report writing for Quantitative Research and Qualitative Research
4.3 Layout of Research Project
4.4 Report Writing: Considerations and Precautions
4.5 Computer Use in Research -Internet Source of Data Collection- Use and Precautions

Basic Reading List:

1. Banamati Mohanty (2015) 'Statistics for Behavioral and Social Sciences' Sage Texts
2. Bryman Alan (2018) 'Social research methods' OUP
3. Cooper Donald R. & Pamela S. Schindler (1999), "Business Research Methods", Tata McGraw-Hill Edition, New Delhi
4. Flick Uwe (2011) 'Introducing Research Methodology' Sage Publications
5. Kothari C. R, Gaurau Garg (2019) 'Research Methodology, Methods and Techniques", New Age International Publications, 4th Edition
6. Kumar Ranjit, (2012), "Research Methodology" 2nd Ed, Pearson Education
7. Wilkinson and Bhandarkar (2016) 'Methodology and Techniques of Social Science Research; HPH
8. Willson Jonathan (2017) 'Essentials of Business Research: A Guide to Doing Your Research Project' Sage Publications

Recommended Readings:

1. Basotia G.R. Sharma K.K. (1999) 'Research Methodology' Mangal Deeop Publications
2. Don E. Ehridge (2004) 'Research Methodology in Applied Economics: Organizing Planning and Conducting Economics Research', John Wiley and Sons
3. Gopal M.H. (1971) 'An Introduction to Research Procedure in Social Sciences', Asia Publishing House
4. Kothari S. R (2012) 'Research Methodology, Methods and Techniques", Pragun Publications
5. Krishnaswamy, O.R. (1993) 'Methodology of Research In Social Sciences, HPH
6. Kurein C. T. (1973) A Guide to Research in Economics' Sangam Publishers for Madras Institute of Development Studies
7. Les Oakshott (2012) 'Essential Quantitative Methods for Business, Management and Finance', Palgrave Macmilan, 5th edition
8. Moser C.A., G. Kalton (1985) 'Survey Methods in Social Investigations' Routeledge
9. BAV Sharma D Ravindra Prasad and P. Satyanarayana (1983) Research Methods in Social Sciences' Sterling publishers, New Delhi
10. Sadhu AN, Amarjit Singh (2007) 'Research Methodology in Social Sciences' HPH
11. Thakur Devendra (2009) 'Research Methodology in Social Sciences' Deep and Deep Publiations
12. Young P.V. (1984) 'Scientific Social Survey and Research', Prentice Hall -India
13. Khandhare V.B., Yadav Y.,2016, Chinmay Publication ,Aurangabad.

Recommended Journals:

Journal of Mixed Methods Research- Sage
Journal of Applied Social Sciences- Sage
Research in Economics- Elsevier
Social Science Research- Elsevier
The Social Science Journal – Elsevier/ ScienceDirect

SEMESTER IV

ELECTIVE PAPERS

(Choose Any ONE Paper)

EC-4004

01 - ECONOMETRICS
02 - PUBLIC POLICY
03 - ECONOMICS OF ENVIRONMENT
04 - FORIGN EXCHANGE MARKET

ELECTIVE COURSE
SEMESTER IV
EC- 4004
ECONOMETRICS
(This course will have *FOUR* credits)

PREAMBLE

Application of economic theory needs a reasonable understanding of economic relationships and relevant statistical methods. The syllabus of econometrics is to equip the students with an understanding of theoretical econometrics and the relevant applications of the econometric methods. This course covers various econometric methods applicable for testing empirical relationships in economics and those needed for applied economic research. An introductory module on time series methods has also been included in this course, which constitutes an important tool for analysis in economic studies.

Course Objectives:

- To apply econometric theory with the help of mathematical modeling and the use of statistical tools in order to solve economic problems.
- To demonstrate the practical and the applied aspects of econometrics involved in conducting empirical studies.

Programme Outcome:

- Ability to develop analytical and quantitative understanding, demonstrate and examine problem solving aptitude.
- Ability to evaluate and examine subject areas in economics with the help of econometric modeling.

1. Introduction: 04

1.1 What is Econometrics?
1.2 Statistical Background and Econometrics
1.3 The Methodology of Econometrics
1.4 Review of Statistical Inference – Statistical Estimation and Hypothesis Testing

2. Simple Regression Analysis: 14

2.1 The Two-Variable Linear Regression Model
2.2 The Ordinary Least-Squares Method and its Properties
2.3 Test of Significance of Parameter Estimates
2.4 Test of Goodness of Fit and Correlation
2.5 Analysis of Variance – One way and Two-way Analysis

3. Multiple Regression Analysis: 10

3.1 The Three-Variable Linear Regression Model
3.2 Tests of Significance of Parameter Estimates
3.3 The Coefficient of Multiple Determination
3.4 Test of the Overall Significance of the Regression
3.5 Partial-Correlation Coefficients

4. Violations of Classical Assumptions and Remedies: 06

4.1 Multicollinearity
4.2 Heteroscedasticity
4.3 Autocorrelation

5. Further Techniques and Applications in Regression Analysis 10

5.1 Functional Forms
5.2 Dummy Variables
5.3 Simultaneous-Equations Models
5.4 Identification using Rank and Order Condition

6. Introduction to Time-Series Methods 04

6.1 Stationary Time Series – Strict Stationarity, Weak Stationarity
6.2 Non-stationary Series
6.3 Concept of Unit Root Process and Testing
6.4 Introduction to Forecasting using Time Series Models

Basic Reading List

1. Enders Walter (2018) 'Applied Econometric Time Series', (4th ed.) Wiley India
2. Gujarati, D. N., Porter, D. C. & Gunasekaran, S. (2009). Basic Econometrics. (5th ed.). Tata McGraw Hill
3. H. Stock James, W. Watson Mark (2017) 'Introduction to Econometrics' Pearson Education, Third Edition
4. Maddala G. S., Kajal Lahiri (2012) 'Introduction to Econometrics', John Wiley & Sons.

Recommended Books:

1. Dominick Salvatore and Derrick Reagle (2011) Schaum's Outline of Statistics and Econometrics, Second Edition (Schaum's Outlines).
2. Dougherty, C. (2011) Introduction to Econometrics (4th ed). Oxford University Press.
3. Gujarati Damodar (2017) 'Econometrics by Example', Palgrave Macmillan, 2nd edition
4. Jeffrey M. Wooldridge (2008) 'Introductory Econometrics: A Modern Approach' South Western, Second Edition
5. Koutsoyiannis A. (2001) 'Theory of Econometrics' Palgrave Macmillan, Second Edition
6. Nachane, Dilip M. (2008). Econometrics: Theoretical Foundations and Empirical Perspective (1st ed.). Oxford Textbooks

Recommended Journals

1. Journal of Quantitative Economics, The Indian Econometric Society
2. Quarterly Journal of Economics, Oxford Academic.
3. Econometrica, The Econometric Society
4. Journal of Econometrics - Elsevier
5. The Econometrics Journal, The Royal Economic Society

ELECTIVE COURSE
SEMESTER IV
EC- 4004
PUBLIC POLICY
(This course will have *FOUR* credits)

PREAMBLE

Public Policy is a specialized area in social sciences, with special reference to economics along with political science and sociology; the subject covers the study of public policy, the process and perspectives of policy making and the analysis and evaluation of Public Policy. The study of Public Policy provides an understanding of the various aspects of policy making on theories, concepts, process, methods, analysis and evaluation. The subject discusses public policy in historical perspective, the concepts of public policy, the methodologies for implementation as well as evaluation along with the impact of globalization on public policy.

Course Objectives:

- To develop an understanding of public policy in the theoretical as well as practical context.
- To discuss and debate the various aspects of public policy and policy making

Course Outcomes:

- Ability to analyze and evaluate the subject with reference to various aspects of Public Policy.
- Ability to develop an understanding of the public policy, its perspectives and processes and to be able to construct intellectual dialogue on the policy making and policy analysis and evaluation

1. Introduction to Public Policy **08**

1.1 Concept, Meaning and Definitions of Public Policy
1.2 Historical Emergence and Relevance of Public Policy
1.3 Nature and Scope of Public Policy; Process of Policy Making
1.4 Perspectives of Policy Making, Impact of Globalization on Policy making

2. Concepts of Public Policy **08**

2.1 Institutionalism
2.2 Process: Policy as a Political Activity
2.3 Public Choice
2.4 Strategic Planning

3. Policy Implementation and Evaluation **10**

3.1 Concept of Policy Implementation and Methods/Techniques of Policy Implementation
3.2 Concept of Policy Evaluation and Methods/Techniques of Policy Evaluation

4. Economics of Public Policy **12**

4.1 Types of Public Policy Analysis – -Empirical, Normative, Retrospective and Prospective; -Descriptive and Prescriptive
4.2 Actors in Public Policy Analysis --Government, Media, Civil Society -Multinational Agencies, Transnational Agencies, International Donor Agencies
4.3 Constraints in Public Policy Analysis- Economic Constraints, International

Constraints, Social and Cultural Constraints, Political Constraints/Feasibility
4.4 Emerging Trends – Ombudsman, Local Bodies, Whistle Blowers, Citizens Organizations

1 5. Globalization and Public Policy 10
2 5.1 Globalization of Economic Activity
3 5.2 Reforming Institutions – The State, The Market and Public Domain
4 5.3Global Public Policy – Global Trade, Global Financial Markets and Global Crime
5 5.4 Globalization and Interdependence, Organizations and Accountability

Basic Reading List:

1. Anderson James. E., (2010) Public Policy-Making: An Introduction", Cengage Learning, 7th Edition
2. Birkland Thomas A., (2005), An Introduction to The Policy Process: Theories, Concepts, And Models of Public Policy Making, Armonk;
3. Chandler. Dye Thomas (2008), Understanding Public Policy, Singapore, Pearson Education
4. Chakrabarti Rajesh, Kaushiki Sanyal (2016) "Public Policy in India" OUP India
5. Mathur Kuldeep (2015) Public Policy and Politics in India: How Institutions Matter" OUP India
6. McCool, Daniel C. (ed.), (1995), "Public Policy Theories, Models, and Concepts: An Anthology", NJ: Prentice-Hall
7. Moran Michael, Martin Rein, Robert E. Goodin (2018) "The Oxford Handbook of Public Policy" OUP
8. Saumitra Mohan (2018) "Indian Policy and Development: A Manual for National Schemes and International Policies" McGraw Hill Education

Recommended Books:

1. Ashford, Doug (ed.), (1992), "History and Context in Comparative Public Policy", Ithaca, NY: University of Pittsburgh Press.
2. Bergerson, Peter J. (ed.), (1991), "Teaching Public Policy: Theory, Research and Practice", Westport, RI: Greenwood Press
3. Dahl, Robert and Charles Lindblom, (1976), "Politics, Economics and Welfare", New York, Harper
4. Dror.Y, (1989), "Public Policy making Re-examined", Routledge, 2nd Edition
5. Hill Michael, (2005), The Public Policy Process, Harlow, UK; Pearson Education, 5th Edition
6. Houghton Bardach, Eugene (1977), "The Implementation Game: What Happens After a Bill Becomes a Law", Cambridge, MA: MIT
7. Howlett, Michael, and M. Ramesh, (1995), "Studying Public Policy: Policy Cycles and Policy Subsystems", OUP, Toronto
8. Jones, C.O., (1970), "An Introduction to the Study of Public Policy", Belmont, Prentice - Hall
9. Lerner, D. and H.D.Lasswell (eds.), (1951), "The Policy Sciences", Stanford University Press
10. Lindblom, C.E., and E.J., Woodhouse, (1993), "The Policy making Process", 3rd ed., Prentice - Hall
11. Nachmias, David, (1979), "Public Policy Evaluation: Approaches and Methods", New York: St. Martin's Press
12. Jay M. Shafritz (ed) (1998), "International Encyclopedia of Public Policy and Administration", Westview Press

13. John, Peter, (2012), “Analysing Public Policy”, Routledge, 2nd Edition
14. M.E. Sharpe Brewer, Gary D., and Peter de Leon (1983), “The Foundations of Policy Analysis”, Homewood, IL.: The Dorsey Press
15. Bellinger William K (2015) “The Economic Analysis of Public Policy” Routledge, 2nd Edition

Recommended Journals

Indian Journal of Public Policy and Administration - Sage
International Journal of Public Policy – Inderscience
Journal of Asian Public Policy –Taylor and Francis Online
Journal of Public Policy – Cambridge
Journal of Public Policy and Administration – Science Publishing Group
Science and Public Policy – Oxford Academic Journals

ELECTIVE COURSE
SEMESTER IV
EC-4004
ECONOMICS OF ENVIRONMENT
(This course will have *FOUR* credits)

PREAMBLE

Environmental economics has emerged as an important sub-discipline of economics in recent times as humanity struggles to respond to the environmental crisis that challenges the very existence of human beings. Environmental economics focuses on the relationship between human behavior, economic systems as well as mechanisms and environmental quality. It attempts to explore fundamental questions of how the economic system shapes economic incentives in ways that lead to environmental degradation as well as improvement. It focuses on the nature of environment as a social good and the relationship between environment and economic development. Environmental economics explores economic principles, economic theories and various analytical tools of economics for environmental protection, regulation and policy making. This curriculum introduces post graduate students of economics to the field of environmental economics and equips them with analytical tools to comprehend various environmental issues.

Course Objectives:

- To develop an understanding of the economics of environment in the theoretical as well as practical context.
- To discuss various analytical tools to comprehend various environmental issues.

Programme Outcome:

- Ability to analyze and evaluate the subject with reference to various aspects of the economics of environment.
- Ability to develop an understanding of the economics of environment and various analytical tools to comprehend environmental issues

1 Introduction 12

1.1 Economics of Environment – Meaning, Nature, Scope and Significance
1.2 Environment as an Economic and a Social Good – Exhaustive and Renewable Common Property Resources
1.3 Economic Development and Environment – Trade-off, Environmental Kuznets Curve & Limits to Growth
1.4 Sustainable Development

2 Environmental Challenges 12

2.1 Environment and Agricultural Development – Technological Change –Use of Water, Fertilizers, Pesticides – Groundwater and Forest Depletion
2.2 Environment and Industrial Development – Pollution, Urbanization
2.3 Global Environmental Issues – Depletion of Ozone Layer, Green House Effect, Global Warming, Climate Change, Loss of Bio-diversity

3 Environmental Regulation – Theories and Analytical Tools 12

3.1 The Economic Theory of Efficient Pollution Control – Marginal Abatement Cost (MAC) & Marginal Environmental Damage (MED)
3.2 Externalities and Market Failures – Coase Theorem

3.3 Environmental Regulation – Command and Control Regulation versus Market Based Instruments – Emission Taxes and Charges, Environmental Taxes and Subsidies, Resolutions through Direct Negotiations, Emissions Trading
3.4 Environmental Value Assessment – Environmental Value, Revealed Preference Method, Stated Preference Method, Cost-Benefit Analysis

4 Climate Change, Environmental Agreements and Policies 12

4.1 Climate Change – Greenhouse Gases, Accumulation of Emissions and Process of Global Warming,
4.2 Kyoto Protocol – Emission Reduction Targets, Kyoto Mechanisms, Limitations of Kyoto Protocol, Carbon Credits
4.3 Paris Agreement – Aims, Nationally Determined Contributions, Effects on Global Temperature, Mechanisms and Criticism
4.4 India's Environmental Policy, Environment Protection Laws, National Green Tribunal

Reading List:

1 Baumol, W.J. & Oates, W.E. (1997), The Theory of Environmental Policy, Prentice Hall, Englewood-cliffs
2 Bhattacharya, R. N. (2006), Environmental Economics: An Indian Perspective, Oxford University Press, New Delhi
3 Field, Barry & Field, Martha (2016), Environmental Economics: An Introduction, McGraw-Hill Education, New York.
4 Managi, Shunsuke & Kuriyama, Koichi (2017), Environmental Economics, Routledge, London and New York
5 Singh, Katar & Shishodia, Anil (2010), Environmental Economics: Theory and Applications, Sage Publications, New Delhi
6 Smith, Stephen (2011), Environmental Economics: A Very Short Introduction, Oxford University Press, New York
7 Ulaganathan, Sankar (2006), Environmental Economics, OUP, New Delhi

Recommended Books:

1 Ali, S.A. (1979), Resources for Future Economic Growth, Vikas Publishing House, New Delhi.
2 Charles Peering (1987) Economy and Environment Cambridge University Press, New York.
3 Dorfman, R & N. Dorfman (Eds.) (1977), Economics of the Environment. W.W. Norton, New York.
4 Hanley, Nick; Shogren, Jason & White, Ben (2004), Environmental Economics in Theory and Practice, McMillan India Limited, Delhi

Recommended Journals:

- Journal of Environmental Economics and Management
- Review of Environmental Economics and Policy
- Environmental and Resource Economics
- Ecological Economics
- Annual Review of Resource Economics
- Land Economics

ELECTIVE COURSE
SEMESTER IV
EC-4004
FOREIGN EXCHANGE MARKET
(This course will have *FOUR* credits)

PREAMBLE:

The course makes an attempt to provide an introduction to the foreign exchange market and at the same time provide an understanding of the analytical rigour of the subject. Foreign exchange market is an elective course that covers meaning and concept of foreign exchange market, transactions in foreign exchange market, exchange rate mechanism and risk management of the foreign exchange market. Foreign exchange market will try to clear the concepts regarding the currency market and provides basic knowledge to the students to get engaged in the activities.

Course Objectives:

- To enable understanding of the concepts and transactions in the foreign exchange market such as spot and forward transactions, etc. and the risks associated.
- To enable understanding of the foreign exchange market activities at national and international level.

Programme Outcome:

- Ability to analyze and demonstrate knowledge of the foreign exchange market transactions, exchange rate mechanism and exchange risk in economics.
- At the end of the course, the student should be able to evaluate Foreign exchange market concepts, market structure, transactions and its use in real life.

1. Introduction **12**

1.1 Foreign Exchange and Foreign Currency- meaning & Definitions
1.2 Structure of Foreign exchange Market: Market Segments, Market Players,
1.3 Features & Functions of Foreign Exchange Market
1.4 Constituents of Foreign Exchange Market- Central Bank, Commercial Banks, Non-Banks, Individuals & Firms, Speculators, Arbitrageurs, Forex Dealers, Forex Brokers

2. Foreign Exchange Transactions **12**

2.1 Sport and Forward Transactions- Meaning & features
2.2 Financial Derivatives- Swaps, Options and Futures- Meaning
2.3 Hedging- Meaning
2.4 Arbitrage- Meaning

3. Exchange Rate Mechanism **12**

3.1 Exchange Rate Determination: The PPP Theory, the BOP Theory
3.2 Fixed and Flexible Exchange Rates, Official and Free Market Rates
3.4 Relation between Rate of Interest and Foreign Exchange Rate

4. Risk Management **12**

4.1 Nature of Risk in Foreign Exchange Market,
4.2 Foreign Exchange Settlement Exposure and Foreign Exchange Settlement Risk
4.3 Types of Risks in Foreign Exchange Market –
4.3.1 Market Risk, Credit risk, Liquidity Risk, Replacement Risk, Interest Rate Risk
4.3.2 Operational Risk, Systemic Risk, Legal Risk, Country Risk, Sovereign Currency Risk
4.5 Intervention in Foreign Exchange Market
4.6 Role of RBI in Foreign Exchange Market in India; Developments since 1991

Basic Reading:

7. Anthony Steve (2002) 'Foreign Exchange in Practice: the New Environment' Palgrave
8. Brandl Michael (2019) 'Money, Banking, Financial Markets and Institutions' Cengage Learning
9. Bhole, L. M., Jitendra Mahakud (2017) 'Financial Institutions and Markets' Tata McGraw Hill, ND
10. Fabozzi Frank J., Steven V. Mann, Moorad Choudhry (2002) 'The Global Money Markets' John Wiley & Sons
11. Frederic Mishkin and Stanley Eakins (2006) 'Financial Markets and Institutions', Pearson 5th Edition
12. Frederic Mishkin (2019) 'The Economics of Money, Banking and Financial Markets' Pearson Education India, 11th edition
13. Luca Cornelius (2007) 'Trading in Global Currency Markets' Penguin, USA
14. Madura Jeff (2014) 'Financial Institutions and Markets' Cengage
15. Gupta SL (2017) 'Financial Derivatives- Theory, Concept and Problems' PHI Learning
16. Srivastava Rajeev (2014) 'Derivatives and Risk Management' OUP

Recommended Readings:

9. Batra G.S. "Financial Services and Markets", New Delhi: Deep and Deep Publications Pvt. Ltd., Latest Ed.
10. Das S. C. (2015) 'The Indian Financial System: Markets, Instruments, Institutions, Services and Regulations' PHI Learning
11. Gurusamy S (2004) "Financial Services and Markets", Vijay Nicole Imprints
12. Hull John C, Sankarshan Basu (2018) "Options, Futures and Other Derivatives", Pearson Education, 10th Edition
13. Kothari Rajesh. "Financial Services in India Concept and Application", New Delhi, Sage Publications. 2010.
14. Meir Kohn (2013) 'Financial Institutions & Markets; OUP
15. Chandra P. (2017), ' Investment Analysis and Portfolio Management', McGraw Hill Education, Fifth Edition

Recommended Journals:

International finance- Wiley Online
Journal of International financial Markets, Institutions and Money- Elsevier
Journal of International Money and Finance

SAVITRIBAI PHULE PUNE UNIVERSITY

(Formerly University of Pune)

T.Y.B.A. Economics Syllabus

(Choice Based Credit System and Semester System)

Revised Syllabus will be implemented with effect from the academic year 2021-2022

T.Y.B.A. Economics

(Sem V & VI)

Semester	Paper Name	Subject Code	Title of the Paper
V	Economics General - III		Indian Economic Development- I
	Economics Special - III		International Economics-I
	Economics Special - IV		Public Finance- I
	Skill Enhancement Course (SEC-3A)		Business Management- I
VI	Economics General - III		Indian Economic Development- II
	Economics Special - III		International Economics- II
	Economics Special - IV		Public Finance- II
	Skill Enhancement Course (SEC-3A)		Business Management- II (Project Report)

T.Y.B.A. Economics
General Paper-III: Indian Economic Development-I
(Course Code:)
Semester V

Preamble:

The course will be useful for learners aiming towards careers in the government sector, policy analysis and the social sector. This course would take an overview of aspects of economic development with special reference to India.

The course aims to introduce the learner to the main concepts in economic and human development, equip them compare and contrast different economies: recognize various indicators of economic and human development. The course will also provide a broad outline of the Sustainable Development Goals.

Course Learning Outcomes

At the end of the course the learner will have ability -

- To relate and recognize the concept and indicators of Economic Development.
- To describe and analyze the concept and indicators of Human Development.
- To explain the characteristics of Developing and Developed Countries.
- To describe the constraints to the process of Economic Development.

Unit No.	Name and Sub Titles of the Topic	No. of Lectures
1	**Economic Development and Growth**	10
	1.1 Economic Development: Meaning, Definition and Indicators	
	1.2 Economic Growth: Meaning, Definition and Indicators	
	1.3 Need and Importance of Economic Development	
2	**Developed and Developing Countries**	14
	2.1 Concepts of Developed and Developing Countries	
	2.2 Characteristics of Developed Countries	
	2.3 Characteristics of Developing Countries : Economic, Demographic, Technological, Social and Political	
	2.4 India as an Emerging Economy	
3	**Constraints to Development Process**	12
	3.1 Vicious Circle of Poverty	
	3.2 Capital Constraints	
	3.3 Technology Constraints	
	3.4 Socio- Cultural Constraints	
	3.5 Political and Administrative Constraints	
	3.6 External Bottlenecks	
4	**Human Resources and Economic Development**	12
	4.1 Role of Human Resources in Economic Development	
	4.2 Human Development Index and India	
	4.3 Concepts of Physical Quality of Life Index:	
	4.3.1 Gender Development Index **4.3.2** Gender Inequality Index **4.3.3** Multidimensional Poverty Index	

Recommended Books -

- Ragnar Nurkse, Problem of Capital Formation in Underdeveloped Countries.
- Sen Amartya (1970) Growth Economics, Penguin.
- Zhingan M.L.(1982) The Economics of Development and Planning. Vrinda Publication (P) Ltd.
- Adelmen, I. (1961) Theories of Economic Growth and Development, Stanford University Press, Stanford.
- Avhad Suhas (2015), 'Economics of Growth and Development' (Marathi Edition) Success Prakashan, Pune
- Behrman, S. and T.N Srinivasan,(1995) Handbook of Development Economic, Vol. 1 to 3, Elsevier, Amsterdam,
- Chenery H. and T.N.Srinivasan, (1989) Handbook of Development Economics Vo1&2, Elsevier. Amsterdam.
- Dasgupta p. (1993) An Enquiry into Well Being and Destitution.
- Datir R.K.(2013) Vikas ani Paryavarniy Arthshastra, Nirali Prakashan, Pune.
- Rasal Rajendra (2020), Indian Economy (Marathi), Success Publication Pune, 7th edn.
- Ghatak,S.(1986) An Introduction to Development Economics,Allen and Unwin, London,
- Ghosh. B.N.(1982) Economic Development and Planning National Book House.
- Grillis M., D H. Perkins, M.Romer and D.R.Snodgrass (1992) Economic of Development (3rdEdition) W.W.Norton, New York.
- Higgins, Benjamin. (1959) Economic Development, W.W.Norton , New York
- Jennifer A. Elliott, (2013), An Introduction to Sustainable Development (Fourth Edition), Routledge Publication, London and New York.
- Kindleberger C.P.(1977) Economic Development (3rd Edition) McGraw Hill, New York.
- Jagdish Bhagwati,The Economics Of Underdeveloped Countries.
- Mahata J.K.(1964) Economic of Growth, Asia.
- Meaer and Baldwin(1970) Economic Development, Asia .
- Mehata J.K.(1971) Economic Development , Chaitanya.
- Mishra &Puri, Development and Planning- Theory And Practice, Himalaya.
- Meier, G.M. (1995) Leading Issue in Economic Development,6ed,Oxford University Press ,New Delhi,
- Todaro M.P. (1996) Economic Development (6th Edition) Longman, London.
- UNDP, Human Development Report [Latest]
- World Development Reports
- India Development Reports

T.Y.B.A. Economics
General Paper- III: Indian Economic Development-II
(Course Code:)

Semester VI

Preamble:

This course would take an overview of the process of Economic Planning and the Development Goals. The course aims to introduce the learner to the main concepts in Economic Planning, equip them with understanding of the planning process in India and changing in recent times and familiarize them to the Sustainable Development Goals. The Course also reviews the relation between Economic Development and Environment.

Course Learning Outcomes

At the end of the course the learner will have ability-

- To describe and explain the process of Economic Planning.
- To describe and examine the changing structure of planning process in India.
- To describe and explain the relation between Economic Development and Environment.

Unit No.	Name and Sub Titles of the Topic	No. of Lectures
1	**Economic Planning**	12
	1.1 Economic Planning – Meaning, Definition and Features	
	1.2 Need of Economic Planning	
	1.3 Objectives of Economic Planning in India	
2	**National Institution for Transforming India Aayog (NITI Aayog)**	12
	2.1 NITI Aayog- Objectives and Structure	
	2.2 Role of NITI Aayog	
	2.3 Difference between Planning Commission and NITI Aayog	
3	**Sustainable Development**	12
	3.1 Sustainable Development **:** Meaning and Importance	
	3.2 17 SDGs (Sustainable Development Goals)	
	3.3 Measures for Sustainable Development	
	3.4 Current Scenario of SDG in India	
4	**Environment and Economic Development**	12
	4.1 Relation between Environment and Economic Development	
	4.2 Environment and Sustainable Development	
	4.3 Environmental Policies in India: **4.3.1** National Conservation Strategy (1992) - Highlights **4.3.2** National Environmental Policy (2006) - Highlights	
	4.4 Global Warming	

Recommended Books -

- Ragnar Nurkse, Problem of Capital Formation in Underdeveloped Countries.
- Sen Amartya (1970) Growth Economics, Penguin.
- Zhingan M.L. (1982) the Economics of Development and Planning. Vrinda Pub.(P) Ltd.
- Adelmen, I. (1961) Theories of Economic Growth and Development, Stanford University Press, Stanford.
- Avhad Suhas (2015), 'Economics of Growth and Development' (Marathi Edition) Success Prakashan, Pune
- Behrman, S. and T.N Srinivasan,(1995) Handbook of Development Economic, Vol. 1 to 3, Elsevier, Amsterdam,
- Chenery H. and T.N.Srinivasan, (1989) Handbook of Development Economics Vo1&2, Elsevier. Amsterdam.
- Dasgupta p. (1993) an Enquiry into Well Being and Destitution.
- Datir R.K. (2013) Vikas ani Paryavarniy Arthshastra, Nirali Prakashan, Pune.
- Ghatak,S.(1986) An Introduction to Development Economics,Allen and Unwin, London,
- Ghosh. B.N.(1982) Economic Development and Planning National Book House.
- Grillis M., D H. Perkins, M.Romer and D.R.Snodgrass (1992) Economic of Development (3rdEdition) W.W.Norton, New York.
- Higgins, Benjamin. (1959) Economic Development, W.W.Norton , New York
- Jennifer A. Elliott, (2013), an Introduction to Sustainable Development (Fourth Edition), Routledge Publication, London and New York.
- Kindleberger C.P. (1977) Economic Development (3rd Edition) McGraw Hill, New York.
- Jagdish Bhagwati,The Economics Of Underdeveloped Countries.
- Mahata J.K. (1964) Economic of Growth, Asia.
- Meaer and Baldwin (1970) Economic Development, Asia .
- Mehata J.K.(1971) Economic Development , Chaitanya.
- Mishra &Puri, Development and Planning- Theory And Practice, Himalaya.
- Meier, G.M. (1995) Leading Issue in Economic Development,6ed,Oxford University Press ,New Delhi,
- Todaro M.P. (1996) Economic Development (6th Edition) Longman, London.
- UNDP, Human Development Report [Latest]
- World Development Reports
- India Development Reports

T.Y.B.A. Economics
Special Paper - III: International Economics-I
(Course Code:)

Semester - V

Preamble:

This course provides the students a thorough understanding and deep knowledge about the concept of international economics and international trade. The contents of the paper spread over various modules, lay stress both on theory and applied nature of the subject. Besides this, the contents prepare the students to know the important theories of international trade. The paper also covers the meaning, types, importance of terms of trade and causes of unfavorable terms of trade to developing countries like India.

Course Learning Outcomes

At the end of the course the learner will have Ability

- To relate and recall the concepts of International Economics and International Trade.
- To describe and apply the theories of international trade.
- To explain and comprehend the issues relating to Terms of trade and Balance of Payment.

Unit No.	Name and Sub Titles of the Topic	No. of Lectures
1	**Introduction**	12
	1.1 International Economics- Meaning, Scope and Importance	
	1.2 Inter-regional and International Trade	
	1.3 Importance of International Trade	
2	**Theories of International Trade**	12
	2.1 Theory of Absolute Cost Advantage and Comparative Cost Advantage	
	2.2 Heckscher-Ohlin Theory	
	2.3 Leontief's Paradox	
	2.4 Intra-Industry Trade	
3	**Terms of Trade**	12
	3.1 Meaning, Types and Importance of Terms of trade	
	3.2 Determinants of Terms of trade	
	3.3 Causes of Unfavorable Terms of trade to Developing Countries	
4	**Balance of Payments**	12
	4.1 Balance of trade and Balance of payments- Concepts	
	4.2 Balance of payments - Components	
	4.3 Disequilibrium of Balance of Payments, Causes and Consequences	
	4.4 Measures to correct Disequilibrium in the Balance of Payments	

Recommended Books -

1.Kenan, P.B. (1994), the International Economy, Cambridge University Press, London.
2.Kindlberger, C.P. (1973), International Economics, R.D. Irwin, Homewood.
3.Krugman, P.R. and M. Obstgeld (1994), International Economics: Theory and Policy, Glenview, Foresman.
4.Salvatore, D.L.(1997), International Economics, Prentice-Hall, Upper Saddle River, N.J.
5.Sodersten, Bo (1991), International Economics, Macmillan Press Ltd., London.
6.International Economics , M.L. Jhingan
7. Bhagwati, J. (Ed.) (1981), International Trade, Selected Readings, Cambridge University Press, Mass.
8.Greenaway, D. (1983), International Trade Policy, Macmillan Publishers Ltd., London.
9. Joshi V. and I.M.D. Little (1998), India's Economic Reforms, 1999-2001, Oxford University Press, Delhi.
10. Panchmukhi, V.R. (1978), Trade Policies of India: A Quantitative Analysis, Concept Publishing Company, New Delhi.
11. Patel, S.J. (1995), Indian Economy towards the 21st Century, University Press Ltd., India.
12. Rasal, Rajendra, International Economics (Marathi), Success Publication Pune.
13. **Reports:**
1. Ministry of Commerce and Industry, Government of India, Recent Annual Report
2. Government of India, Economic Survey Latest
3. Reserve Bank of India, Annual Report

T.Y.B.A. Economics
Special Paper - III: International Economics-II
(Course Code:)

Semester – VI

Preamble:

This course provides the students a thorough understanding and deep knowledge about India's foreign trade and trade policies. The contents of the paper spread over various modules, lay stress both on theory and applied nature of the subject that have registered rapid changes during the last few decade. Besides this, the contents prepare the students to know the foreign exchange market, provisions in FEMA and convertibility of rupee. The paper also covers the Indian government's policy towards foreign capital and role of multinational corporations in India and regional and international co-operation. This paper has become relatively more relevant from the policy point of view under the present waves of globalization and liberalization.

Course Learning Outcomes:

At the end of the course, the learner will have-

- Ability to relate and explain the concept of Exchange Rate and Foreign Exchange Market.
- Ability to describe the trends in Growth, Composition and Direction of India's Foreign Trade.
- Ability to comprehend the issues relating to Foreign Capital and Regional and International Co-Operation.

Unit No.	Name and Sub Titles of the Topic	No. of Lectures
1	**India's Foreign Trade and Policy**	12
	1.1 Role of Foreign Trade in Economic Development	
	1.2 India's Foreign Trade- Growth, Composition and Direction since 2000	
	1.3 Free Trade v/s Protection - Case For and Case Against	
	1.4 Highlights of India’s Foreign Trade policy Since 2015	
	1.5 Evaluation of Policy of Special Economic Zones in Export Promotion	
2	**Foreign Capital**	12
	2.1 Role of Foreign Capital in Economic Development	
	2.2 Types of Foreign Investment	
	2.3 Foreign Investment Policy in India since 1991	
	2.4 Problems of Foreign Capital	
3	**Foreign Exchange**	12
	3.1 Exchange Rate : Concept; Fixed & Flexible Exchange Rate -Merits and Demerits	
	3.2 Foreign Exchange Market- Meaning, Structure and Functions	
	3.3 Convertibility of the Rupee	
	3.4 Foreign Exchange Management Act, 1999, Main Provisions	
4	**Regional and International Co-operation: Nature and Functions of-**	12
	4.1 South Asian Association for Regional Cooperation (SAARC)	
	4.2 Brazil, Russia, India, China and South Africa (BRICS)	
	4.3 European Economic Community (EEC)	
	4.4 World Trade Organization (WTO)	

1. **Recommended Books -**

2. Kenan, P.B. (1994), the International Economy, Cambridge University Press, London.
3. Kindlberger, C.P. (1973), International Economics, R.D. Irwin, Homewood.
4. Krugman, P.R. and M. Obstgeld (1994), International Economics: Theory and Policy, Glenview, Foresman.
5. Salvatore, D.L. (1997), International Economics, Prentice-Hall, Upper Saddle River, N.J.
6. Sodersten, Bo (1991), International Economics, Macmillan Press Ltd., London.
7. International Economics , M.L. Jhingan
8. Bhagwati, J. (Ed.) (1981), International Trade, Selected Readings, Cambridge University Press, Mass.
9. Greenaway, D. (1983), International Trade Policy, Macmillan Publishers Ltd., London.
10. Joshi V. and I.M.D. Little (1998), India's Economic Reforms, 1999-2001, Oxford University Press, Delhi.
11. Panchmukhi, V.R. (1978), Trade Policies of India: A Quantitative Analysis, Concept Publishing Company, New Delhi.
12. Patel, S.J. (1995), Indian Economy towards the 21st Century, University Press Ltd., India.
13. **Reports:**

1. Ministry of Commerce and Industry, Government of India, Recent Annual Report
2. Government of India, Economic Survey Latest
3. Reserve Bank of India, Annual Report

T.Y.B.A. Economics
Special Paper – IV: Public Finance -I
(Course Code:)
Semester – V

Preamble:

The role and functions of the Government in an economy has been hanging with the passage of time. The term 'Public Finance' has traditionally been applied to involve the use of revenue and expenditure measures along with the budgetary policy is an important part to understand the basic problems of use of resources, distribution of Income etc. The course will be useful for students aiming towards careers in the government sector, policy analysis, banking and business. This course would take an overview of government finances with special reference to India. The course aims to introduce the learner to the main concepts in public finance, equip them with an analytical grasp of government taxes: direct and indirect taxes and familiarize students with the main issues in government expenditure and debt.

Objectives:

1. To make students to analyze the role of Public Finance in Economic Development.
2. To know the sources of Revenue, Expenditure and Debt of Govt. of India.
3. To make students competent to become success in competitive examination.

Course Learning Outcomes

At the end of the course the learner will have ability-

- To relate and recognize the Nature and Scope of Public Finance.
- To describe and analyze the concept of Public Revenue and its components.
- To explain types of Public Expenditure and reasons for rising Public Expenditure.
- To explain the types of Public Debt and its effects.

Unit No.	Name and Sub Titles of the Topic	No. of Lectures
1	**Introduction to Public Finance**	12
	1.1 Meaning, Nature, Scope and Importance of Public Finance	
	1.2 Public Finance versus Private Finance	
	1.3 Role of Public Finance in Economic Development	
	1.4 Principle of Maximum Social Advantage: Musgrave's Approach	
2	**Public Revenue**	12
	2.1 Sources of Public Revenue	
	2.2 Meaning of Tax, Types of Taxes- Direct Tax and Indirect Tax, Merits and Demerits	
	2.3 Goods and Service Tax: Concept and Characteristics; Need for GST in India	
	2.4 Concepts**:** Impact of Tax, Incidence of Tax, Shifting of Tax and Taxable Capacity	
3	**Public Expenditure**	12
	3.1 Meaning and Principles of Public Expenditure	
	3.2 Classification of Public Expenditure	
	3.3 Reason for Increasing Public Expenditure	
	3.4 Wagner's Law of Public Expenditure	

4	**Public Debt**	**12**
	4.1 Meaning, Sources and Importance of Public Debt	
	4.2 Methods of Repayment of Public Debt	
	4.3 Burden of Public Debt	
	4.4 The Fiscal Responsibility and Budget Management Act 2003- Highlights	

Recommended Books

1. Andley and Sundaram- Theory and Practice of Public Finance.
2. Bhatia H.L "Public Finance " Vikas Publishing House, 18th edition
3. Jayaram Hiregange, Deepak Rao (2017), India GST for Beginners, White Falcon Pub.
4. Government of India (2017). GST-Concept and Status
5. Singh S.K, Public Finance in Theory and Practice, S. Chand, New Delhi.
6. Ozerkar S.R.,Rajaswa (Marathi), Vidya Prakashan, Ruikar Marg Nagpur
7. Deo and Zamre, Rajaswa (Marathi) Pimpalapure and Co, Publishers, Nagpur.
8. Buchanan J. M.,, Public Principles of Public debt, Irwin, Homewood, III, USA.
9. Herber, B.P., Modern Public finance, AITBS, New Delhi.
10. Hicks Ursula (1961) "Public Finance" Digswell Place, James Nishbet & Co. Ltd.
11. Musgrave R. A. (1959) "The Theory of Public Finance: A study in Public Economics" McGraw Hill Logakwha Ltd.
12. Musgrave R. A. & Musgrave P. B "Public Finance: In Theory & Practice" McGraw Hill Logakwha Ltd.
13. Prest, A.R. and Barr N.A., Public Finance in Theory and Practice, ELBS, London.
14. Bhadane Jaywant R, (2020) GST Smart Taxation System, International Publication
15. Taylor Philip C (1968) "The Economics of Public Finance" Oxford Univeristy & IBH Publishing Co.
16. Alam, S, (2016) GST and the States, Sharing tax administrations, Economic and Political Weely, 51 (31) (Article)
17. Ministry of Finance, Government of India (Oxford Press), Economic Survey 2020.
18. Websites:

    https://data.gov.in
    https://www.gst.gov.in
    https://www.incometaxindia.gov.in

T.Y.B.A. Economics
Special Paper – IV: Public Finance -II
(Course Code:)
Semester – VI

Objectives:

1. To make students able to analyze Budget process of India.
2. To make the students aware about Role and working of Finance Commission.
3. To make students competent to become success in competitive examination.

Course Learning Outcomes

At the end of the course the learner will have ability

- To explain and assess the components and instruments of Fiscal Policy.
- To relate to the concepts of Budget and its components.
- To describe and analyze the concept of Deficit Financing and its effects.
- To describe and explain the Centre and State Financial Relationship.

Unit No.	Name and Sub Titles of the Topic	No. of Lectures
1	**Fiscal Policy**	12
	1.1 Fiscal Policy- Meaning, Instruments and Objectives	
	1.2 Fiscal Policy in Developing Countries	
	1.3 Limitations of Fiscal Policy	
	1.4 Review of Fiscal Policy in India Since 2011	
2	**Budget**	12
	2.1 Budget- Meaning, Nature and Objectives	
	2.2 Classification of Budget	
	2.3 Preparation of Indian Central Budget	
	2.4 Gender Budget- Meaning and Importance.	
3	**Deficit Financing**	12
	3.1 Deficit Financing- Meaning and Objectives	
	3.2 Role of Deficit Financing in Developing Countries	
	3.3 Trends in India's Deficit Financing Since 2011	
	3.4 Effects of Deficit Financing	
4	**Centre-State Financial Relationship**	12
	4.1 Centre-State Financial Relationship: Constitutional Provisions	
	4.2 Conflict in the Centre-State Financial Relationship	
	4.3 Role of the Finance Commission	
	4.4 Recommendations of 15th Finance Commission	

Recommended Books

1. Andley and Sundaram- Theory and Practice of Public Finance.
2. Bhatia H.L "Public Finance " Vikas Publishing House, 18th edition
3. Jayaram Hiregange, Deepak Rao (2017), India GST for Beginners, White Falcon Pub.
4. Government of India (2017). GST-Concept and Status
5. Bhadane Jaywant R, (2020) GST Smart Taxation System, International Publication

6. Singh S.K, Public Finance in Theory and Practice, S. Chand, New Delhi.
7. Ozerkar S.R.,Rajaswa (Marathi), Vidya Prakashan, Ruikar Marg Nagpur
8. Deo, and Zamre, Rajaswa (Marathi) Pimpalapure and Co, Publishers, Nagpur.
9. Buchanan J. M., Public Principles of Public debt, Irwin, Homewood, III, USA.
10. Herber, B.P., Modern Public finance, AITBS, New Delhi.
11. Hicks Ursula (1961) “Public Finance” Digswell Place, James Nishbet & Co. Ltd.
12. Musgrave R. A. (1959) “The Theory of Public Finance: A study in Public Economics” McGraw Hill Logakwha Ltd.
13. Musgrave R. A. and Musgrave P. B “Public Finance: In Theory & Practice” McGraw Hill Logakwha Ltd.
14. Prest, A.R. and Barr N.A., Public Finance in Theory and Practice, ELBS, London.
15. Taylor Philip C (1968) “The Economics of Public Finance” Oxford University and IBH Publishing Co.
16. Alam, S, (2016) GST and the States, Sharing tax administrations, Economic and Political Weely, 51 (31) (Article)
17. Ministry of Finance, Government of India (Oxford Press), Economic Survey 2020.
18. Websites:
    https://data.gov.in
    https://www.gst.gov.in
    https://www.incometaxindia.gov.in

T.Y.B.A. Economics
Skill Enhancement Course
Business Management

Semester	CC Paper	Paper No.	Name of Paper	Lectures / Week	Total Lect.	CA Marks	ESE Marks	Total	No. of Credits
V	SEC -III SEC-3A		Business Management- I	03	30	15	35	50	**2**
VI	SEC -IV SEC-3A		Business Management - II Project	03	30	15	35	50	**2**

SEC -Skill Enhancement Course; CC -Core Course; CA - Continuous Assessment;
ESE -End of Semester Examination

T.Y.B.A. Economics
Skill Enhancement Course
SEC 3A: Business Management-I
(Course Code:)
Semester – V

Course Learning Outcomes:
At the end of the Course, the Learner will have the following skills:

- Management of Business.
- Business planning and decision making
- Leadership Skills- Ability to work in teams at the same time, ability to show leadership qualities

Unit No.	Name and Sub Titles of the Topic	No. of Lectures	Skill Enhancement Exercises
1	**Business Management** **1.1** Nature and Scope of Management **1.2** Characteristics of Management **1.3** Need & Importance of Study of Management **1.4** Process of Management	**6**	• Discussion/ Practical/ Field Study
2	**Business Planning and Decision Making** **2.1** Nature of Planning **2.2** Steps in Planning Process **2.3** Types of Business Planning **2.4** Study of Planning Process **2.5** Steps in Decisions Making Process **2.6** Factors affecting decision Making	**6**	• Case Studies / Mini Projects / Individual /Team Presentations. • Practical Exercises in Decision Making Process/ Problem Solving

3	**Schemes of Government :** Make in India Start-up India Stand up India Mudra Loans Dairy Management Scheme Fruits Management Development Programme Agriculture Products Sell Management	**6** **2 + 2** Guest Lecture	• Visit to SSS/ Interview with Mudra Beneficiary. • Study of Street Vendors/ Hawkers/ Mini Enterprises etc. • Exhibitions Business Plan Ideas Competitor
4	**Workshop:** Workshop on Entrepreneurship Development Training Programme	**8**	2 -Half-Day Work - shops -4 hours each **OR** 1- One Day Workshop - 8 hours

Recommended Books

1. Stephen R. Covey, The 7 Habits of Highly effective People (1989), Guerilla Marketing.
2. Harvard Business Review, Management Tips, hbr.org/books.
3. Pandey, I.M. Financial Management, Persons 12th edn.
4. Saksena, S.C., Principles of Business Management (2019), Sahitya Bhawan Publi.Agra.
5. Kalkar Parag and Ajinath Doke, Vyavsay Vyavsthapan, Nirali Prakashan, Pune.
6. Vasistha, Neeru, Principles of Management, Taxmann.
7. Hannagan, Tim. Management Concepts and Practices, Macmillan India Ltd.
8. Government of India, Official Websites.

T.Y.B.A. Economics
Skill Enhancement Course
SEC-3A: Business Management-II (Project Report)
(Course Code:)
Semester – VI

Course Learning Outcomes:
At the end of the Course, the Learner will have the following skills:

- Analytical Skills – Ability to analyze data collected and interpret in the most logical manner
- Project Report Writing Skills- Ability to comprehend and illustrate/demonstrate findings
- Presentation Skills – PPT/Poster- Ability to illustrate findings in the most appealing manner
- Leadership Skills: Ability to show leadership skills with business ideas or work on business ventures as a practical example

Unit No.	Name and Sub Titles of the Topic	No. of Lectures	Skill Enhancement Exercises
1	**Case Study** Guest Lecture – Local Entrepreneur – Success Stories / Struggles/ Historical Reviews/ Start-ups, etc	2	Preview to Students for Project Report
2	**Project Interim Presentation** Detailed Study of ANY Business Enterprise under the Guidance of Subject Teacher OR Presentation of a Business Idea	14	Initial Mid Semester Presentation (15 marks)
3	**Project Final Presentation** Presentation with PPT or Poster or Exhibition of Business Ideas/ Reports	14	Final Presentation Viva (35 Marks) Int. Examiner - 10 Ext. Examiner - 10 Report- 15

Recommended Books

1. Stephen R. Covey, The 7 Habits of Highly effective People (1989), Guerilla Marketing.
2. Harvard Business Review, Management Tips, hbr.org/books.
3. Pandey, I.M. Financial Management, Persons 12th Edn.
4. Saksena, S.C., Principles of Business Management (2019), Sahitya Bhawan Publi.Agra.
5. Kalkar Parag and Ajinath Doke, Vyavsay Vyavsthapan, Nirali Prakashan, Pune.
6. Vasistha, Neeru, Principles of Management, Taxmann.
7. Hannagan, Tim. Management Concepts and Practices, Macmillan India Ltd.
8. Government of India, Official Websites.

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Savitribai Phule Pune University
(Formerly University of Pune)

Three Year B. Sc. Degree Program in Zoology
(Faculty of Science & Technology)

T. Y. B. Sc. Zoology

Choice Based Credit System Syllabus

To be implemented from
Academic Year 2021 - 2022

Preamble:

Zoology is one of the major subjects of Basic Sciences and deals with all aspects of animal biology. It includes an interesting range of highly diverse topics. A zoology student needs to gain understanding of many areas of the subject to keep pace with advancements in Life Sciences.
This under-graduate degree program has been designed by the Board of Studies in Zoology of Savitribai Phule Pune University with a substantial component of what is needed from a zoologist as a skilled career and what zoologists needs to pursue for post-graduation and further academic studies. It follows the guidelines laid down by the University Grants Commission, New Delhi. This newly designed curriculum is a perfect blend of the classical aspects in Zoology with the advanced and more specialized areas.

This degree offers Discipline Specific Core Courses **[CC]** in Animal Systematics, Animal Ecology, Animal Cell biology, Applied Zoology, Pest Management, Histology, Biological Chemistry, Genetics, Developmental Biology, Parasitology, Medical & Forensic Zoology, Animal Physiology, Molecular Biology, Entomology, Techniques in Biology and Evolutionary Biology.
In addition to the Core Courses, Ability Enhancement Compulsory Courses **[AECC]** have been added in the second year i.e. Semester III and Semester IV of the undergraduate course. In the third year i.e. Semester V and Semester VI, Discipline specific Elective Courses **[DSEC]** and Skill Enhancement Courses **[SEC**] have been offered. The students, therefore, have an opportunity to take courses in Environment Awareness, Language & communication, English / Marathi, Aquarium Management, Poultry Management and Environmental Impact Assessment. In Semester VI the students also have a course dedicated to Project work.

The syllabus has been framed in such a way that the student gains each year, a broader perspective of the subject as he progresses towards completion of the degree program. Field visits, Educational visits and the Project work have been included for the student to experience the applications of the theory learnt in the classroom.

After completion of the program, it is expected that students will understand and appreciate: animal diversity, few applications of Zoology, the structure, functions and life processes at cellular, tissue, organ and system level, significance of evolution, and basic concepts of human health. The students would also gain an insight into laboratory and field work through the practical course, field work and the project.

While presenting this new syllabus to the teachers and students of T. Y. B. Sc. Zoology, I am extremely happy to state that efforts have been made to seek inputs of all the stake holders to make it more relevant.

The new course will be effective from the academic year 2021- 2022 and will follow the Choice Based Credit System in a Semester mode. It has been primed keeping in view the distinctive requirements of B. Sc. Zoology students. The contents have been drawn-up to accommodate the widening prospects of the discipline of Life Sciences. They reflect the changing pre requisites of the students. This graduate program has been introduced with 132 credits for the subject group while 08 credits to earn from any of the 08 groups offering a range of curricular, co-curricular and extracurricular activities. This pattern has been specially aimed towards the overall development of the students.

The calculation of credits and CGPA will be as per the guidelines of the University. The B. Sc. Zoology program provides an appropriate blend of classical and applied aspects of the subject. This newly designed curriculum will allow students to acquire the skill in handling scientific instruments planning and performing in the laboratory and exercising critical judgement, independent thinking and problem solving skills. The Syllabus has been revised with the following aims -

- To foster curiosity in the students for Zoology,
- To create awareness amongst students for the basic and applied areas of Zoology,
- To orient students about the importance of abiotic and biotic factors of environment and their conservation,
- To provide an insight to the aspects of animal diversity,
- To inculcate good laboratory practices in students and to train them about proper handling of lab instruments.

Board of Studies in Zoology
Savitribai Phule Pune University

1. Course Structure:

Course Structure with Credit Distribution of the Undergraduate Science Program in Zoology

Course	Course Code and Name of the Course		Credits
F. Y. B. Sc.	**SEMESTER I**	**SEMESTER II**	
CC	ZO-111 Animal Diversity I	ZO-121 Animal Diversity II	2+2
CC	ZO-112 Animal Ecology	ZO-122 Cell Biology	2+2
CC	ZO-113 Zoology Practical Paper	ZO-123 Zoology Practical Paper	1.5+1.5
S. Y. B. Sc.	**SEMESTER III**	**SEMESTER IV**	
CC	ZO-231 Animal Diversity III	ZO-241 Animal Diversity IV	2+2
CC	ZO-232 Applied Zoology I	ZO-242 Applied Zoology II	2+2
CC	ZO-233 Zoology Practical Paper	ZO-243 Zoology Practical Paper	2+2
AECC	EVS 231-Environment Awareness	EVA 241-Environment Awareness	2+2
AECC	LA 231-English / Marathi	LA 241- English / Marathi	2+2
T. Y. B. Sc.	**SEMESTER V**	**SEMESTER VI**	
DSEC	ZO-351 - Pest Management	ZO-361 - Medical & Forensic Zoology	2+2
DSEC	ZO-352 - Histology	ZO-362 - Animal Physiology	2+2
DSEC	ZO-353 - Biological Chemistry	ZO-363 - Molecular Biology	2+2
DSEC	ZO-354 - Genetics	ZO-364 - Entomology	2+2
DSEC	ZO-355 - Developmental Biology	ZO-365 - Techniques in Biology	2+2
DSEC	ZO-356 - Parasitology	ZO-366 - Evolutionary Biology	2+2
DSEC	ZO-357 - Zoology Practical Paper 1	ZO-367 - Zoology Practical Paper 1	2+2
DSEC	ZO-358 - Zoology Practical Paper 2	ZO-368 - Zoology Practical Paper 2	2+2
DSEC	ZO-359 - Zoology Practical Paper 3	ZO-369 - Zoology Practical Paper 3	2+2
SEC	ZO-3510 - Aquarium Management	ZO-3610 - Environmental Impact Assessment	2+2
SEC	ZO- 3511 - Poultry Management	ZO-3611 - Project	2+2

2. Detailed Syllabus of T. Y. B. Sc.

Following is the syllabus of each course along with the course outcomes:

SR.NO.	SEMESTER	COURSE NUMBER AND NAME	CREDITS
1	V	ZO 351 - Pest Management	2
2	V	ZO 352 - Histology	2
3	V	ZO 353 - Biological chemistry	2
4	V	ZO 354 - Genetics	2
5	V	ZO 355 - Developmental Biology	2
6	V	ZO 356 - Parasitology	2
7	V	ZO 357 - Zoology Practical Paper 1	2
8	V	ZO 358 - Zoology Practical Paper 2	2
9	V	ZO 359 - Zoology Practical Paper 3	2
10	V	ZO 3510 - Aquarium Management	2
11	V	ZO 3511 - Poultry Management	2
12	VI	ZO 361 - Medical & Forensic Zoology	2
13	VI	ZO 362 - Animal Physiology	2
14	VI	ZO 363 - Molecular Biology	2
15	VI	ZO 364 - Entomology	2
16	VI	ZO 365 - Techniques in Biology	2
17	VI	ZO 366 - Evolutionary Biology	2
18	VI	ZO 367 - Zoology Practical Paper 1	2
19	VI	ZO 368 - Zoology Practical Paper 2	2
20	VI	ZO 369 - Zoology Practical Paper 3	2
21	VI	ZO 3610 - Environmental Impact Assessment	2
22	VI	ZO 3611 - Project	2

SEMESTER - V

Course Title: Pest Management
Course Code: ZO 351
Credits - 02

ZO 351 - Pest Management

Course Objectives:

After you complete your study of this unit, you should be able to:

- Explain why identification of the pest is the first step in developing an effective pest control strategy.
- Explain the differences between continuous pests, sporadic pests, and potential pests.
- Explain what is meant by prevention, suppression, and eradication of pests.
- Describe "thresholds" and why they are an important consideration in developing a pest control strategy.
- Describe "monitoring" as it relates to pest control and explain why it is important to pest control strategy.

Course Outcomes:

1. Define pest management.
2. Describe the economic, ecological, and sociological benefits of IPM.
3. Distinguish positive and negative impacts of pesticide use.
4. Understand problems resulting from misuse, overuse, and abuse of chemical pesticides.
5. Define and describe pesticide resistance and how it develops.
6. Identify ecological and biological characteristics important in development of pest populations.
7. Identify 10 tactics commonly used in IPM and be able to distinguish them.
8. Understand society's role in IPM decisions.
9. Describe different groups of pests and compare them to weeds and plant pathogens.
10. Analyse and compare management tactics to determine the best approach to reducing pest populations, weeds, and disease presence.
11. Locate appropriate, scientifically valid sources of information on specific tactics to manage insect pests, weeds, and diseases.
12. Know and how to develop an IPM program.

Title & Contents	**Number of lectures**
1. Pest:	**2 L**
1.1. Definition.	
1.2. Types of pests.	
1.3. Types of damages caused by the pest.	
2. Pest management using Regulatory control:	**4 L**
2.1. Quarantine.	
2.2. Eradication.	

2.3. Control districts.
2.4. "Crop-free" periods.

3. Pest management using Cultural control: 4 L

3.1. Sanitation.
3.2. Tillage.
3.3. Crop rotation.
3.4. Cropping systems.

4. Pest management using Biological control: 4 L

4.1. Ecological considerations.
4.2. Biological control of insects.
4.3. Biological control of plant disease.
4.4. Biological control of weeds.

5. Biotechnology approaches in pest management: 4 L

5.1. Introduction.
5.2. Recent advance in use of fungi and viruses.
5.3. Methodology in Biotechnology.
5.4. Somaclonal variability.
5.5. Concept of Genetic engineering and Transgenic plants.

6. Integrated pest management (IPM): 5 L

6.1. Principles and its components.
6.2. Advantages and disadvantages.
6.3. Biological control -
Predators, Parasitoids, Entomopathogens, Weed killers and their mass production.

7. Insecticides: 4 L

7.1. Classification of insecticides based on mode of entry.
7.2. Action and chemical nature.
7.3. Insecticides formulations and their uses.
7.4. Safe handling of insecticides.

8. Insecticide residue: 3 L

8.1. Methods of residue detection – Organochlorine, Organophosphates, Synthetic Pyrithroides, Systemic.
8.2. Problems in fruits, vegetables, medicinal plants.
8.3. Maximum permissible residue limits (MRLs).

Reference Books -

1. Handbook of Pest Management in Agriculture by Pimentel.
2. Principles of Insect Pest Management by Dhaliewal and Arora.
3. Agricultural Pest of India & South East Asia by A. Satwal.
4. Pathological Problems of Economics Crop Plants & their Management by Paul Khurana, S. M., 1998.

5. Integrated Diseases Management and Plant Health by Gupta V. K. & Sharma R. C.
6. Diseases of Millets by Ramkrishnan T. S., I. C. A. R. Publ. New Delhi.
7. Fungal diseases of Rice in India by Padmanabhan S. Y., I. C. A. R. Publ., New Delhi.
8. Analysis of Pesticides Residues by H. A. Moye (JW)
9. Advance in Pest Control Research by R. L. Methcalf (JW)
10. Chemistry of pesticides by K. H. Buchel (JW).
11. Progress in Pesticides Biochemistry and Toxicology Vol. I, II & III by D. H. Hutsonand T. R. Robert.
12. Evaluation of Pesticides in Ground Water by W. Y. Garnett, R. C. Honeycatt and others.
13. Chemistry of Pesticides by Edward
14. Insecticide Biochemistry and Physiology by C. F. Wilkinson.

Course Title: Histology
Course Code: ZO 352
Credits: 02

ZO 352 - Histology

Objectives –

1. To understand the histological aspects of mammalian organs.
2. To study the important features of different types of tissues in organ system.
3. To understand the classification of various types of basic tissues.
4. To study structure & functions of various tissues in organ system.
5. To understand histological structure of various glands and its functions.

Learning Outcomes for the course –

1. The students will be able to understand, classify and identify the different types of tissue.
2. The students will understand the complexity of various tissues in an organ.
3. The students will be able to learn structure & functions of various tissues.
4. The students will understand the various diseases related to organs.
5. The student will be able to know the role of glands in mammals.

Title & Contents	Number of lectures
1. Introduction: Definition and Scope of Histology.	**1 L**
2. Definitions and Review of Types of Tissues: 2.1 Epithelial tissue. 2.2 Connective tissue. 2.3 Nervous tissue. 2.4 Muscular tissue.	**3 L**
3. Histological study of following mammalian organs: 3.1 Skin (V. S.). 3.2 Tooth (V. S.).	**5 L**

3.3 Tongue (C. S.) with reference to mucosa papillae and taste buds.

4. Histological study of Alimentary canal and Liver: 6 L

4.1 Oesophagus (T. S.).
4.2 Stomach (T. S.).
4.3 Duodenum (T. S.).
4.4 Rectum (T. S.).
4.5 Liver (C. S.).

5. Histological study of Respiratory organs: 2 L

5.1 Trachea (T. S.).
5.2 Lung (C. S.).

6. Histological study of Excretory organs: 3 L

6.1 Kidney (L. S.).
6.2 Juxtaglomerular complex.

7. Histological study of Reproductive organs: 4 L

7.1 Testis (T. S.) with reference to Seminiferous Tubules and Cells of Leydig.
7.2 Ovary (C. S.).

8. Histology of Endocrine glands: 6 L

8.1 Pituitary gland.
8.2 Thyroid gland.
8.3 Adrenal gland.
8.4 Pancreas (C. S.) including both exocrine and endocrine components.

Reference Books: -

1. A Text Book of Histology, 2014, 5th Edn. Krishna Garg, Indira Bahl & Mohini Kaul CBS Publication & Distributors, Delhi.
2. Histology, 1987, 9th Edn., Arthur W. Ham, David H. Cormack, J. B. Lippincott Co. Philadelphia.
3. Histology, 1977, 4th Edn., R. O. Greep and L. Weiss, McGraw Hill Int. Book Co., New York.
4. Hand Book of Histo-pathogical & Histo-chemical Techniques, 1983, 3rd Edn. reprint, Butterworth & Co. (Publishers) Ltd, UK.

Course Title: Biological Chemistry
Course code: ZO 353
Credits: 02

ZO 353 - Biological Chemistry

Objectives –

1. To understand the basic concepts and significance of biochemistry.
2. To understand the basic concepts pH and Buffers
3. To understand the chemical structures of carbohydrate, and their biological and clinical significance.
4. To understand the structure and importance of proteins and lipids
5. To understand the variations in enzyme activity and kinetics.

Learning Outcomes for the course -

1. Learners shall be able to understand basic concepts and significance of biochemistry
2. The students will learn about the pH and Buffers.
3. The students will learn about the chemical structures of carbohydrate, and their biological and clinical significance.
4. The students will be able to understand, interpret structure and importance of proteins, carbohydrates and lipids
5. Learners will be able to comprehend variations in enzyme activity and kinetics.

Title & Contents	**Number of lectures**
1. Introduction of Biochemistry: Importance of Biochemistry in Life Sciences.	**1 L**
2. p^H and Buffers: 2.1 Concept of p^H. 2.2 Concept of p^H scale, biological significance of p^H 2.3 Concept of acid and base, Ionization of acids and bases. 2.4 Derivation of Henderson-Hassel Balch equation & its applications. 2.5 Buffer - Definition, Concept, Functions, Types of buffer and Buffering Capacity.	**3 L**
3. Carbohydrates: 3.1 Definition, Classification & Biological importance of Carbohydrates. 3.2 Isomerism in carbohydrates - Structural and Stereoisomerism. 3.4 Significance of Gluconeogenesis, Glycogenolysis and Glycogenesis. 3.3 Clinical Significance - Hypoglycemia and Hyperglycemia.	**7 L**
4. Amino acids and Proteins: 4.1 General Structure of amino acids and Peptide bond. 4.2 Essential and non-essential amino acids. 4.3 Types of proteins, protein structures (primary, secondary, tertiary and quaternary structures with suitable example), Forces responsible for their stability. 4.5 Biological importance of proteins – Biocatalysts, Carrier proteins Contractile proteins, Hormonal role of proteins.	**6 L**
5. Enzymes: 5.1Nomenclature, Types and properties of enzymes. 5.2 Regulatory and non-regulatory enzymes. 5.3 Enzyme inhibition. 5.4 Factors influencing enzyme activity (pH, temperature, substrate concentration). 5.5 Introduction of isoenzymes and cofactor. 5.6 Clinical significance of enzymes - PKU and AKU.	**10 L**
6. Lipids:	**3 L**

6.1 Introduction.
6.2. Fatty acids - Types and nomenclature (saturated and unsaturated).
6.3 Clinical significance (obesity, atherosclerosis, myocardial infarction).
6.4 Biological importance of lipids.

Reference books

1. Principles of Biochemistry, 1993, Lehninger A. L. Nelson D. L. & Cox M. M. W. H. Freeman Company, USA.
2. Biochemistry, 1995 5th Edn. Zuby G. W, C. Brown Communications USA.
3. Harpers Biochemistry, 1996 26th Edn. p Murray R. K., Granner D. K., Mayes P. A. & Rodwell V. W. Prentice Hall international USA.
4. Outline of Biochemistry, 1995 5th Edn, Conn E. E., Stumph P. K. Bruening G & Doi R. H. John Wiley & Sons, USA.
5. Principals of Biochemistry, 1993, 1st Edn., Pattabhiraman T. N. Gajanan Book publishers and distributors Bangalore.
6. Clinical Biochemistry, 1994, B. P. Godkar, Bhalini Publishing House, Mumbai.
7. Biochemistry, 1995 5th Edn., Stryer San Francisco, W. H. Freeman & Co.
8. Biochemistry, 1990, 8th Edn., D. Voet & J. Voet, John Willey, New York
9. David T. Plummer: An Introduction to Practical Biochemistry, IIIrd edition (1988)

Course Title: Genetics
Course code: ZO 354
Credits: 02

ZO 354 - Genetics

Title & Contents	**Number of lectures**
1. Introduction to genetics:	**3 L**
1.1 Classical and Modern concept of Gene, Cistron, Muton, Recon.	
1.2 Mendel's laws of Inheritance.	
2 Exceptions to Mendelian Inheritance:	**6 L**
2.1 Incomplete dominance.	
2.2 Co-dominance.	
2.3 Multiple alleles: Concept, characteristics and importance of multiple. alleles, ABO & Rh - blood group system and its medico legal importance.	
2.4 Lethal alleles.	
3. Gene Mutation:	**6 L**
3.1 Definition.	
3.2 Types of mutations: spontaneous, induced, somatic, gametic, forward, reverse. Types of point mutation - deletion, insertion, substitution, transversion, transition.	
3.3 Mutagenic agents	
a) UV radiation and ionising radiation.	
b) Base analogs, alkylating and intercalating agents.	

4. Sex-determination: **4 L**

4.1 Introduction.

4.2 Types of sex determination: -XX-XY, ZZ-ZW, XX-XO and Parthenogenesis, Hypodiploidy.

4.3 Gynandromorphism.

5. Population Genetics: **3 L**

5.1 Basic Concepts in population genetics: Mendelian population, gene pool, gene / allele, Frequency, chance mating (Panmictic mating).

5.2 Hardy Weinberg law and its equilibrium.

6. Human Population Genetics: **4 L**

6.1 Karyotype.

6.2 Genetic disorders, Structural & numerical alterations of chromosomes (chromosomal aneuploidy - Down, Patau, Edward, Turner and Klinefelter syndromes).

7. Sex linked inheritance in human: **2 L**

7.1 Colour – blindness.

7.2 Haemophilia.

7.3 Hypertrichosis.

8. Application of genetics: **2 L**

8.1 Genetic counselling.

8.2 Diagnostics & breeding technology.

Reference Books -

1. Principles of Genetics, 1997, P. D. Snustad, M. L. Simmons J. B. Jenkins, John Wiley & Sons, USA
2. Genetics, 2014, 9th Edn., Verma P. S. and Agarwal V. K., S. Chand and Co., New Delhi.
3. Genetics, 2014, 4th Edn. Gupta P. K., Rastogi Publications, Meerut.
4. Principles of Genetics, Gardner, E. J. *et al.* (2006), John Wiley and Sons Inc.
5. Genetics: A Molecular Approach, 3rd Edn, Russell, P. J., Benjamin Cummings.
6. Principles of Genetics 8th Edition, Gardner, E. J., Simmons, M. J., Snustad, D. P. (2008). John Wiley and Sons Inc.
7. Principles of Genetics. 5th Edn. Snustad, D. P. and Simmons, M. J. (2009). John Wiley and Sons Inc.
8. Concepts of Genetics, 10th Edn. Benjamin Cummings. Klug, W. S., Cummings, M. R. and Spencer, C. A. (2012).
9. An Introduction to Genetic Analysis, 11th Edn. Carroll S. B.; Doebley J., Griffiths, A. J. F. and Wessler, S. R. (2018) W. H. Freeman and Co. Ltd.

Course Title: Developmental Biology
Course code: ZO 355
Credits: 02

ZO 355 - Developmental Biology

Title & Contents	Number of lectures
1. Fundamentals of Developmental Biology: 1.1 Definition and scope. 1.2 Concepts in Developmental Biology: Growth, Differentiation, Dedifferentiation, Cell determination, Cell communication, Morphogenesis, Induction and Regeneration.	**3 L**
2. Theories of Developmental Biology: 2.1 Preformation. 2.2 Pangenesis. 2.3 Epigenesis. 2.4 Axial gradient. 2.5 Germplasm.	**3 L**
3. Gametogenesis: 3.1 Spermatogenesis & Structure of sperm with respect to human. 3.2 Oogenesis & Structure of ovum with respect to human. 3.3 Types of eggs.	**5 L**
4.Fertilization: 4.1 Concept and types. 4.2 Chemotaxis. 4.3 Sperm penetration: Acrosome reaction, Capacitation & Decapacitation. 4.4 Activation of ovum: Fertilization cone. 4.5 Prevention of polyspermy: Fast block & Slow block. 4.6 Significance of fertilization.	**6 L**
5. Cleavage and Blastula: 5.1 Planes and symmetry of cleavage. 5.2 Types of cleavage. 5.3 Significance of cleavage. 5.4 Definition and types of Blastula.	**5 L**
6. Gastrulation: 6.1 Definition and Concept. 6.2 Basic cell movements in gastrulation: Epiboly, Emboly, Convergence, Invagination, Ingression & Involution with reference to frog. 6.3 Concept of Organizer : Primary, Secondary and Tertiary.	**3 L**
7. Chick Embryology: 7.1 Structure of Hen's egg.	**6 L**

7.2 Fertilization and cleavage in Chick.
7.3 Formation of primitive endoderm.
7.4 Primitive streak development.
7.5 Head process and regression of Primitive streak.

References:

1. An Introduction to Embryology (2012), 5th Edition., Balinsky B. L., Fabian B. C. Brooks Cole Pub. Co., USA
2. Developmental Biology (2013), 10th Edn. Gilbert S. F., Sinauer Associates Inc.
3. Developmental Biology: Patterns**,** Principle and Problems (1982), Saunders J. W., Prentice Hall Coll Div.
4. Principles of Development (2007), 3rd edition, Lewis Wolpert, Oxford University Press Publisher

Course Title: Parasitology
Course code: ZO 356
Credits: 02

ZO 356 - Parasitology

Objectives:

1. To understand the basic terminologies in parasitology.
2. To understand the concepts of animal association with examples.
3. To understand the morphology and life cycle of common parasites (Protists and Platyhelminthes).
4. To understand the phenomenon of Host-parasite relationship.
5. Explain the importance of arthropod vectors with examples.

Learning outcomes:

1. The students will be able to learn about basics and scope of parasitology.
2. The students will be able to learn the types of host and parasite with examples.
3. The students will be able to learn about the morphology, life cycle, pathogenicity and treatment of common parasites (Protists and Platyhelminthes).
4. The students will be able to learn about host -parasite relationships and their effects on host body.
5. The students will be able to learn about the arthropod parasites and their role as vector.

Title & Contents	**Number of lectures**
1. Introduction, Scope and Branches of Parasitology: 1.1. Definition: host, parasite, vector, commensalisms, mutualism and parasitism. 1.2. Branches of parasitology.	**2 L**
2. Types of Parasites and Hosts: 2.1 Ectoparasites.	**3 L**

2.2 Endoparasites and its subtypes.
2.3 Types of hosts - Intermediate, definitive, paratenic and reservoir.

3. **Host - Parasite relationship:** **3 L**
3.1 Host specificity.
3.2 Types of host specificity: structural specificity, physiological specificity and ecological specificity.
3.3 Effects of parasite on host.

4. Study of Parasitic Protists: **9 L**
4.1 *Entamoeba histolytica* - Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment.
4.2 *Plasmodium vivax* - Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment.

5. Study of Parasitic worms: **9 L**
5.1 *Ascaris lumbricoides* - Study of Morphology, Life Cycle, Prevalence.
5.2 Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment.
5.3 *Taenia solium* (Tapeworm) - Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment.

6. Study of Parasitic Arthropoda: **4 L**
Morphology, pathogenicity and control measures of –
6.1 Soft tick.
6.2 Head louse.
6.3 Rat flea.
6.4 Bed bug.

Reference Books:

1. Parasitology: K. D. Chatterjee.
2. Parasites: ecology, diseases, and management (2013).
3. Parasitic Helminths: Targets, Screens, Drugs, and Vaccines, 201.
4. Parasitism: The Diversity and Ecology of Animal Parasites (2014) Tim Goater, Timothy M. Goater, Cameron P. and Esch, Gerald W. Cambridge University Press.
5. Principles of Veterinary Parasitology (2016), 1st Edn, Dennis E. Jacobs, Mark Fox, Lynda M. Gibbons, Carols Hermosilla, John Wiley & Sons.
6. Veterinary Parasitology (2013), Hany M. Elsheikha, Jon S. Patterson, CRC Press Taylor & Francis Group
7. Textbook of medical parasitology – C. K. Jayaram Panikar.
8. Textbook of medical parasitology – Arora & Arora.
9. Textbook of medical parasitology – S. C. Parija.
10. Veterinary Parasitology, 2013 - (Taylor, M. A.).
11. Encyclopedia of parasitology, 2008.
12. The Biogeography of Host-Parasite Interactions by Serge Morand, Boris R. Kransov, Oxford University Press.
13. Textbook of medical microbiology – Rajesh Bhatia & Itchpujani.

14. Textbook of medical microbiology – Arora & Arora.
15. Biological Control of Parasites, 2012.
16. Biology of Malaria Parasites, 2012.
17. Sherris medical microbiology: Ryan.
18. Medical microbiology: Jawetz Melnick & Adelbergs.
19. Current concepts in parasitology, 2012.
20. Textbook of Parasitology, Ashok Kumar, Discovery Publishing.
21. Introduction to parasitology: With special reference to the parasites of man, A.C. Chandler- John Wiley & Sons.
22. A text book of Parasitology – D. P. Karyakarte & A. S. Damle.

For Practical papers of both V and VI semester, minimum 6 practicals should be conducted from each section, thus a minimum of 12 practicals should be conducted per practical paper. (C) stands for compulsory.

Course Title: Zoology Practical Paper I
Course code: ZO 357
Credits: 02

Course Title : Zoology Practical Paper - I

Section I: Practicals in Pest Management

1.	To study the plant protection appliances.	D
2.	Studies on beneficial insects. (C)	D
3.	Study of pests and diseases of honeybees. (C)	D
4.	Applications of IPM components in various crops.	D
5.	Separation of the pesticides or plant products by TLC and Column chromatography. - 2 P(C)	E
6.	Detection of pesticides residues in food stuffs. (C)	E
7.	Rearing of pest species (Any 2 species). (C)	D
8.	Study of life cycle of Red cotton bug and Lemon butterfly.	D
9.	Study of the detection of damage caused by pests.	D
10.	Plant disease, its intensity & calculation of VI (Virulence Index) of at least two diseases.	D

Section II: Practicals in Histology

1.	Study of the different types of tissues with the help of permanent slides – Epithelial tissue, Connective tissue, Muscular tissue and Nervous tissue.	D
2.	Study of permanent histological slides of T. S. of skin, V. S. of tooth and C. S. of tongue.	D
3.	Study of permanent histological slides of digestive parts – T. S. of Stomach, T. S. of Duodenum, T. S. of Rectum, C. S. of Liver.	D

4. Study of permanent histological slides of glands - T. S. of Pituitary gland, T. S. of Thyroid gland, T. S. of Adrenal gland, C. S. of Pancreas. D
5. Study of permanent histological slides of reproductive organs- T. S. of Testis, C. S. of Ovary. D
6. Study of human blood smear to observe different types of blood cells. (C) E
7. Temporary mounting of tissues of any mammal (freshly dissected or preserved) - Striated Muscle Fibre. (C) E
8. Temporary mounting of tissues of any mammal (freshly dissected or preserved) - Smooth Muscle Fibre. (C) E

Course Title: Zoology Practical Paper - II
Course code: ZO 358
Credits: 02

ZO 358 - Zoology Practical Paper - II

Section I: Practicals in Biological Chemistry

1. To determine the enzyme activity - salivary amylase/ urease/ invertase. E
2. To determine specific activity of an enzyme. E
3. Detection of carbohydrates (monosaccharides, disaccharides and polysaccharides) with the help of suitable tests. (C) E
4. Isolation of starch from potato and digestion of starch by salivary amylase. (C) E
5. Preparation of buffer of desired pH and molarity. (C) E
6. Protein estimation by Lowry *et al*. method. (C) E
7. Isolation of Caesin from milk by adjusting iso-electric point. (C) E
8. Preparation of Acid, Alkali & it's standardisation. E
9. Principle, Working & Measurement of pH of any three samples. E

Section II: Practicals in Genetics

1. Study of monohybrid ratio by providing hypothetical data and deducing applicability of Mendelian laws (Two examples). (C) D
2. Study of Dihybrid ratio by providing hypothetical data and deducing applicability of Mendelian laws (Two examples). (C) D
3. Study of genetic traits in human beings (tongue rolling, widow's peak, ear lobes, colour-blindness and PTC tasters/ non-tasters). D

4. Study of blood groups in human (ABO and Rh). (C) D
5. Study of Hardy - Weinberg law with suitable recording of genetic traits. D
6. Study of human karyotypes and numerical alterations (simulated & theoretical sample data) (Down syndrome, Klinefelter syndrome and Turner syndrome). D
7. Temporary preparation of polytene chromosomes from suitable material. (C) E
8. Study of structural chromosome aberrations (dicentric, ring chromosomes and inversions in polytene chromosomes) from prepared slides / photographs. D
9. Study of external characters, life cycle and Rearing of *Drosophila.* (C) D
10. Study of *Drosophila* mutants. D

Course Title: Zoology Practical Paper III
Course code: ZO 359
Credits: 02

ZO 359 - Zoology Practical Paper - III

Section I: Practicals in Developmental Biology

1. Study of ultrastructure of Sperm and Ovum of Mammal. D
2. Study of eggs with the help of slide / Photograph / chart / Model (Insect, *Amphioxus*, Frog and Hen). (C) D
3. Study of cleavage and its types with the help of Slide / Photograph / Chart / Model. D
4. Study of blastulae (*Amphioxus*, Frog and Hen). D
5. Study of gastrulae (*Amphioxus*, Frog and Hen). D
6. Study of whole mount slides of chick embryology – 24 hrs, 33 hrs and 48 hrs. (C) D
7. Study of T. S. and V. S. of chick embryo of Brain & Heart with the help of slide / Photograph / chart / Model – 24 hrs & 33 hrs. D
8. Temporary preparation of chick embryo. (C) E
9. Ex-ovo culture of chick embryo. D

Section II : Practicals in Parasitology

1. Study of parasitic association with their example - D
   a) Commensalism.
   b) Parasitism.
2. To study the life cycle, pathogenecity, diagnosis and treatment of *Entamoeba histolytica* and *Plasmodium vivax* through permanent slides or microphotographs. D
3. To study the life cycle, pathogenecity, diagnosis and treatment of *Ascaris lumbricoides* and *Taenia solium* through specimen, permanent slides or microphotographs. (C) D

4. Study of following parasites with its role as vector - Soft tick, *Pediculus humanus*, *Xenopsylla cheopis* and *Cimex lectularius* through permanent slides or photographs. (C)	D
5. Study of effects of parasites on host body.	D
6. Study of the pathogenecity and control measures of - Tick (soft tick and hard tick) and Mite *(Sarcoptes scabiei*).	D
7. Study of parasites from the gut of cockroach. (C)	E
8. Collection & submission of various parasites. (C)	E

Course Title: Aquarium Management
Course Code: ZO 3510
Credits: 02

ZO 3510: Aquarium Management

Title & Contents	**Number of lectures**
1. Introduction to Aquarium Fish Keeping: 1.1 The potential scope of Aquarium Fish Industry as a Cottage Industry. 1.2 Exotic and Endemic species of Aquarium Fishes. 1.3 Nutritional value of fish.	**4 L**
2. Biology of Aquarium Fishes: 2.1 Common characters and sexual dimorphism of Aquarium fishes - Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish, Butterfly fish and Fighter fish.	**6 L**
3. Food and feeding of Aquarium Fishes: 3.1 Use of live fish feed organisms. 3.2 Preparation and composition of formulated fish feeds. 3.3 Overview on types of fish food.	**4 L**
4. Fish Transportation: 4.1 Live fish transport: a) Fish handling. b) Fish packing. c) Fish forwarding techniques. 4.2 Causes of mortality in transport.	**4 L**
5. Maintenance of Aquarium: 5.1 General Aquarium Maintenance - budget for setting up an Aquarium. 5.2 Fish Farm as a Cottage Industry, Rules & regulations of fish rearing. 5.3 Common diseases of Aquarium fish.	**3 L**
6. Physico-chemical parameters of water for fish culture: 6.1 Acidity, Alkalinity, Calcium, Nitrate, Ammonia, Total hardness.	**4 L**
7. Fish preservation: 7.1 Fish preservation and processing.	**2 L**

7.2 Fish preservation techniques.

8. Fish breeding: **3 L**

8.1 Types of fish breeding -

a) Natural fish breeding.

b) Induced fish breeding.

Course Title: Poultry Management

Course Code: ZO 3511

Credits: 02

ZO – 3511 Poultry Management

Objectives:

1. To understand the basics of Poultry Farming and its important.
2. To understand breeding management of broilers and layers of chickens.
3. To understand housing management and equipment of Poultry farming.
4. To understand food, feeding and digestion mechanism of chickens.
5. To understand the poultry diseases and their control.
6. To understand the economic importance of poultry products.

Expected Outcome:

1. The students will be able to understand the Poultry farming practices.
2. The students will able to understand the poultry breeding techniques.
3. The students will be able to understand poultry rearing techniques.
4. The students will be able to understand feeding requirement and food ingredients.
5. The students will be able to understand the poultry disease and their pathogens.
6. The students will be able to understand market value of poultry products.

Title & Contents	**Number of lectures**
1. Introduction to Poultry Farming: 1.1 Definition of Poultry, Importance of Poultry Farming and Poultry Development in India. 1.2 Present and future prospects.	**2 L**
2 Breeding Management: 2.1 Male and female reproductive system of chicken. 2.2 Breeds and strains of broilers and layers of chicken. 2.3 General aspects of breeding for better egg production and body weight gain. 2.4 Selection and culling. 2.5 Artificial insemination.	**5 L**

3 Housing Management: **5 L**

3.1 Establishment of poultry farm.
3.2 Housing and equipment.
3.3 Incubation and hatching of eggs.
3.4 Broiler and layer management.
3.5 Lighting schedule for poultry.
3.6 Transport strategy of Poultry birds.

4 Feeding Management: **6 L**

4.1 Digestive system and Digestion Mechanism of chicken.
4.2 Feed ingredients.
4.3 Feed processing.
4.4 Formulation of feed *viz*., Starter, Grower, Layer, Finisher and Breeder ration, Feed conversion ratio (FCR), Nutritional deficiency conditions.

5 Health Management: **5 L**

5.1 Vaccination schedule for poultry birds.
5.2 Common poultry diseases, i. e. Ranikhet, Marek, Chicken pox, Gumboro, Infectious bronchitis and Chronic Respiratory Disease (CRD).
5.3 Control of internal and external parasites.

6 Poultry Products: **4 L**

6.1 Preservation and storage of eggs.
6.2 Grading of eggs and AGMARK standard of egg.
6.3 Egg powder.
6.4 Slaughtering and processing of chicken.
6.5 Poultry By Products – Feathers and Poultry Manure.

Reference Books

1. Commercial Chicken Meat and Egg Production (2007), 5th Edn,Bell D. Donald and Weaver D. William Jr., Springer India Pvt. Ltd., Noida.
2. Poultry Science (2015) 3rd Edn, Ensmiger. M. E., International Book Distribution Co., Lucknow, India.
3. Modern Poultry Farming (2003), 1st Edn, Hurd M. Louis, International Book Distributing Company, Lucknow.
4. Handbook of Poultry Production and Management (2007), 2nd Edn., Jadhav N. V., and Siddique M. F., Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi.
5. Successful Poultry Management (2007), 2ndEdn, Jull A. Morley, Biotech Books, New Delhi.
6. Poultry Husbandry (2008) 2nd Edn, Jull A. Morley, J. V. Publishing House, Jodhpur, Rajasthan.
7. Broiler Breeder Production (2001), 1stEdn, Leeson. S., and Summers J. D. International Book Distributing Company, Lucknow.
8. Poultry and Ratite Nutrition (2013), 1stEdn, Pathak N. N., Narendra Publishing House, New Delhi, India.
9. Simply Poultry Science (2011) 1st Edn, Rajini Asha R., Alfa Publications, New Delhi.

10. Poultry Production (2011) 3rd Edn, Singh, R. A., Kalyani Publishers, New Delhi.
11. Textbook of Poultry Science (2015) 1stEdn, Sreenivasaiah., P. V. Write & Print Publications, New Delhi.
12. Encyclopedia of Broiler Breeder Production: Production, Feeding and Management Techniques (2013) Vol. 1, 2 & 3, Youn Michael, Anmol Publications Pvt. Ltd., New Delhi

Note: Latest editions of the recommended books may be referred.

SEMESTER - VI

Course Title: Medical & Forensic Zoology
Course Code: ZO 361
Credits: 02

ZO 361 - Medical & Forensic Zoology

Objectives:

1. To understand the scope, need and History of Forensic Science.
2. To understand the role of different institutes & allied institutes of Forensic Science.
3. To understand the various branches of Forensic Sciences from Life Sciences.
4. To understand human physiology, post mortal investigations.
5. To understand knowledge of handling different types of evidences and their examinations.

Expected Outcome

1. The students will be able to understand the basics principles of Medical and Forensic Zoology.
2. The students will able to understand scientific methods in crime detection.
3. The students will be able to understand the advancements in the field of Medical and Forensic Zoology.
4. The students will be able to understand modern tools, techniques and skills in forensic investigations.
5. The students will be able to describe the fundamental principles and functions of forensic science and its significance to human society.

Title & Contents	**Number of lectures**
1. Introduction to medical zoology and its importance :	**2 L**
2. Medico-legal Autopsy: 2.1 Death and its Causes- External examination of deceased body – Internal Examination - Determination of time since death and cause of death. 2.2 Injuries – Classification - Medico-legal aspects of injuries. 2.3 Post-mortem changes - collection of post-mortem samples and Preservation.	**6 L**
3. Urine Analysis: 3.1 Physical characteristics, abnormal constituents, renal failure, renal calculi, dialysis.	**3 L**

4. Non infectious Diseases: **2 L**

4.1 Causes, Types, Symptoms, Complications, Diagnosis and Prevention of Diabetes (Type I and II), Hypertension, Hypotension, Obesity, Atherosclerosis, Myocardial Infraction.

5. Infectious Diseases: **2 L**

5.1 Causes, Types, Symptoms, Complications, Diagnosis and Prevention of Tuberculosis and Hepatitis.

6. Introduction to Forensic Zoology: **3 L**

6.1 Definition, Scope and Application of Forensic Zoology.
6.2 Forensic Laboratories in India.
6.3 Basic Principles of Forensic Science with Examples.

7. Forensic Medicine: **3 L**

7.1 Introduction to Forensic Medicine: Definitions of Forensic Medicine.
7.2 Medical Jurisprudence.
7.3 Medical evidence documentations.

8. Forensic Analysis: **9 L**

8.1 Examination of Biological Materials: Examination of Hair, Fibres, Diatoms, plants materials, human tissues.
8.2 Examination of Body Fluid: Blood, Semen and Saliva.
8.3 Forensic Importance of Insects: Insects of forensic importance - indicators of time of death stages of insect development & comparative decomposition of human body - colonization - Evidence collection of insects – Territorial & Aquatic Insects.
8.4 DNA Fingerprint Technique and Examination of Biological Traces: Liquid blood, blood stains, & swabs, semen, Seminal stains, tissues, Bones, Hairs, Teeth, Saliva, Skeletal remains.
8.5 Toxicological Investigations: Poisons – Definition, Forms of Poison – Physical, Chemical & Mechanical state. Introduction with examples of – Neurotoxic Poisons – Cerebral & Spinal, Cardiovascular Poisons, Asphyxiants, Miscellaneous poisons – Pesticides, Pharmaceutical drugs, Petroleum poisons, Food poisons, Radioactive poisons.

Reference Books

1. Godkar P. B and Godkar D. P, Textbook of Medical Laboratory Technology, II Edition, Bhalani Publications
2. Textbook of Microbiology: R. Ananthanarayan, C. K. Jayaram Panikar, University Press.
3. A textbook of Microbiology: P. Chakraborty
4. Text book of pathology: Robbins & Cotran, Vol. 1 & 2, Tenth Edition, Elsevier Publication.
5. Pathologic basis of disease: M. K. Singh & Vinay Kumar, Vol. 1 & 2, 10th edition, Elsevier.
6. Text book of General pathology: Bhende & Deodhare Part I & II.
7. Pathologic basis of Disease: Robbins & Cotran, Vol. 1 & 2, 10th edition, Elsevier publications.
8. Essentials of medical pharmacology: K. D. Tripathi, 8th edition, Jaypee brothers publishers.
9. Review of pharmacology: K. D. Tripathi, Jaypee brothers publishers.

10. Essentials of medical microbiology: Apurba S. Sastry & Sandhya Bhat, Jaypee brothers.
11. W. G. Eckert and S. H. James, Interpretation of Bloodstain Evidence at Crime Scenes, CRC Press, Boca Raton (1989).
12. The essentials of forensic medicine & toxicology: K. S. Narayan Reddy.
13. A textbook of Clinical pharmacology: Roger H. J., Spector R. G., Trounce J. R., Hodder & Stoughton publishers.
14. Pharmacology & Pharmacotherapeutics : Satoskar R. S., Bhandarkar S. D., Popular Prakashan, Mumbai.
15. The synopsis of forensic medicine & toxicology: K. S. Narayan Reddy.
16. Textbook of pathology: Harsh Mohan.
17. G. T. Duncan and M. I. Tracey, Serology and DNA typing in, Introduction to Forensic Sciences, 2nd Edition, W. G. Eckert (Ed.), CRC Press, Boca Raton (1997).
18. T. Bevel and R. M. Gardner, Blood stain Pattern Analysis, 3rd Edition, CRC Press, Boca Raton (2008).
19. Arti Nigam and Archana Ayyagari, Lab manual in Biochemistry, immunology and biotechnology, Mc Graw Hill Publishing Company ltd.
20. Fundamentals of Forensic Science, Second Edition, Max M. Houck and Jay A Siegel, Academic Press.
21. Forensic Science, Third Edition, Stuart H James and Jon. J. Nordby.
22. Forensic Science in India and the World, Deepak Ratna and Mohd. Zaidi, Alia Law Agency, Allahabad.
23. Forensic Science in India - A Vision for 21st Century, B. B. Nanda and Dr. R. K. Tewari, Select Publishers.
24. Cell Biology, Sixth Edition International Students Edition, Gerald Karp, Wiley Publications, 2010.
25. Human Physiology: From Cells to Systems, Lauralee Sherwood, Cengage Learning, 2008.
26. Forensic Biology, Richard Li, CRC Press.
27. Human Anatomy Vol. 1,2,3,4, Chaurasia B. D.
28. Text Book of Medical Jurisprudence, Forensic Medicine and Toxicology by Parikh C. K.
29. Forensic Science: An introduction to Scientific and Investigative Techniques by S. H James, J. J. Nordby.
30. Parikh C. K., Medical Jurisprudence.

Course Title: Animal Physiology
Course Code: ZO 362
Credits: 02

ZO 362 - Animal Physiology

Course Objectives:

1. To acquaint students with the principles and basic facts of Animal Physiology and with some of the laboratory techniques and equipment used in the attainment of physiological data. The importance will be on mammalian.
2. The course will focus on organ-system physiology,
3. Furthermore, emphasis will be placed on nutritive, circulatory, respiratory, excretory, muscular, nervous, reproductive and endocrine physiology. Where appropriate, basic chemical and physical laws will be reviewed in order to enhance and to promote student understanding.

4. The laboratory module of the course is designed to support the topics discussed in theory lecture, as well as to acquaint students with some of the laboratory techniques and equipment used in the gaining of physiological facts**.**

Learning Outcomes:

Upon successful completion of this course, the students will be able to describe, identify, and/or explain:

1. The various physiological organ-systems and their importance to the integrative functions of the human body.
2. Understand Concept of energy requirements
3. Various aspects of Digestive physiology.
4. Circulatory system with medical conditions
5. Understand Respiratory mechanism and gases transport.
6. Eliminations of waste materials from the body.
7. Develop understanding in Structure and functions of muscles
8. Understand formation of gametes and function of endocrine glands.

Title & Contents	**Number of lectures**
1**. Nutrition and digestion:** 1.1 Nutritional requirement & balanced diet. 1.2 Digestion and absorption of carbohydrates, proteins and lipids. 1.3 Vitamins - outline of fat soluble and water-soluble vitamins; Sources, deficiency and diseases.	**5 L**
2. Respiration: 2.1 Mechanism of respiration: Regulation of ventilation in lungs, exchange of gases at respiratory surface. 2.2 Respiratory pigments in animals: Haemoglobin, Hemocyanin, Hemerythrin, Chlorocruorin. 2.3 Transport of gases : O_2 and CO_2 transport.	**5 L**
3. Circulation: 3.1 Blood: Definition and its constituents, functions of blood. 3.2 Heart: Structure of human heart, Pace maker, Cardiac Cycle. 3.3 Origin and conduction of heart beat.	**5 L**
4. Excretion: 4.1 Structure of Uriniferous tubule. 4.2 Mechanism of urine formation. 4.3 Normal and abnormal constituents of urine, Elementary idea of dialysis.	**5 L**
5. Muscles: 5.1 Structure of smooth, skeletal and cardiac muscles. 5.2 Mechanism of muscle contraction by Sliding filament theory.	**3 L**
6. Reproduction and Endocrine Glands: 6.1 Physiology of male reproduction, hormonal control of spermatogenesis. 6.2 Physiology of female reproduction, hormonal control of menstrual cycle.	**7 L**

6.3 Structure and functions of pituitary, thyroid, parathyroid, pancreas and adrenal glands.

Reference Books

1. Textbook of Medical Physiology, Guyton A. C. & Hall J. E., 2006, 11th Edition, Hercourt Asia Pvt. Ltd. / W. B. Saunders Company
2. Principles of Anatomy & Physiology, 2006, 11th Edition, Tortora G. J. & Grabowski S., John Wiley & sons, Inc.
3. Haematology: De Gruchi.
4. Human physiology, Vol. I & II, 1980, 12th Edn. Dr. C. C. Chatterjee, Medical Applied Agency, Kolkata
5. Text book of Animal Physiology, 2008, 2nd Edn. Nagabhushanam, S. V. S. Rana, S. Kalavathy, Oxford University Press, India.
6. Animal Physiology: Adaptation and Environment, 1997, Schmidt-Nielsen, Knut, Cambridge University Press.
7. General and Comparative Physiology, 1983, 3rd Edn., Hoar W. S., Prentice Hall, UK.7.
8. Medical Physiology, 2006, Asis Das, Books and Allied Pvt. Ltd., Kolkata.
9. Endocrinology, 2005, Lohar P. S., M J P Publishers, Chennai.
10. Vander, Sherman, Luciano's Human Physiology: The Mechanisms of Body Function, 2003, 9th Edn., Eric P. Widmaier, Hershel Raff, Kevin T. Strang, Mc Graw H.
11. Tortora, G. J. and Derrickson, B. H. (2009) Principles of Anatomy and Physiology (12th edition) John Wiley and Sons, Inc.
12. Widmaier, E. P., Raff, H. and Strang, K. T. (2008) Vander's Human Physiology (9th edition) McGraw Hill.
13. Human Anatomy and Physiology, (1998) Marieb, E. (4th edition) Addison-Wesley.
14. Experimental Physiology, (2007) Kesar, S. and Vashisht, N., Heritage Publishers.

Course Title: Molecular Biology
Course Code: ZO 363
Credits: 02

ZO 363 - Molecular Biology

Objectives:

1. The course aims to provide students with an introduction of the underlying molecular mechanisms of various biological processes in cells and organisms.
2. To understand the Structure of DNA and RNA, DNA and RNA as genetic material
3. To understand the Central Dogma of Molecular Biology
4. To understand the concept of gene regulation
5. To understand the DNA Damage and Repair
6. The course aims to develop basic understanding of structure-function relationships of nucleic acids and proteins.

Learning outcomes:

1. Learner shall get an insight into molecular mechanisms of various biological processes in cells and organisms
2. Learner shall get an insight into the Structure of DNA and RNA, DNA and RNA as genetic material
3. The course shall prepare learner to get insight into the Central Dogma of Molecular Biology

4. Learner shall also understand the concept of gene regulation
5. Learner shall get an insight into the DNA Damage and Repair

Title & Contents	**Number of lectures**
1. Nucleic Acids and Chromatin: 1.1 Structure of RNA & DNA. 1.2 Types of RNA. 1.3 DNA as genetic material - evidences (Griffith's, Avery *et al*., Hershey and Chase experiment), RNA as genetic material - TMV 4. 1.4 Structure of Chromatin, packaging of DNA, Heterochromatin, Euchromatin.	**7 L**
2. Central Dogma of Molecular Biology: 2.1 **DNA Replication -** Semiconservative (Messelson and Stahl experiment), Basic mechanism of replication in prokaryotes and eukaryotes. 2.2 **Transcription -** 2.2.1 Basic mechanism of transcription in prokaryotes and eukaryotes, RNA polymerase enzyme in prokaryotes. 2.2.2 RNA modifications and processing (splicing - mRNA, modifications at 3'and 5' end). 2.3 **Translation -** Genetic code, properties of genetic code, Basic mechanism of Translation in *E. coli* and eukaryotic cells.	**15 L**
3. Lac operon:	**1 L**
4. DNA repair mechanism: Photo repair, dark repair, base excision repair.	**3 L**
5. Recombinant DNA Technology: Introduction, restriction enzymes, cloning vector, PCR (polymerase chain reaction), DNA finger printing.	**4 L**

Reference Book:

1. Molecular biology of cell, 3rd and 4th edition, Albert's B. D. Lewis J. Raff M. Roberts K. and Watson.
2. Gene, Vol. V, VI, VII, VIII and IX, Lewin B., Oxford University Press, Oxford.
3. Molecular biology of the Gene, 1993, Watson J. Hopkins, Roberts Steitz & Weiner, Benjamin Cummings.
4. Text Book of Molecular Biology, 1994, K. Sivrama Sastry G. Padmanabhan and C. Subramanyam : MacMillan, India.
5. Cell and Molecular biology, 1996, G. Karp, John Willey & Sons, U.S.A.

6. Principles of Genetics, 1997, P. D. Snustad, M. L. Smmons, J. B. & Jenkins, John Willey & Sons, U.S.A.
7. Cell and Molecular biology, De Robertis and De Robertis, 8th & 9th Edition, Saunders Publications.

Course Title: Entomology
Course Code: ZO 364
Credits: 02

ZO 364 - Entomology

Objectives:

1. To understand the scope of Entomology and general characters of Insects.
2. To study the morphology and anatomy of Insects.
3. To learn the concept of social organization in Insects.
4. To understand metamorphosis in Insects.
5. To study the economically important insects and Pest management of harmful insects.

Course outcomes:

At the end of this course, Students will -

1. Understand basic concepts in Entomology and its scope.
2. Learn morphology and anatomy of Insects.
3. Understand the concept of social organization in Insects.
4. Understand the development process of Insects.
5. Identify disease causing insect vectors.
6. Will be able to design and implement pest controlling methods against pests.

Title & Contents	Number of lectures
1. Fundamentals of Entomology: 1.1 Definition and scope of Entomology. 1.2 General Classification of Insects. 1.3 General Characters of Insects.	**2 L**
2. Insect Morphology: 2.1 Insect Integument and its derivatives. 2.2 Insect Head, Head Orientations, Head articulations, Insect antennae and Mouth parts. 2.3 Insect Thorax, Insect Wing and modifications, Insect Leg and Modifications – a) Cursorial – Cockroach, b) Fossorial – Mole cricket, c) Saltorial – Grasshopper, d) Raptorial – Praying mantis, e) Pollen basket – Honey bee. 2.4 Insect Abdomen, Genital and Pre – genital appendages of Grasshopper.	**7 L**

3. Insect Anatomy (Grasshopper): 4 L

3.1 Digestive System.
3.2 Circulatory System.
3.3 Nervous System.
3.4 Respiratory System.
3.5 Reproductive System.

4. Insect Ecology: 3 L

4.1 Definition of Insect Ecology.
4.2 Abiotic Factors (Photoperiod, Temperature and Humidity) and Biotic Factors (Food, Foraging and Nesting).
4.3 Mimicry in insects with suitable examples.

5. Insect Metamorphosis: 2 L

5.1 Definition.
5.2 Types and examples of Metamorphosis.

6. Insects as social groups: 6 L

6.1 Definition & significance of Eusociality, Intraspecific and Interspecific relationships among insects.
6.2 Social organization in Wasps and Termites.

7. Economic Importance of Insects: 3 L

7.1 Insects in Research.
7.2 Insects in Medicines and Cosmetics.
7.3 Insects as Vectors.
7.4 Insects as food.

References

1. Social Insects: Their Origin and Evolution, 2006, W. M. Wheeler, Discovery Publishing House, Delhi.
2. Lives of Social Insects, 1968, P. P. Larson, M. W. Larson, World Pub. Co.
3. Modern Entomology, 2nd edition - By D. B. Tembhare, Himalaya Publication House, Bombay.
4. Principles of Insect Morphology - By R. E. Snodgrass, Tata Mc-Graw Hill Bombay.
5. The Insect: Structure & Function - By R. F. Chapman, E. L. B. S., & E. U. P. London.
6. General Entomology, 2nd edition - By M. S. Mani Oxford & IBH Publishing Company, New Delhi.
7. A Text book of Entomology - By H. H. Ross, John Wiley and Sons, Ins. New York.
8. An Introduction to Entomology - By J. H. Comstock, Ithaca, New York.
9. General & Applied Entomology - By K. K. Nayar, T. N. Anathakrishnan & B.V. David, Tata McGraw-Hill, New Delhi.

Course Title: Techniques in Biology
Course Code: ZO 365
Credits: 02

ZO 365 - Techniques in Biology

Title & Contents	Number of lectures
1. Microscopy:	**3 L**
1.1 Definitions - Resolving Power, Limit of Resolution and Magnification, Numerical Aperture.	
1.2 Basic principle of microscopes - Light, Fluorescence, Phase Contrast, Stereo Microscope, SEM and TEM.	
2. Microtomy: Tissue fixation and Processing	**8 L**
2.1 Methods of tissue fixation: Chemical fixation and physical fixation.	
2.2 Procurement of tissue and importance of fixation of tissues.	
2.3 Dehydration, clearing, impregnation, embedding and block making.	
2.4 Types of microtomes.	
2.5 Section cutting: steps and precautions**,** common faults in section cutting, reasons & remedies.	
2.6 Mounting and spreading of ribbons.	
2.7 General procedure for staining of sections.	
2.8 Demonstration of Nucleic acid (Feulgen Reaction).	
3. Haematological Techniques:	**2 L**
3.1 Total count of RBCs, WBCs and Differential count of WBCs and their significance.	
3.2 Bleeding time, clotting time and their significance.	
4. Immunological Techniques:	**3 L**
4.1 Antigen-Antibody Interactions – Immunodiffusion.	
4.2 Principle & Working of ELISA.	
4.3 Raising Monoclonal Antibodies.	
4.4 Application of Immunological techniques in disease diagnosis.	
5. Types of PCR & DNA Barcoding :	**2 L**
6. Methods in Biodiversity:	**4 L**
6.1 Introduction to sampling and sample size.	
6.2 Biodiversity Indices - Species richness, Simpson Diversity Index, Shannon Diversity Index.	
6.3 Measuring Biodiversity- Quadrat sampling, Transect sampling, Insect survey - Active (sweep netting, aquatic nets) and Passive methodology (Pit fall traps, Light traps).	
7. Instruments in Field Biology:	**3 L**
7.1 Binoculars, GPS, Basic digital camera techniques: Camera lens - prime	

and kit lens, Aperture mode, Shutter mode, Megapixels, Telephoto lens, macro lens.

7.2 Adapters for camera and microscopes, Mobile's camera.

8. Laboratory techniques: 3 L

8.1 Microphotographic techniques - CCD and CMOS camera, digital camera.

8.2 Software for image analysis - Image J and GIMP.

References:

1. *Welch*, P. S. 1948. *Limnological* Methods. Blakiston Philadelphia. 381 pp.
2. Wetzel, R. G. 1983. *Limnology*. 2nd Ed. Saunders ColI. Philadelphia.
3. Wilson, E. O. (1992). *The Diversity of Life*. Cambridge, Mass, Belknap Press of Harvard University Press.
4. Krebs C. J., 2009. Ecology. Benjamin-Cummings Publishing Company or Pearson International Edition
5. Eugene P. Odum and Gary W. Barrett. Fundamentals of Ecology Brooks / Cole; 5th Revised edition.
6. Suzanne Bell, Keith Morris. An Introduction to Microscopy. CRC press.
7. *Kato*, M. The Biology of Biodiversity. Springer.
8. Robert Smith and Thomas M. Smith Ecology and Field Biology.
9. Bikram Grewal *et al*., A Photographic Field Guide to the Birds of India, Pakistan, Nepal, Bhutan, Sri Lanka, and Bangladesh. Princeton University Press.

Course Title: Evolutionary Biology
Course Code: ZO 366
Credits: 02

ZO 366 - Evolutionary Biology

Objectives:

1. To provide comprehensive overview of Concept of Evolution.
2. To explain Origin of Life especially Prokaryotes as well as Eukaryotes in detail.
3. To explore salient features of various theories of evolution comprising of Lamarckism, Darwinism and Neo-Darwinism.
4. To impart detailed understanding of Analogy, Homology, Paleontological Evidences, Embryological Evidences and Molecular Phylogeny.
5. To provide adequate information about Geological Time Scale and Neutral Theory of Molecular Evolution.
6. To develop comprehensive knowledge regarding various Sources of Variations and their role in evolution.
7. To give detailed explanation of key concepts of Population Genetics in terms of Hardy-Weinberg Law, Genetic Drift and Types of Natural Selection.
8. To provide adequate knowledge about Micro-evolutionary changes, Speciation and Adaptive Radiation.
9. To give detailed outline of Extinctions and its types.
10. To impart descriptive knowledge regarding Origin and Evolution of Man.

11. To provide glimpse of Phylogenetic Trees and highlight their construction along with interpretation.

Learning outcomes

After completing the course, the student should be able to

1. Students will be able to learn most of the essential aspects of Evolutionary Biology in detail which will help them in acquiring better understanding regarding the subject.
2. Explain important processes, principles and concepts and critically evaluate theories and empirical research within evolutionary biology
3. Apply evolutionary theory and concepts to address empirical and theoretical questions in evolutionary biology.
4. Independently investigate evolutionary questions using literature and analyses of empirical data.
5. Communicate the principles, theories, problems and research results associated with questions that lie within the evolutionary framework to students

Title & Contents	**Number of lectures**
1. Introduction: 1.1 Concept of Evolution. 1.2 Origin of life. 1.3 Origin of eukaryotic cell (Origin of mitochondria, plastids & symbionts).	**4 L**
2. Evidences of Evolution: 2.1 Analogy and Homology. 2.2 Embryological Evidences of Evolution. 2.3 Evolutionary & Paleontological Evidences.	**5 L**
3. Historical Review of Evolutionary Concept: 3.1 Theories of Evolution. 3.2 Lamarckism. 3.3 Darwinism and Neo Darwinism. 3.4 Mutation Theory. 3.5 Modern Synthetic theory.	**3 L**
4. Sources of Variations: 4.1 Variation and Mutations.	**4 L**
5. Isolation	**5 L**
6. Speciation: 6.1 Types of speciation (Allopatric & Sympatric). 6.2 Mechanism of speciation. 6.3 Patterns of speciation. 6.4 Factors influencing speciation.	**4 L**

7 Population Genetics: **2 L**

7.1 Hardy-Weinberg Law & Genetic Drift.

7.2 Types of Natural Selection.

8 Origin of Man: **4 L**

8.1 Evolution of Man (Evolution of anthropoids including man) - Kenyapithecus to *Homo sapiens*.

9 Zoogeographical Realms With reference to fauna: **2 L**

10 Extinctions: **2 L**

10.1 Extinction - An Overview.

Reference Books

1. Mark Ridley. Evolution. 3rd Edition. Blackwell Publishing. (2004).
2. Mathur, Tomar, Singh. Evolution and Behaviour. Rastogi Publication, Merrut.
3. Mohan P. Arora. Evolutionary Biology, Himalaya Publishing House, Bombay.
4. P. S. Vermin and V. K. Agarwal. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Revised Edition. S. Chand Publication (2004).
5. Strickberger. Evolution. Prentic Hall. (2002).
6. Theodore H., Jr Eaton. Evolution. 1st Edition. W. W. Norton Publication. (1970).
7. Organic Evolution, Richard Swann Lull, Light & Life Publishers.
8. Introductions to Evolution, Paul Amos Moody, Kalyani Publishers, New Delhi.
9. Organic Evolution, 1991 T.S. Gopal krishanan, Itta Sambashivarab Publ. House.
10. Evolutionary Biology, 1990, Mohan P. Arora, Himalaya Publi. House, Delhi.
11. Evolution, 1968, E. O. Dodson, Reinhold Publ. Crop., New York.
12. The major features of evolution, 1953, Simpson G. G. Columbia, New York.
13. The origin of species, 1959, Charles Darwin, New American Library, New York.

Course Title: Environmental Impact Assessment
Course Code: ZO 3610
Credits: 02

ZO 3610 - Environmental Impact Assessment

Title & Contents	Number of lectures
1. Environment:	**2 L**
1.1 Definition.	
1.2 Divisions.	
1.3 Importance.	
2. Pollution:	**3 L**
2.1 Definition and types.	
2.2 Impact on wildlife, natural resources, development.	
3. Sustainable development:	**2 L**

3.1 Definition and need.
3.2 Exploitation of natural resources.
3.3 Concept of carrying capacity.
3.4 Three pillars of Sustainability.
3.5 UN 17 Sustainable Development Goals (SDGs).

4. Overview of Environmental Protection acts: 5 L

4.1 The Air (Prevention and Control of Pollution) Act 1981.
4.2 The Water (Prevention and Control of Pollution) Act 1974.
4.3 The Environment Protection Act 1986.
4.4 The National Green Tribunal Act 2010.
4.5 Biological Diversity Act 2002.

5. Environmental Impact Assessment (EIA): 5 L

5.1 Definition, need and importance of EIA.
5.2 EIA notification 2006 - key elements, History and Evolution of EIA.
5.3 Categories of Industries / establishments requiring EIA, Types of EIA - strategic EIA, regional EIA, sectoral EIA, project level EIA and life cycle assessment.
5.4 Rapid and comprehensive EIA.

6. EIA Process: 5 L

6.1 Screening, Scoping and consideration of alternatives.
6.2 Baseline data collection, Impact analysis, Mitigation, Reporting, Public hearing.
6.3 Review of EIA.
6.4 Decision-making, monitoring clearance conditions.

7. Stakeholders in EIA process: 3 L

7.1 Project proponent, Environmental consultant.
7.2 CPCB / MPCB.
7.3 Public, EIA agency (IAA).

8. Overview of Scheme for Accreditation of EIA Consultant Organizations (NABET / QCI): 5 L

8.1 Eligibility and benefits.
8.2 EIA coordinator (EC), Functional area experts (FAEs).
8.3 Functional area associate (FAA) and team members: Role, educational qualification, experience and functions.

References:

1. Glasson, J., Therivel, R. (2019) Introduction to Environmental Impact Assessment. Routledge. London.
2. Judith, P. 1999. Handbook of Environmental Impact Assessment. Blackwell Science.
3. Marriott, B. 1997. Environmental Impact Assessment: A Practical Guide. McGraw-Hill, New York, USA.

Course Title: Project
Course Code: ZO 3611
Credits: 02

ZO 3611 - Project

Students have to complete the research project in the stipulated time and present the dissertation at the time of the examination in a proper format. Students should be encouraged to take up laboratory work, hands-on practical investigation and design experimental setup. Field work to be carried out under proper supervision and permissions from the concerned authorities.

Possible key aspects of the project work -

1. Planning the project
2. Selecting a suitable title
3. Significance of the work
4. Hypothesis, Objectives
5. Reviewing the available literature
6. Methodology to be used
7. Outcomes of the Project work
8. Conclusion and Discussion
9. Future plans

Students should be made aware of plagiarism and research ethics.

Course Title: Zoology Practical Paper - I
Course Code: ZO 367
Credits: 02

ZO 367 - Zoology Practical Paper - I

Section I: Practicals in Medical & Forensic Zoology

1. To carry out routine analysis of given urine sample for - 2 (E)
   i. Physical Properties: Volume, Colour, pH, Turbidity, Specific gravity.
   ii. Chemical Properties: Sugars, Protein, Bile salts & bile pigments, Ketone bodies, Blood. (C)
2. Determination of serum urea. E
3. Determination of serum uric acid. E
4. Determination of serum Calcium. (C) E
5. To examine human hair for cortex and medulla. (C) E
6. To examine hair morphology and determine the species to which the hair belongs. E
7. To prepare slides of scale pattern of human hair. (C) E
8. To Visit a Forensic Laboratory and submission of the report. E
9. To Identify and differentiate various types of Finger prints. (C) E

10. To prepare a case report on forensic entomology with respect to insect's succession and its relationship to determine time since death. E

Section II: Practicals in Animal Physiology

1. Haemoglobin estimation using Sahli's haemoglobinometer. (C) E
2. Preparation of haemin and haemochromogen crystals. (C) E
3. To estimate the blood glucose level from given sample. (C) E
4. Estimation of bleeding and clotting time. (C) E
5. Study of disorders caused by endocrine glands with the help of photographs. D
6. Detection of blood groups in human being. E
7. Differential count of blood. E
8. Estimation of haemoglobin percentage with the help of haemometer. E
9. Qualitative detection of nitrogenous waste products (Ammonia, urea, uric acid) in given sample. (C) E
10. Demonstration of kymograph unit, Respirometer through available resources. D
11. Measurement of lung capacity. E

Course Title: Zoology Practical Paper - II
Course Code: ZO 368
Credits: 02

ZO 368 - Zoology Practical Paper - II

Section I: Practicals in Molecular Biology

1. Lab safety techniques & sterilisation. D
2. Preparation of DNA paper model and study its characteristics. E
3. Staining of DNA and RNA by methyl green – pyronin. (C) E
4. Estimation of DNA by Diphenylamine method. (C) E
5. Estimation of RNA by Bial's Orcinol method. E
6. Isolation of DNA from Bacteria / liver / Onion. (C) – 2 P E
7. Absorption spectra of DNA isolated from Bacteria / Liver / Onion. (C) E
8. Principle & application of Spectrophotometer & PCR. D

Section II - Practicals in Entomology

1. Study of external characters of any Insect (Grasshopper / Cockroach / Plant bug). E
2. Study of Insect Head, its articulations and types of mouthparts and their modifications. D
3. Study of Insect Legs, wing and their modifications. D
4. Study of Digestive system of any locally available insect pest. (C) E

5. Study of Reproductive system of any locally available insect pest. (C) E
6. Study of Social organization in Termites and Honey Bees. D
7. Study of Insect egg, larva, pupa and their types. D
8. Study of Insect vectors - Mosquito, House fly, Cockroaches, Bugs. D
9. Temporary mountings of Mouthparts, Antennae, E
   Legs and Wings of any locally available insect pest. (C)
10. Study of Preservation of Insect pest by using spreading techniques & submission
    of any five insect pests / vectors. (C) E
11. Compulsory field visit to a Wildlife Sanctuary / National Park / Tiger Reserve / E
    to study the Insect diversity – 2P.

Course Title: Zoology Practical Paper – III
Course Code: ZO 369
Credits: 02

ZO 369 - Zoology Practical Paper III

Section I: Practicals of Techniques in Biology

1. Compound and Stereo microscope: Components, usage and maintenance. D
2. To observe different kind of cells under compound microscope and its measurement E
   using micrometer scale or by image analysis software (Ex. Image J). (C)
3. Tissue collection, fixation & Block preparation. (C) E
4. Sectioning, staining & mounting. Submission of any three permanent E
   slides from three different organs. (C)
5. To study population density and percentage frequency of different animal / D
   insect species of a given area.
6. Calculating the different alpha and beta biodiversity indices of different D
   animal /insect species of a given area.
7. Survey for insects using pit fall trap and light traps in your college E
   campus / agriculture field.
8. Use of photography (Mobile camera / DSLR) in scientific documentation D
   of at least 5 species of insects / birds/ mammals.
9. Visit to a water body / forest to study faunal biodiversity using field equipment – (C) 2P E
10. Study of Principle & working of PCR & DNA Barcoding – 2 P E

Section II - Practicals in Evolutionary Biology

1. Study of morphological similarities and differences between man and ape (C) D
2. Study of types of fossils with the help of specimens/ charts/ photos (C) D
3. Study of animal adaptations in: Turtle, Draco, Exocoetus, Bat and Parrot (C) D
4. Study of evidences of evolution- embryological, paleontological, connecting links, morphology and comparative anatomy. (C) E
5. Study of successive stages of evolution of man : a) Australopithecus b) *Homo erectus* c) *Homo neanderthalis* d) Cro-Magnon man e) *Homo sapiens.* (C) D
6. To record Zoogeographical distribution of animals to respective zoogeographical Realms on the world map (Lung fishes, marsupials, flightless birds, Camel, Elephant, Ostrich etc.). (C) E

Syllabus for

Ability Enhancement Compulsory Course (AECC – Environment Studies)(2 credit) for under graduate

(For All Faculties - Second Year - Semester III)

It is as per UGC guidelines and framing -

Unit 1 : Introduction to environmental studies

- Multidisciplinary nature of environmental studies;
- Scope and importance; Concept of sustainability and sustainable development.

(2 lectures)

Unit 2 : Ecosystems

- What is an ecosystem? Structure and function of ecosystem ; Energy flow in an ecosystem : food chains, food webs and ecological succession. Case studies of the following ecosystems :

a) Forest ecosystem
b) Grassland ecosystem
c) Desert ecosystem
d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

(8 lectures)

Unit 3 : Natural Resources : Renewable and Non-renewable Resources

- Land resources and landuse change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- Water : Use and over-exploitation of surface and ground water, floods, droughts conflicts over water (international & inter-state).
- Energy resources : Renewable and non renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

(10 lectures)

Unit 4 : Biodiversity and Conservation

- Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots
- India as a mega-biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity : Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.
- Ecosystem and biodiversity services : Ecological, economic, social, ethical, aesthetic and Informational value.

(10 lectures)

References :

1. Carson, R. 2002. Silent Spring. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R. 1993. This Fissured Land: An Ecological History of India. Univ. of California Press.

3. Gleeson, B. and Low, N. (eds.) 1999. Global Ethics and Environment, London, Routledge.

4. Gleick, P. H. 1993. Water in Crisis. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.

5. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates, 2006.

6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339 : 36-37.

7. McCully, P. 1996. Rivers no more: the environmental effects of dams (pp. 29-64). Zed Books.

8. McNeill, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.

9. Odum, E.P., Odum, H.T. & Andrews, J. 1971. Fundamentals of Ecology. Philadelphia: Saunders.

10. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.

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12. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons.

13. Rosencranz, A., Divan, S., & Noble, M.L. 2001. Environmental law and policy in India. Tripathi 1992.

14. Sengupta, R. 2003. Ecology and economics : An approach to sustainable development. OUP.

15. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.

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17. Thapar, V. 1998. Land of the Tiger: A Natural History of the Indian Subcontinent.

18. Warren, C. E. 1971. Biology and Water Pollution Control. WB Saunders.

19. Wilson, E. O. 2006. The Creation: An appeal to save life on earth. New York : Norton.

20. World Commission on Environment and Development. 1987. Our Common Future. Oxford University Press.

Syllabus for

Ability Enhancement Compulsory Course (AECC – Environment Studies)(2 credit) for under graduate

(For All Faculties - Second Year - Semester IV)

It is as per UGC guidelines and framing -

Unit 5 : Environmental Pollution

- Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution
- Nuclear hazards and human health risks
- Solid waste management : Control measures of urban and industrial waste.
- Pollution case studies.

(10 lectures)

Unit 6 : Environmental Policies & Practices

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture
- Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act;

Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).

- Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

(9 lectures)

Unit 7 : Human Communities and the Environment

- Human population growth: Impacts on environment, human health and welfare.
- Resettlement and rehabilitation of project affected persons; case studies.
- Disaster management : floods, earthquake, cyclones and landslides.
- Environmental movements : Chipko, Silent valley, Bishnois of Rajasthan.
- Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
- Environmental communication and public awareness, case studies (e.g. CNG vehicles in Delhi).

(6 lectures)

Unit 8 : Field work

- Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.

- Visit to a local polluted site-Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds and basic principles of identification.
- Study of simple ecosystems-pond, river, Delhi Ridge, etc.

(Equal to 5 lectures)

References :

1. Carson, R. 2002. Silent Spring. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R. 1993. This Fissured Land: An Ecological History of India. Univ. of California Press.
3. Gleeson, B. and Low, N. (eds.) 1999. Global Ethics and Environment, London, Routledge.
4. Gleick, P. H. 1993. Water in Crisis. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
5. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates, 2006.
6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339 : 36-37.
7. McCully, P. 1996. Rivers no more: the environmental effects of dams (pp. 29-64). Zed Books.
8. McNeill, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.
9. Odum, E.P., Odum, H.T. & Andrews, J. 1971. Fundamentals of Ecology. Philadelphia: Saunders.
10. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
11. Rao, M.N. & Datta, A.K. 1987. Waste Water Treatment. Oxford and IBH Publishing Co. Pvt. Ltd.
12. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons.
13. Rosencranz, A., Divan, S., & Noble, M.L. 2001. Environmental law and policy in India. Tripathi 1992.
14. Sengupta, R. 2003. Ecology and economics : An approach to sustainable development. OUP.
15. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
16. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. Conservation Biology : Voices from the Tropics. John Wiley & Sons.
17. Thapar, V. 1998. Land of the Tiger: A Natural History of the Indian Subcontinent.
18. Warren, C. E. 1971. Biology and Water Pollution Control. WB Saunders.
19. Wilson, E. O. 2006. The Creation: An appeal to save life on earth. New York : Norton.
20. World Commission on Environment and Development. 1987. Our Common Future. Oxford University Press.

Savitribai Phule Pune University

(Formerly University of Pune)

Three Year B.Sc. Degree Program in Botany

(Faculty of Science & Technology)

F.Y.B.Sc. Botany

Choice Based Credit System Syllabus

To be implemented from Academic Year 2019-2020

Title of the Course: B. Sc Botany

1. Structure of Course:

Structure B.Sc. Botany syllabus					
Year	Semester	Course Type	Course code	Course Name	Credits
1	1	Compulsory Course	BO 111	Plant life and utilization I	2
			BO 112	Plant morphology and Anatomy	2
			BO 113	Practical based on BO 111 & BO 112	1.5
	2	Compulsory Course	BO 121	Plant life and utilization II	2
			BO 122	Principles of plant science	2
			BO 123	Practical based on BO 121 & BO 122	1.5
2	3	Compulsory Course	BO 231	Botany Theory Paper 1	2
			BO 232	Botany Theory Paper 2	2
			BO 233	Botany Practical Paper	2
	4	Compulsory Course	BO 241	Botany Theory Paper 1	2
			BO 242	Botany Theory Paper 2	2
			BO 243	Botany Practical Paper	2
3	5	Discipline Specific Elective Course	BO 351	Botany Theory Paper 1	2
			BO 352	Botany Theory Paper 2	2
			BO 353	Botany Theory Paper 3	2
			BO 354	Botany Theory Paper 4	2
			BO 355	Botany Theory Paper 5	2
			BO 356	Botany Theory Paper 6	2
			BO 357	Botany Practical Paper 1	2
			BO 358	Botany Practical Paper 2	2
			BO 359	Botany Practical Paper 3	2
		Skill Enhancement course	BO 3510	Botany Theory Paper 7	2
			BO 3511	Botany Theory Paper 8	2
3	6	Discipline Specific Elective Course	BO 361	Botany Theory Paper 1	2
			BO 361	Botany Theory Paper 2	2
			BO 362	Botany Theory Paper 3	2
			BO 363	Botany Theory Paper 4	2
			BO 364	Botany Theory Paper 5	2
			BO 365	Botany Theory Paper 6	2
			BO 366	Botany Practical Paper 1	2
			BO 367	Botany Practical Paper 2	2
			BO 368	Botany Practical Paper 3	2
		Skill Enhancement course	BO 3610	Botany Theory Paper 7	2
			BO 3611	Botany Theory Paper 8	2

2. Equivalence of Previous Syllabus:

Old Course (2013 Pattern)	New Course (2019 CBCS Pattern)
Fundamentals of Botany: PAPER – I Term- I: Plant Diversity	BO 111 Plant life and utilization I
Botany Theory Paper II Term I – Industrial Botany	BO 112 Plant morphology and Anatomy
Fundamentals of Botany: PAPER - I Term- II: Morphology and Anatomy	BO 121 Plant life and utilization II
Botany Theory Paper II Term- II – Industrial Botany	BO 122 Principles of plant science
F. Y. B. Sc. Botany Practical Paper - III based on Theory Paper I and Paper II	BO 113 Practical based on BO 111 & BO 112 and BO 123 Practical based on BO 121 & BO 122

SEMESTER-I: PAPER-I

BO-111: PLANT LIFE AND UTILIZATION I (30 Lectures)

CREDIT-I **15 Lectures (15 Hours)**

1. INTRODUCTION **3 L**

General outline of plant kingdom (**Lower Cryptogams**: Thallophytes- Algae, Fungi & Lichens; **Higher Cryptogams**: Bryophytes and Pteridophytes; **Phanerogams**: Gymnosperms and Angiosperms- Dicotyledons and Monocotyledons). Distinguishing characters of these groups and mention few common examples from each.

2. ALGAE **9 L**

2.1: Introduction
2.2: General Characters
2.3: Classification (Bold and Wynne 1978) up to classes with reasons
2.4: Life Cycle of *Spirogyra* w.r.t. Habit, Habitat, Structure of thallus, structure of typical cell, Reproduction- Vegetative, Asexual and Sexual, systematic position with reasons
2.5: Utilization of Algae in Biofuel Industry, Agriculture, Pharmaceuticals, Food and Fodder

3. LICHENS **3 L**

3.1: Introduction
3.2: General Characters
3.3: Nature of Association, forms- Crustose, Foliose and Fruticose.
3.4: Utilization of lichens.

CREDIT-II **15 Lectures (15 Hours)**

4. FUNGI **9 L**

4.1: Introduction
4.2: General Characters
4.3: Classification (Ainsworth, 1973)
4.4: Life Cycle of Mushroom- *Agaricus bisporus* w.r.t. Habit, Habitat, Structure of thallus, Structure of Sporocarp, Structure of Gill, Reproduction- Asexual and sexual, Systematic position.
4.5: Utilization of Fungi in Industry, Agriculture, Food and Pharmaceuticals.

5. BRYOPHYTES **6 L**

5.1: Introduction
5.2: General Characters
5.3: Classification (G.M. Smith 1955)
5.4: Life Cycle of *Riccia* w.r.t. Habit, habitat, external and internal structure of thallus, Reproduction- vegetative, asexual and sexual- Structure of sex organs, fertilization, structure of mature sporophyte, structure of spore, systematic position with reasons.
5.5: Utilization: Bryophytes as ecological indicators, agriculture, fuel, industry and medicine.

(Development of sex organs not expected for all the above mentioned life cycles).

REFERENCES:

1. Ainswarth, Sussman and Sparrow (1973). The Fungi. Vol. IV-A and IV-B. Academic Press.
2. Bilgrami, K.S. and Saha, L.C. (1992) A Textbook of Algae. CBS Publishers and Distributors, Delhi.
3. Gangulee, Das and Dutta (2002). College Botany. Vol. I, New Central Book Agency (P) Ltd.
4. Dube, H.C. (1990). An Introduction to Fungi. Vikas Publishing House Pvt. Ltd., Delhi.
5. Krishnamurty, V. (2000). Algae of India and neighboring countries, Chlorophyta, Oxford and IBH, New Delhi.
6. Parihar, N.S. (1980). Bryophyta, An Introduction of Embryophyta. Vol. I. Central Book Distributors, Allahabad.
7. Puri, P. (1980). Bryophyta: Broad prospective. Atma Ram & Sons, Delhi.
8. Smith, G.M. (1971). Cryptogamic Botany. Vol. I: Algae & Fungi. Tata McGraw Hill Publishing Co., New Delhi.
9. Smith, G.M. (1971). Cryptogamic Botany. Vol. II: Bryophytes & Pteridophytes. Tata McGraw Hill Publishing Co., New Delhi.
10. Vashista, B.R., Sinha, A.K. and Singh, V.B. (2005). Botany for degree students- Algae, S. Chand Publication.
11. Vashista, B.R., Sinha, A.K. and Singh, V.B. (2005). Botany for degree students- Fungi, S. Chand Publication.
12. Vashista, B.R., Sinha, A.K. and Singh, V.B. (2005). Botany for degree students- Bryophytes, S. Chand Publication.

SEMESTER-I: PAPER-II

BO-112: PLANT MORPHOLOGY AND ANATOMY (30 Lectures)

CREDIT-I **15 Lectures (15 hours)**

1. MORPHOLOGY: **2 L**

1.1: Introduction, definition, descriptive and interpretative morphology.
1.2: Importance in identification, nomenclature, classification, phylogeny and Plant breeding.

2. MORPHOLOGY OF REPRODUCTIVE PARTS:

2.1: INFLORESCENCE: **3 L**

2.1.1 Introduction and definition
2.1.2 Types:
a) Racemose -Raceme, Spike, Spadix, Corymb, Umbel, Catkin and Capitulum.
b) Cymose -Solitary, Monochasial- Helicoid and scorpiod; Dichasial and Polychasial.
c) Special types -Verticillaster, Cyathium and Hypanthodium.
2.1.3 Significance

2.2: FLOWER: **7 L**

2.2.1 Introduction and definition
2.2.2 Parts of a typical flower: Bract, Pedicel, Thalamus- forms, Perianth- Calyx and Corolla, Androecium and Gynoecium.
2.2.3 Symmetry: Actinomorphic and zygomorphic, Sexuality- Unisexual ands bisexual, Insertion of floral whorls on thalamus- Hypogyny, Epigyny and perigyny, Merous condition-Trimerous, tetrmerous and pentamerous.
2.2.4 Floral whorls:
a) **Calyx:** Nature- Polysepalous, Gamosepalous; Aestivation- types, Modifications of Calyx- Pappus, Petaloid and Spurred.
b) **Corolla:** Forms of Corolla-
i) Polypetalous- Cruciform and Papilionaceous.
ii) Gamopetalous- Infundibuliform, Bilabiate, Tubular and Campanulate.
iii) Aestivation- types and significance.
c) **Perianth:** Nature- Polytepalous, Gamotepalous.
d) **Androecium:** Structure of typical stamen, Variations- cohesion and adhesion.
e) **Gynoecium:** Structure of typical carpel, number, position, cohesion and adhesion; placentation- types and significance.

2.3: FRUITS: **3 L**

2.3.1 Introduction and definition
2.3.2 Types of fruits:
a) **Simple:** Indehiscent - Achene, Cypsela, Nut and Caryopsis.
Dehiscent - Legume, Follicle and Capsule,
b) **Fleshy:** Drupe, Berry, Hespiridium and Pepo.
c) **Aggregate:** Etaerio of Berries and Etaerio of Follicles.
d) **Multiple fruits:** Syconus and Sorosis.

CREDIT- II **15 Lectures (15 Hours)**

3. ANATOMY: **2 L**

3.1 Introduction and definition

3.2 Importance in Taxonomy, Physiology, Ecological interpretations, Pharmacongnosy and Wood identification.

4. TYPES OF TISSUES: **8 L**

Outline with brief description, simple and complex tissues.

4.1: **Meristmatic tissues:** Meristem, characters and types based on origin, position and plane of division, functions.

4.2: **Permanent tissues:** Simple tissues - parenchyma, collenchymas, chlorenchyma and sclerenchyma.

4.3: **Complex/Vascular tissues:** Components of xylem and phloem, types of vascular bundles and functions.

4.4: **Epidermal tissues:** Epidermis, structure of typical stomata, trichomes, motor cells; functions.

5. INTERNAL ORGANIZATION OF PRIMARY PLANT BODY: **5 L**

5.1: Internal structure of dicotyledon and monocotyledon root.

5.2: Internal structure of dicotyledon and monocotyledon stem.

5.3: Internal structure of dicotyledon and monocotyledon leaf.

REFERENCES:

1. Chandurkar, P.J. (1989). Plant Anatomy. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Dutta, A.C. (2003). Botany for Degree students. Oxford University Press, New Delhi.
3. Eames, J. and Mc. Daniels (1994). An Introduction to Plant Anatomy. Tata McGraw Hill Publishing Comp., New Delhi.
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11. Pandey, B.P. (2009). A Text Book of Botany- Angiosperms. S. Chand and Co. Ltd. New Delhi.
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14. Sharma, O.P. (1993). Plant Taxonomy. 2nd Edition, McGraw Hill Education, New Delhi.
15. Singh, Gurucharan (2005). Systematics- Theory and Practice. Oxford IBH.
16. Sutaria, R.N.A. Text Book of Systematic Botany.
17. Tayal, M.S. (2012). Plant Anatomy. Rastogi Publications.

BO 113: PRACTICALS BASED ON BO 111 & BO 112 (1.5 CREDITS)

1. Study of Life Cycle of *Spirogyra.* 1 P
2. Study of Life Cycle of *Agaricus.* 1 P
3. Study of Life Cycle of *Riccia* 1 P.
4. Study of forms of Lichens- Crustose, Foliose and fruticose. 1 P
5. Study of Mushroom Cultivation. 1 P
6. One day visit to study Algae, Fungi, Bryophytes and Lichens. 1 P
7. Study of Inflorescence. 2 P
   a. Racemose: Raceme, Spike, Spadix, Catkin, Corymb, Umbel and Capitulum
   b. Cymose: Solitary cyme, Uniparous cyme: helicoid and scorpiod, Biparous cyme and Multiparous cyme.
   c. Special type: Verticillaster, Hypanthodium and Cyathium.
8. Study of flower with respect to Calyx, Corolla and Perianth, Androecium and Gynoecium. 2 P
9. Study of fruits with suitable examples. 2 P
   a) Simple fruit: Dry: Achene, Cypsella and Legume; Fleshy: Berry and Drupe.
   b) Aggregate fruit: Etaerio of follicles and Etaerio of Berries.
   c) Multiple fruit: Syconus and Sorosis.
10. Study of internal primary structure of dicotyledonous root and stem e.g. Sunflower. 1 P
11. Study of internal primary structure of monocotyledonous root and stem e.g. Maize. 1 P
12. Study of internal primary structure of dicotyledonous and monocotyledonous leaf e.g. Sunflower and Maize. 1 P

SEMESTER-II: PAPER-I

BO-121: PLANT LIFE AND UTILIZATION-II (30 Lectures)

CREDIT-I **15 Lectures (15 hours)**

1. **INTRODUCTION:** Introduction to plant diversity- Pteridophytes, Gymnosperms and Angiosperms with reference to vascular plants. 3 L
2. **PTERIDOPHYTES:** General characters, Outline classification according to Sporne (1976) up to classes with reasons. Life cycle of *Nephrolepis* w.r.t. Habit, habitat, distribution, morphology, anatomy of stem and leaf, Reproduction – vegetative and sexual. 10 L
3. Utilization and economic importance of Pteridophytes. 2 L

CREDIT-II **15 Lectures (15 hours)**

1. **GYMNOSPERMS:** General characters, Outline classification according to Sporne (1977) up to classes with reasons. Life cycle of *Cycas* w.r.t. Habit, Habitat, Distribution, Morphology and Anatomy of Stem, leaf and reproductive organs- Male cone, Microsporophyll, microspores and megasporophyll, megaspore; structure of seed; Utilization and economic importance of gymnosperms. 8 L
2. **ANGIOSPERMS:** General characters, Outline of classification of Bentham and Hooker's system up to series, comparative account of monocotyledons and dicotyledons. 4L
3. Utilization and economic importance of Angiosperms: In food, fodder, fibers, horticulture and medicines. 3L

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2. Chamberlain, C.J. (1934). Gymnosperms- Structure and Evolution. Chicago.
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16. Sundar Rajan, S. (1999). Introduction to Pteridophyta. New Age International Publishers, New Delhi.
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18. Vashista, B.R., Sinha A.K. and Kumar, A. (2008). Botany for degree students-Pteridophyta, S. Chand and Comp. Ltd. New Delhi.

SEMESTER-II: PAPER-II

BO-122: PRINCIPLES OF PLANT SCIENCE (30 Lectures)

CREDIT-1: PLANT PHYSIOLOGY AND CELL BIOLOGY

15 Lectures (15 Hours)

1. Introduction, definition and scope of plant physiology. 1 L
2. Diffusion – definition, importance of diffusion in plants, imbibition as a special type of diffusion. 1 L
3. Osmosis – definition, types of solutions (hypotonic, isotonic, hypertonic), endosmosis, exo-osmosis, osmotic pressure, turgor pressure, wall pressure, importance of osmosis in plants. 2 L
4. Plasmolysis – definition, mechanism and significance. 1 L
5. Plant growth - introduction, phases of growth, factors affecting growth, 2 L
6. Structure of plant cell, differences between prokaryotic and eukaryotic cell. 2 L
7. Plant cell wall – components of primary cell wall, structure and functions. 1 L
8. Ultrastructure and functions of chloroplast 2 L
9. Cell cycle in plants- importance of cell cycle in plants, divisional stages of mitosis and meiosis. 3 L

CREDIT-II: MOLECULAR BIOLOGY (15 Lectures) 15 Hours

1. Introduction and scope of molecular biology, central dogma of molecular biology. 2 L
2. Structure of DNA, nucleoside and nucleotide 2 L
3. Watson Crick model of DNA and its characteristic features, types of DNA (A, B and Z DNA). 3 L
4. Types of chromosomes. 2 L
5. Structure and types of RNA. 3 L
6. DNA replication- Types of replication (conservative, semi-conservative and dispersive), enzymes involved, leading and lagging strands, Okazaki fragments. 3 L

REFERENCES:

1. Buchanan, B.B, Gruissem, W. and Jones, R.L (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists Maryland, USA.
2. Cooper, G.M. and Hausman, R.E. (2007). The Cell: Molecular Approach 4th Edition, Sinauer Associates, USA.
3. David, Nelson and Cox, Michael (2007). Lehninger Principles of Biochemistry. W.H. Freeman and Company. New York.
4. Devlin, R.M. (1983). Fundamentals of Plant Physiology. Mc. Millan, New York.
5. Dutta, A.C. (2000). A Class Book of Botany. Oxford University Press, UK.
6. Hopkins, William G. (1995). Introduction to Plant Physiology. Publ. John Wiley and Sons, Inc.

7. Lewin, Benjamin (2011). Genes. X Jones and Bartlett.
8. Lincolin, Taiz and Eduardo, Zeiger (2010). Plant Physiology. 5th Edition. Sinauer Associates, Inc. Publishers. Sunder land, USA.
9. Opik, Helgi, Rolfe, Stephen A. and Willis, Arthur J. (2005). The Physiology of Flowering Plants. Cambridge University Press, UK.
10. Pal, J.K. and Ghaskadbi, Saroj (2009). Fundamentals of Molecular Biology. Oxford University Press. India.
11. Pandey, S.N. and Sinha, B.K. (2014). Plant Physiology. Vikas Publishing House Pvt. Ltd., India.
12. Salisbury, F.B. and Ross, C.B. (2005). Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont California, USA.
13. Watson, James D., Baker, Tania; Bell, Stephen P.; Alexander Gann; Levine, Michael and Lodwick, Richard (2008). Molecular Biology of the Gene. 6th Edition, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA.
14. Weaver, R. (2011). Molecular Biology. 5th Edition, Publisher- McGrew Hill Science. USA.

BO 123: PRACTICALS BASED ON BO 121 & BO 122 (1.5 CREDITS)

1. Study of life cycle of *Nephrolepis*. 1 P
2. Study of life cycle of *Cycas*. 1 P
3. Study of Bentham and Hooker's system of classification outline up to series with example 1 P
4. Study of comparative account of Dicotyledonous and Monocotyledonous plants w.r.t to external morphological characters. 1 P
5. Study of utilization and economic importance of Angiosperms- food, fodder, fibers, horticulture and medicines. 1 P
6. One day visit to study diversity of vegetation. 2 P
7. To observe characteristic features of prokaryotic and eukaryotic plant cell. 1 P
8. Staining of suitable nuclear material by Basic Fuchsin 1 P
9. Study of mitosis- preparation of slides using onion root tips to observe divisional stages. 1 P
10. Study of meiosis- preparation of slides using *Tradescantia/ Rhoeo/* Maize / Onion flower buds to observe divisional stages. 2 P
11. Estimation of chlorophyll-a and chlorophyll-b by using suitable plant material. 1 P
12. Plasmolysis- endosmosis, exosmosis, incipient plasmolysis using *Rhoeo* leaf peeling and Demonstration of Osmosis- curling experiment. 1 P
13. Study of DPD by using suitable plant sample 1 P

Savitribai Phule Pune University

(Formerly University of Pune)

Two Year Degree Program in Botany

(Faculty of Science & Technology)

Revised Syllabi for

M.Sc. (Botany) Part-II

(For Colleges Affiliated to Savitribai Phule Pune University)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2020-2021

Title of the Course: M.Sc. Botany

Structure for M. Sc. Botany Second Year:

Year	Semester	Course Type	Course code	Course Name	Credits
2	3	Core Compulsory Theory paper	BOUT 231	**Botany Theory Paper 1- Computational Botany**	4
			BOUT 232	Botany Theory Paper 2- **Developmental Botany**	4
			BOUT 233	Botany Theory Paper 3- **Plant Physiology-**	4
		Choice Based optional paper	BODT 234 (Any one)	Botany Theory Paper 4 **a. Mycology** b. **Angiosperm Taxonomy-** c. **Plant Ecology** d. **Plant Biotechnology** e. **Genetics and Plant breeding** f. **Seed science**	2
			BODP 234	Botany Practical Paper based on BODT 234	2
		Core Compulsory practical paper	BOUP 235	Botany Practical Paper **based on BOUT 231, BOUT 232, BOUT 233**	4
2	4	Core Compulsory Theory paper	BOUT 241	Botany Theory Paper 1- **Botanical Techniques**	4
			BOUT 242	Botany Theory Paper 2- **Advanced Ecology**	4
		Choice Based optional paper	BODT 243 (Any one)	Botany Theory Paper 3- **a) Applied Mycology** **b) Advanced Medicinal Botany** **c) Advanced Plant Physiology** **d) Industrial Biotechnology-** **e) Seed Technology**	2
			BODP 243	Botany Practical paper based on BODT 243	2
			BODT 244 (Any one)	Botany Theory Paper 4- **a) Plant Tissue culture Technology** b) **Herbal Technology** c) **Research Methodology**	2

			BODP 244	Botany Practical Paper based on BODT 244 Or PG Dissertation	2
		Core Compulsory practical paper	BOUP 245	Botany Practical paper based on BOUT 241 and BOUT 242	4

BO 4.1 Computational Botany (60 L)

Credit I-Basic Biostatistics (15 L)

1. Introduction to Statistics : 9L
   Measures of central tendency – mean, mode, median and their properties Measures of dispersion – variance, standard deviation, coefficient of variance Symmetry and skewness, measures of skewness, kurtosis Sampling and sampling distributions – concept of sample and population, statistic, standard error, methods of sampling
2. Correlation and regression 6L
   Bivariate correlation, positive correlation, negative correlation Measures of correlation – Scatter diagram, Karl-Pearson's coefficient of correlation, Spearman's rank correlation coefficient Regression – Equations of regression lines using least square method, regression estimate and its standard error

Experimental Statistics (15 L)

1.1 Statistics using R, SPSS and Excel : Introduction , features, installation, starting and ending of the sessions, R commands and case sensitivity (08L)

a. Data types: Logical and Numerical
b. Vectors and vector arithmetic
c. Data frames: Creation using data, frame, subset and transform commands
d. Statistical methods using R : Sampling methods, Diagrams, graphs:
   : Measures of central tendency, Dispersion, Skewness and Kurtosis
e. Probability Distributions: Hypergeomertric distribution, Binomial. Normal and poison distribution
f. Correlation and Regression

1.2. SPPS (Statistical Package for the Social Sciences) Software: Concept and applications in Means, t – test, ANOVA and Correlation and linear regression

1.3 Excel : concept and applications on Biology

2. Testing of Hypothesis : critical difference for pairs of treatments Tukey's test for pairwise comparison of treatments Dunnet's test for comparison of treatment means with control Duncan's multiple range test Mann–Whitney U test

3. Testing of hypothesis 7L
Hypothesis, statistical hypothesis, critical region, level of significance, p-value, normal distribution T-test: t-test for mean, equality of two means, paired t-test, unpaired t-test, chi-square test: chi square test for goodness of fit, independence of attributes, non-parametric test

Credit III – Scientific Communication (15 L)

1. Importance of scientific communication Types of scientific communications Logical organization of scientific data and documentation
2. Different modes of scientific communication Details of – Steps involved in Proposal writing, Research paper writing, Thesis writing
3. Oral forms of scientific communication Popular and Scientific talks, Poster presentations
4. Legal forms of communication of science 4 Ethics in scientific communication IPR, patent submissions

Credit IV: Bio-analytical techniques & Bioinformatics (15L)

1. Making solutions – moles and molarity, stock solutions and dilutions, making media and reaction mixtures (4 L)

2. pH measurements and preparation of buffers (2L)

3. Measuring concentrations using spectrophotometry, Cell counting using serial dilutions, haemocytometry (2L)

4. Bioinformatics: What is Bioinformatics, What is database, Classification of database, Sequences and nomenclature, IUPAC symbols, Types of sequences used in Bioinformatics, Information sources: NCBI, the GDP, MGD. (4L)

5. Data Retrieval tools – ENTREZ, OMIM, PubMed, Taxonomy Browsers, LocusLink, SRS. Database Similarity Searching – BLAST, FASTA, Resources for Gene Level Seqoences, Use of Bioinformatics tools in analysis (3L)

NOTE – Emphasis be given on methodology and numerical problem solving rather than derivations and proofs.

Suggested Reading:

1. P.N. Arora and P.K. Malhan (2002) Biostatistics, Himalaya publishing House.
2. Rama Krishnan, P. (1995) Biostatics, Saras publication A.R.P. camp Road, Periavilai, Kottar, po. Nagercoil, Kanyakumari- Dist. Pin- 629 002.
3. Banerjee, P.K. (2005) Introduction to Biostatics' S. Chand and Company Ltd. Ram Nagar, New Delhi- 110 055.
4. Norman T.J. Bailey (2004), Statistical methods in biology (Third Edition) Cambridge University press (Low price Editions).
5. Dr. Mungikar A.N. (1997) an introduction to Biometry, Saraswati publication, Aurangabad.
6. Mungikar, A. M. (2003) Biostatistial Analysis. Saraswati Printing Press. Aurangabad.

7. Lab Math – Adams, D.S. I.K. InternationsPvt Ltd. New Delhi, 2004
8. T. M. Apostol: Mathematical Analysis (Narosa publishing house)

BOUT 232 Botany Theory paper 2

BOUT 232 Developmental Botany (4 Cr - 60 L)

Credit I: Basic concepts of Plant development (15L)

1. Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development, 7L

2. Polarity & Symmetry 2L

3. Difference between Plant and Animal development 2L

4. Factors for development- intrinsic and extrinsic 2L

5. Juvenility -Characteristics,Transition to Adult phase. 2L

Credit II: Embryology (15L)

1. Reproductive structure in plant 1L

2. Gametophyte development- Stamen and Microsporogenesis, Male gametophyte or male germ unit development, Carpel and Megasporogenesis, Female gametophyte or female germ unit development 4L

3. Fertilization-Pollen tube growth and its path,it sentry into embryo sac, gametic fusion, significance of double fertilization, abnormalities in fertilization. 2L

4. Development of embryo in dicots and monocot 2L

5. Development of Endosperm 2L

6. Polyembryony- concept and classification of polyembryony, special cases and causes of polyembryony. 2L

7. Apomixis - concept, categories- agamospermy and vegetative reproduction apospory, parthenogenesis 2L

Credit III: Physiological & Molecular Basis of Plant Development (15L)

1. Physiology of plant development - Photo-morphogenesis, Light mediated development, Photoreceptors, Hormonal Signaling in development 4L

2. Molecular and Cellular Events in –

a. Embryogenesis 1L

b. Leaf development 2L

c. Stomatal development 2L

d. Root development 2L

e. Root Hair Development 2L

f. Shoot development 2L

Credit IV: Molecular and Cellular Events in – 15L

g. Inflorescence development 2L

h. Flower development 2L

3. Mutants in Developments 3L

4. Genetic and Epigenetic Mechanisms Underlying Vernalization 4L

5. Radial and Axial Pattern of development 2L

6. Process of Senescence 2L

References:

1. Embryology of Angiosperm by Maheswari
2. Embryology of Angiosperm by BhojwaniandBhatnagar
3. Plant Physiology by Taize and Zeiger
4. Arabidopsis Book
5. Current Trends in the Embryology of Angiosperms by SS Bhojwani
6. Developmental Biology of Flowering Plants by V. Raghavan
7. Flowering Plant Embryology By Nels R. Lersten

Semester III

M Sc Syllabus, 2020-2021

BOUT 233 Theory Paper 3-Plant Physiology (4 Credit)

Credit I: Plant Nutrition: 15L

- Soil- Formation, structure, composition, classification and role 2L.
- Essential elements- Mineral and nonmineral, criteria of essentiality, role-structural, catalytic osmotic and others; influence of pH, mineral elements interaction and microbes on availability of essential elements 3L
- Mechanism of absorption of mineral elements; mechanism of assimilation of sulfur, phosphorus and nitrogen 2L
- Active and passive transport, Transporters, role of ATPase and PPase 2L
- Merits and demerits of use of natural and chemical fertilizers, conventional and modern methods of application of fertilizers 2L
- Properties of water, water potential and factor influencing transport of water 2L
- Mechanism of opening and closing of stomata, transpiration ratio and water conservation strategies in plants 2L

Credit II: Photosynthesis: 15L

- Photosystem I and II (composition, light harvesting mechanism and functioning). 2L
- Organization of Photosynthetic electron transport system(evidence from Membrane chemical composition, electro-potential gradient and use of ETS Component inhibitors) 3L
- Photo-oxidation of water 2L
- Mechanism of establishment of proton gradient across the thylakoid membrane. Production of assimilatory powers of photosynthesis (ATP and NADPH) 3L
- Fixation of CO2: Calvin (C3), steps and regulation, Photorespiration-mechanism and significance 3L
- Fixation of CO2: C4 cycle, Kranz anatomy, biochemical sub-types, Single cell C4 Photosynthesis.
- CAM pathway 2L

Credit III: Respiration and lipid metabolism: 15L

- Schematic presentation of Glycolysis, TCA cycle and PPP (Home assignment). Release of energy in Glycolysis, TCA cycle and PPP and their significance 7L
- Organization of respiratory electron transport system(evidence from membrane chemical composition, electro-potential gradient and use of ETS component inhibitors) 2L

- Mechanism of NADPH and NADH oxidation, establishment of proton gradient across the membrane and ATP formation 1L
- Cyanide resistance pathway 1L
- Fatty acid biosynthesis 1L
- Synthesis of membrane lipids 1L
- Catabolism of storage lipids 1L
- Significance of lipids(energy storage, defense, structure and others) 1L

Credit IV: Solute transport, Growth and development: 15L

- Seed dormancy, types of dormancy, causes, and methods of break dormancy. 1L
- Growth- Relative growth rate and net assimilation rate, IRGA 1L
- Physiology of flowering- photoperiodism, mechanism of vernalization. 4L
- Physiological organization phloem element for transport (Home assignment), Loading and unloading of phloem and mechanism of transport of solutes (Munch hypothesis); Source and sink relationship 3L
- Plant growth regulators-types and the physiological roles of auxin and cytokinin. 2L
- Stress physiology: Definition, Types: biotic and abiotic stress, effect of stress on Plants and elaborate any one abiotic and biotic tolerance mechanism. 2L
- Schematic presentation of secondary metabolite synthesis pathways (home assignment), Classification, biosynthesis and significance of alkaloidsin plants. 2L

REFERENCES:

- Berg J.M., Tymoczko J.L., Stryrer L. (2002) Biochemistry. 5th Ed. Wlt. Freeman and Company, New York.
- Biology of Plants. American Society of Plant Physiologists Maryland, USA.
- Buchanan B.B, Gruissem W. and Jones R.L 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologistsm Maryland, USA.
- Concept in Photobiology; Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
- Davis P. J. (Eds.)(2004) Plant Hormones.Kluwer Academic Publishers, Dordrecht, Netherlands.
- Dennis D.T., Turpin, D.H. Lefebvre D.D. and Layzell D.B. (eds) 1997. Plant Metabolism (Second Edition) Longman, Essex, England.
- Galstone A.W. 1989. Life processes in Plants. Scientific American Library, Springer Verlag, New York, USA.
- Goodwin T.W., Mercer E.I. (1998) Introduction to Biochemistry. CBS Publishers, New Delhi.
- Heldt H. W. (2004) Plant Biochemistry. Academic Press, California.
- Hopkins W. G. 1995. Introduction to Plant Physiology. John Wiley and Sons, Inc., New York, USA
- Lawlor D.W. (2001) Photosynthesis in C3 and C4 Pathway. 3rd Ed. Viva. New Delhi.

- Leninger A.C 1987. Principles of Biochmistry, CBS Publishers and Distributers (Indian Reprint)
- Lincolin Taiz and Eduardo Zeiger (2010) Plant Physiology, Fifth edition. Sinauer Associates, Inc. Publishers. Sunder land, USA.
- Lodish H., Berk A., Zipursky S, L., Matsudaira P., Baltimore D and Darnell J. 2000. Molecular Cell Biology (Iv Edition) W. H. Freeman and Company, New York, USA.
- Metabolism (Second Edition) Longman, Essex, England.
- Moore T.C. 1989. Biochemistry and Physiology of Plant Hormones Springer –Verlag, New York, USA.
- Nelson David and Cox Michael. (2007) Lehninger Principles of Biochemistry.W.H.Freeman and Company. New York.
- Nobel P.S 1999. Physiochemical and Environmental Plant Physiology (Second Edition) Academic Press, San Diego, USA.
- Salibury F.B and Ross C.W 1992. Plant physiology (Fourth Edition) Wadsworth Publishing Company, California,USA.
- Singhal G.S., Renger G., Sopory, S.K. Irrgang K.D and Govindjee 1999. Concept in Photobiology; Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
- Lincolin Taiz and Eduardo Zeiger (2010) Plant Physiology, Fifth edition. Sinauer Associates, Inc. Publishers. Sunder land, USA.
- Thomas B. and Vince-Prue D. 1997. Photoperiodism in Plants (Second Edition) Academic Press, San Diego, USA.
- Verma S.K. and Verma Mohit 2007. A.T.B of Plant Physiology, Biochemistry and Biotechnology, S.Chand Publications.

Semester –III

M.Sc. Botany – II Botany Theory paper -4

BODT 234- a) Mycology (2 Cr- 30 Lectures)

Credit I – Fungi **(15L)**

1. Fungi – Affinities with plants, animals and their significance 2L

2. Outline classification of fungi upto order- 3L

E. A. Bessey System (1950)

Alexopoulos System (1962),

L. E. Hawkers System (1966),

Alexopoulos and Mims System (1979),

Webster and Weber System (2007)

3. General characters and structural variations in-

A) Myxomycota- Acrasiomycetes, Protosteliomycetes, Dictyosteliomycetes, Myxomycetes 4L

B) Straminipila- Plasmodiophoromycota, Hyphochytridiomycota, Labyrinthulomycotaand Oomycota 2L

C)Mastigomycota-Chytridiomycetes 1L

D)Zygomycota- Zygomycetes, and Trichomycetes 3L

Credit II –Higher Fungi – 15L

4.General characters, structural variations in-

A. Ascomycota- Archiascomycetes, Hemiascomycetes,Plectomycetes, Pyrenomycetes, Loculoascomycetes, Discomycetes 5L

B. Basidiomycota- Hymenomycetes- Agarics and Polypores, Homobasidiomycetes - Gasteromycetes,Heterobasidiomycetes- Auricularials Dacrymycetales, Tremellales Teliomycetes–Uredinales and Ustilaginales fungi 6L

C. Deuteromycota- Hyphomycetes- Moniliales, Mycelia Sterilia, Coelomycetes - Melanconiales, Sphaeropsidales 4L

Suggested Readings:

1. Ainsworth et al., 1973. The fungi VI –A, VI – B, Academic press.

2. John Webster and Weber, 2007. Introduction to Fungi, Cambridge.

3. Alexopolous C.J. Minms C.W. and Blackwell M., 1999. Introductory Mycology (4th Edition), Willey, New York.

4. Deacon J. W. Fungal Biology (4th Edition) , Blackwell Publishing, ISBN 1405130660

5. Kendrick B., 1994. The Fifth Kingdom, North America, New York Publisher.

6. Kirk et al., 2001. Dictionary of fungi, 9th edition, Wallingford.

7. Mehrotra R.S. and Aneja K.R., 1990. An introduction to mycology, New Age Publication.

8. Miguel U., Richard H., and Samuel A. 2000. Illustrated dictionary of mycology Elvira Aguirre Acosta Publisher.

9. WebsterJ., and Rpland W. 2007. Introduction to fungi (3rd Edition), Cambridge University Press.

10. Dube H.C. 2010.An Introduction to fungi, Vikas Publication.

11. Vashista B. R. and Sinha A.K. 2008. Botany for Degree students- Fungi, S. Chand's Publication.

Semester III

Botany Theory paper -4

M Sc Syllabus, 2020-2021

BODT 234 b) TAXONOMY OF ANGIOSPERMS (2 credits-30 Lectures)

Credit I: **15 Lectures**

- Introduction to Taxonomy , 4L

  Botanical Nomenclature: Brief history, Scientific names, ICN, Principles, typification, Principle of priority, effective and valid publication, rank of taxa
- Tools of taxonomy: Floras, monographs, revisions, websites. 4L

  Herbarium and botanical gardens, their role in teaching, research and conservation, important herbaria and botanic gardens of theWorld.

  Botanical Survey of India.
- Identification of Plants: Introduction, Morphological features used in identification.

  Keys: Types and Importance 4L
- Biodiversity, types, importance and methods of conservation 3L

  IUCN and its categories, Endemism, Hotspots

Credit II: **15 Lectures**

- Modern Trends in Angiosperm Taxonomy 4L

Embryology in relation to taxonomy: Embryological characters of taxonomic importance, Anatomy in relation to taxonomy: Anatomical characters of taxonomic importance, Palynotaxonomy: pollen characters of taxonomic importance.

- Chemotaxonomy 2L

  Classes of compounds and their biological significance, stages in chemotaxonomic investigations, Techniques-Criteria for use of chemical in plant taxonomy
- Serology and taxonomy 2L

  History, precipitation reaction, techniques, antigen, antisera antibody, application of serological data in systematic
- UltrastructuralSystematics: 3L

  SEM and TEM studies and plant systematics; SEM and plant surface structure, TEM and dilated cisterneae of endoplasmic reticulum and sieve element, plastids
- Molecular Systematics: 4L

  Molecular diagnostic tools, restriction fragment length polymorphism (RFLPs), Random Amplified Polymorphic DNA (RAPD), Polymerage Chain Reaction (PCR) analysis, specific applications of RAPD in molecular systematics. Molecular data and systematic position of Hydatellaceae.

Suggested Readings:

1. Balfour Austin (2016). Plant Taxonomy. Syrawood Publishing House
2. Chapman, J.L. and Reiss, M.J. (1998). Ecology: Principles and applications. Cambridge, University Press.
3. Chopra G.L. (1984). Angiosperms: Systematics and Life-Cycle., Pradeep Publications
4. Cooke, Theodore (1903-8). The Flora of the Presidency of the Bombay Vol. I, II, III (Repr. ed), Botanical Survey of India.
5. Cronquist, A. (1968). The Evolution and Classification of Flowering Plants. Thomas Nel and Sons Ltd. London.
6. Datta S.C. (1988). Systematic Botany. New Age Publ.
7. Davis P.H and V.H Heywood (1963). Principles of Angiosperm Taxonomy. Oliver and Boyd, London.
8. Heywood V.H. (1967). Plant Taxonomy, Hodder & Stoughton Educational, London.
9. Judd Walter S., Campbell, C. S., Kellogg, E. A., Stevens, P.F. and M. J. Donoghue. (2008). Plant Systematics- A Phylogenetic Approach. Sinauer Associates, INC, Publishers.Sunderland, Massachusetts, USA.
10. Kormondy Edward (1995). Concepts of Ecology, Pearson Publ.
11. Lawrence G.H.M. (1955). An Introduction to Plant Taxonomy. McMillan, New York.

12. Lawrence, G.H.M. (1951). Taxonomy of Vascular Plants. McMillan, New York.
13. Michael P. (1984). Ecological Methods for field and Laboratory investigations TMH Co. ltd. Bombay.
14. Mondol A.K. (2016) Advanced Plant Taxonomy, New Central Book Agency (NCBA)
15. Naik V.N. (1988) Taxonomy of Angiosperms. Oxford and IBH
16. Odum E.P., (2004). Fundamentals of Ecology, Publ. Cengage Learning, Australia
17. Pande B.P. (1997). Taxonomy of Angiosperms. S. Chand.
18. Pande B.P. (2001) Taxonomy of Angiosperms. S. Chand.
19. Radford A.E. 1986. Fundamentals of Plant Systematics, Harper and Row N Y.
20. Santapau H. (1953). The Flora of Khandala on the Western Ghats of India. BSI
21. Sharma O.P. (2011), Plant Taxonomy, Tata Mc grow Hill
22. Shivrajan V.V. & N.K.P. Robson (1991). Introduction to Principles of Plant Taxonomy. Cambridge Univ. Press
23. Shukla Priti and Shital Mishra (1982). An introduction to Taxonomy of angiosperms. Vikas Publ.
24. Simpson, M.G. (2010). Plant Systematics. Elsevier, Amsterdam.
25. Singh Gurucharan (2005). Systematics: Theory and Practice. Oxford IBH.
26. Singh J.S., S.P. Singh, and S.R. Gupta (2006). Ecology, Environment and Resource Conservation. Anamaya Publ. New Delhi.
27. Singh N.P. (2001) Flora of Maharashtra Volume-II BSI, Kolkatta
28. Singh N.P. (2003) Flora of Maharashtra Volume-III BSI, Kolkatta
29. Singh N.P., S. Karthikeyan (1996) Flora of Maharashtra Volume-I, BSI, Kolkatta
30. Singh V. and D.K. Jain, (1981). Taxonomy of Angiosperms. Rastogi Publication, Meerut.
31. Singh, Gurcharan. (2012). Plant Systematics: Theory and Practice. Completely revised and enlarged 3rd edition. Oxford & IBH, New Delhi.
32. Stuessy, Tod F. (2009). Plant Taxonomy: The Systematic Evaluation of Comparative Data, second edition. Columbia University Press.
33. Swingle D.B. (1946). A Text book of Systematic Botany. McGraw Hill Book Co. New York.
34. Takhtajan A. (1969). Flowering Plants: Origin and Disposal.

IMPORTANT WEBSITES

THE FAMILIES OF FLOWERING PLANTS- L. Watson and M.J. Dallwitz
https://www.delta-intkey.com/angio/index.htm

ANGIOSPERM PHYLOGENY WEBSITE, version 14.
http://www.mobot.org/MOBOT/research/APweb/

THE PLANTS OF THE WORLD ONLINE PORTAL
http://www.plantsoftheworldonline.org/

INTERNATIONAL PLANT NAME INDEX (IPNI)
https://www.ipni.org/

TROPICOS
https://www.tropicos.org/home

BIODIVERSITY HERITAGE LIBRARY
https://www.biodiversitylibrary.org/

BOTANICUS DIGITAL LIBRARY
https://www.botanicus.org/
INTERNET ARCHIVE- DIGITAL LIBRARY
https://archive.org/
DATABASE OF PLANTS OF INDIAN SUBCONTINENT
https://sites.google.com/site/efloraofindia/
BOTANICAL SURVEY OF INDIA
https://bsi.gov.in/content/1416_1_FloraofIndia.aspx
FLOWERS OF INDIA
http://www.flowersofindia.net/
eFLORAS OF WORLD
http://www.efloras.org/

Botany Theory paper -4

M.Sc. Botany Semester-III

BOUT 234: c) Plant Ecology

(2 Credits) (30 Lectures)

Topic Details	Lectures
Credit-I	
Introduction to science of ecology, definition, concept, and scope, interdisciplinary science, autecology and synecology, branches of ecology	2
Environmental factors controlling plant distributions: geology, topography, elevation, soils, light, temperature, precipitation, water and humidity, fire	3
Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of meta-population – demes and dispersal, interdemic extinctions, age structured populations.	4
Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.	2
Community Ecology: definition, nature, composition and characteristics of community, structure/ stratification of community, levels of species diversity and its measurement; edges and ecotones, habitat, niche and guild	4
Credit-II	
Ecological succession: Types, mechanisms, changes involved in succession; concept of climax; relationship between ecosystem stability and diversity, ecological indicator plants	3

Ecosystems – concept, nature, structure and function; Structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine).	3
Energy flow in ecosystem, food chain, food web, biogeochemical cycles (C,N,P), primary production and decomposition; ecological pyramids, homeostasis, concept of limiting factors	3
Biogeography: Major terrestrial biomes; theory of island biogeography; floristic regions and vegetation zones of Maharashtra, India, and world and its characters, principals of classification, key species of each region.	3
Applied Ecology: Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.	3

Suggested Readings:

- Ambasht R.S. and N.K. Ambasht (2017). A Textbook of Plant Ecology (15/E). CBS Publishers & Distributors-New Delhi.
- Ambasht R.S., and N.K. Ambasht (2003). Modern Trends in Applied Terrestrial Ecology. Springer
- Avery Thomas E. and Burkhart Harold E. (2015). Forest Measurements. (5/E). McGraw-Hill.
- Barbier E.B., Burgess J.C. and Folke C. (1994). Paradise Lost? The Ecological Economics of Biodiversity; Earthscan, London
- Bhatnagar Aditya (2010). Ecology and Environment. Oxford Book Company
- Bowles M.L. and Whelan C.J (1996) edt. Restoration of Endangered Species Cambridge Univ. Press.
- Chapman, J.L. and Reiss, M.J. (1998). Ecology: Principles and applications. Cambridge University Press.
- Dash M.C. and S.P. Dash (2009). Fundamentals of Ecology (3/E). McGraw Hill Education (India) Private Limited
- Gadgil M. and Guha R (1992). This Fissured Land: An Ecological History of India. Oxford University Press, New Delhi
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Botany Theory paper -4

M.Sc. Botany – II

Semester –III

BODT 234- d) Plant Biotechnology (2 Cr- 30 Lectures)

Credit –I **15 L**

Introduction to Biotechnology:

1. Definitions of Biotechnology, Multidisciplinary approach, scope and importance of Biotechnology wrt Plant genetic Engineering, Plant micropropagation, Plant mutation cloning, Plant cell technology and Environmental Biotechnology (02)
2. A. Plant Genetic Engineering: Gene constructs, A typical Plant gene, Promoters/ Enhancers, reporter genes

B. Vectors for production of Transgenic plants: Plasmid Vectors; Structure of Ti Plasmid, organization of T DNA, Vir region, transfer and integration of T DNA in host plant genome, Plant Virus vectors; Cauliflower Mosaic Virus (CaMV) , Gemini Viruses and Tobacco Mozaic Virus (TMV) (05)

3. Agrobacterium mediated gene transfer, integration of the transgenes, inheritance of transgenes, Analysis and confirmation of transgene integration (03)
4. Applications of transgenic Plants: Applications of Transgenic plants in Biotic and Abiotic Stress resistance, Quality modifications and Novel features such as modification of Endogenous genes, molecular farming, Plant derived vaccines (05)

Credit – II 15 L

5. **Plant tissue culture technology** (05)
   A. Introduction to plant tissue culture, Scope, Importance and types, Protoplast Culture and Somatic Hybridization: Isolation of protoplast, culture and regeneration of protoplasts, fusion of protoplasts, selection of hybrid cells. Identification of hybrid plants, Cybrids, Applications of somatic hybridization
   B. Somaclonal Variations: Introduction, Isolation of somaclonal variants, with and without *in-vitro* selection, factors affecting somaclonal variation, applications and limitations of somaclonal variation

6. **Environmental Biotechnology:** (05)
   Environmental Pollution: Sources and Nature, Measurement of Pollution: Biotechnological methods of Pollution management, air pollution ad its control, water pollution and sewage: Nature of water pollutants, organic and inorganic, microbiological and radioactive pollutants, Waste water and sewage: composition of sewage and its types, Sewage water treatment: Preliminary, Primary, Secondary or biological treatment processes, water recycling
7. **Biotechnology and Society**
   A. Biotechnology- Society, Risks, Ethics and Patenting (02)

ELSI of Biotechnology, Recombinant and Therapeutic products for human healthcare, Genetic modifications and food consumption, recombinant food and religious beliefs, Release of Trangenics

Patenting : What is a Patent, Intellectual property rights, the process of patenting, Plant Breeder's rights

B. Biosafety- (03)

Introduction, definitions, objectives and biosafety guidelines, Risk assessment during Laboratory research, planned introduction, for biotechnology products, Risk regulations, Physical and Biological contaminants, Biosafety guidelines in India

Suggested Readings:

1. U. Satyanarayan, Biotechnology Published by Books and Allied PVT. LTD.
2. B. D. Singh. Biotechnology : Expanding Horizons Kalyani Publishers
3. S. C. Dubey Biotechnology , Rastogi publication

Botany Theory paper 4

M.Sc. Botany – II
Semester –III
BODT 234 e) Genetics and plant breeding- (2 Credits – 30 lectures)

Credit - I **15 L**

1. **Karyotype analysis and application**: **7L**

Introduction and concept, Role of karyotype in evolution and plant species identification, Chromosome banding: i) Quinacrine dihydroculoride (Q) banding, ii) G-banding, iii) Giemsa C-banding, Modified C-banding, Combined C and N bonding for plants, B-Chromosome and accessory chromosomes, Applications of karyotyping analysis in taxonomy, Molecular analysis through in Situ hybridization of chromosomes: Types of hybridization, Nature of probes, P.C.R. and in situ hybridization, Prerequisites, steps and techniques of hybridization: Probe sequence, Metaphase chromosome, Labelling of probes, Hybridization and detection

2. **Transposable Elements:** **3L**

Genetic instability and the discovery of transposable elements. Transposable element in bacteria: IS elements and Tn3 Family, Transposable elements in Maize, The Genetics and evolutionary significance of transposable elements: Mutation and Chromosome Brekage, Use in genetic analysis and Evolutionary issues or significance

3. **Population and evolutionary genetics: 5L lectures**

Genetic variation, random mating and Hardy- Hardy-Weinberg Principle, Mating frequencies - Non-dominance - Codominance - Snyder's ratio, importance,and its effect over random mating in succeeding generations, Application of Hardy-Weinberg method in breeding, The inbreeding coefficient, Calculating F from pedigree, Genotype frequencies under inbreeding, Quantitative effects of inbreeding, Outbreeding and assortative mating, Evolutionary genetics: The synthetic theory of evolution, Evidence for adaptive evolution and Molecular evolution

Credit - II: 15 L

4. **Addition Molecular Markers in Plant breeding:** 4L

QTL mapping; Strategies for QTL mapping, desired populations for QTL mapping, Marker assisted selection (MAS),Classification of markers -Enzyme based markers, Hybridization based markers, DNA-sequence based markers, Approaches to apply MAS in plant breeding, Factors influencing MAS

5. **Breeding for resistance to Salinity:** 4L

Introduction, Effect of salinity stress: Salt toxicity, Salinity resistance : Resistance to salinity induced ion toxicity, Genetics of salinity resistance: Interspecific variation, Intraspecific variation, Gene action and heritability, Measurement of salinity resistance: Saline environment and Estimation of salinity resistance and selection criteria.

6. **Biometrical techniques in plant breeding: 4 L**

Introduction, Assessment of variability, Simple measures of variability.
Genetic Diversity: Introduction, D^2 statistics, Metroglyph Analysis, Correlation coefficient analysis (Aids to selection): Simple coefficient Analysis, Partial correlation, Choice of parents and Breeding procedures: Diallel cross analysis

7. **Intellectual Property Rights**: **3L**

Introduction, Intellectual property rights, Plant breeder's rights, A comparison among UPOV acts, PPVER Acts., Requirement for PBR and Farmers rights, The protection of plant varieties and farmers right act,2001, Geographical indications, Indian response to the IPR upheaval, The conditions for granting breeding rights (DUS) : Novelty , Distinctness, Uniformity and stability

Suggested Readings

Charles B. 1993. Discussions in Cytogenetics. Prentice Hall.Darlington CD & La Cour LF. 1969.

The Handling of Chromosomes. Georger Allen & Unwin Ltd.

Arun Sharma and Archana Sharma, 1988. Chromosome Techniques: Theory and Practice. Butterworth.

Sumner AT. 1982. Chromosome Banding. Unwin Hyman Publ.

Elgin SCR. 1995. Chromatin Structure and Gene Expression. IRL Press.

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Genetics, Breeding and Evolution. Part A. Elsevier.

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E.J. Gardner Priciples of Genetics

Monroe Strikberger, (1995) Genetics Publisher: Prentice Hall India Learning Private Limited; 3

Hartl and Jones (1998) Genetics : Principal and Analysis. Sudbury, Mass. : Jones and Bartlett Publishers,

Peter J.Russel, Genetics (5^{th} edition),Pearson publication

Primrose, S.B.,and R.M. Twyman. Principles of gene manipulation and genomics , Blakwell Publication

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Weir DS. 1990. Genetic Data Analysis. Methods for Discrete Population Genetic Data. Sinauer Associates.
Wricke G & Weber WE. 1986. Quantitative Genetics and Selection in Plant Breeding. Walter de Gruyter.Chawla V & Yadava RK. 2006. Principles of Population Genetics – A Practical Manual. Dept. of Genetics, CCS HAU Hisar.
Falconer DS & Mackay J.1996. Introduction to Quantitative Genetics. Longman.
Jain JP, Jain J & Parbhakaran, VT. 1992. Genetics of Populations. South Asia Books. Li CC. 1955. Population Genetics. The Univ. of Chicago Press

Botany Theory paper -4

M.Sc. Botany – II

Semester –III

BODT- 234: f) SEED SCIENCE- 2 Credit (30 Lectures)

Credit -1 **15 L**

1. **Introduction:** **1 L**
   - Scope, Importance and Definition of Seed Technology
2. **Seed:** **4 L**
   - Definition
   - Difference between seed and grain
   - Orthodox and Recalcitrant seed
   - Classes of seed
   - Seed quality characteristics
3. **Seed Morphology:** **2 L**
   - Seed structure (embryo, endosperm and seed coat)
   - Chemical composition of seed (carbohydrates, proteins, oils, fats and other)
4. **Seed Dormancy and Seed Germination:** **6 L**
   - Definition of dormancy
   - Types of dormancy
   - Causes of seed dormancy
   - Methods of breaking dormancy
   - Definition of seed germination
   - Types of germination
   - Factors affecting seed germination
   - Seed vigour, Seed ageing and Seed viability,
5. **Genetic Purity** **2 L**
   - GOT (grow out test).
   - Germination testing, its methods (paper, sand and soil), evaluation and reporting of results

Credit 2 **15L**

1. **Quality testing** **3 L**
   - Moisture testing: Moisture Meter and Air oven method.
   - Physical purity analysis
   - Biochermical tests (Quick viability test (Tz), Peroxidase and Phenol colour test)
   - Aids for varietal identification: PCR, RAPD, RFLP, DNA finger printing, ELISA test.
2. **Seed Production:** **8 L**
   - General Principles of seed production
   - Artificial pollination (Hand pollination, Dusting and Honey bee)

- Seed production techniques in hybrids (use of Male Sterility, Self Incompatability and gametocides)
- Procedure of seed production in tomato, okra, soybean, cotton and maize (Land requirements, isolation requirements, brief cultural practices, plant protection-physical, chemical and biological, types of chemical pesticides-systemic and contact, roguing, harvesting and threshing)
- True potato seed (TPS), Artificial Seed Production

3. Seed Testing: 4 L

- Objectives and Definition
- ISTA, CSTL and SSTL
- Seed Sampling: Definition, Sampling, Dividing and Mixing equipments
- Procedure of sampling, (Kinds-Primary, composite, submitted and working)
- Types of seed samples (Service, official and certification sample)

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6. Agrawal, R.L. 1996. Seed Technology, IBH publishing Co., New Delhi.
7. Mayer, A.M. and A.P. Mayber. 1989. Germination of Seeds. Pergamon Press, Oxford.
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10. Jaima Kigel, J. and G. Galili. 1997. Seed Development and Germination. Marcel Dekker, New York.
11. Bewley, J.D. and M. Black. 1982. Physiology and Biochemistry of Seeds in relation to Germination, Vol. I & II. Springer Verlag, Berlin, Heidelberg, New York.
12. Justice, O.L. and L.N. Basu. 1978. Principles and Practices of Seed Storage. Castle House Publications Ltd, Great Britain.
13. Khan, A.A. 1977. The Physiology and Bio-chemistry of seed Dormancy and Germination. North Holland Publishing Co., Amsterdam, New York.
14. Kozlowski, T.T. 1972. Seed Biology, Vol. 1 Academic Press, London.
15. Purseglove, J.W. 1977. Tropical crops of Monocotyledons, Longmans, Green and Co., Ltd., London.

M. Sc II Botany Practical Paper

BODP 234 Practical Paper based on BODT 234

BODP 234 based on BODT 234 a) Mycology

Sr. No	Title of practical	No.
1	Preparation of culture medium for fungi-PDA medium, CDA medium, Sabourard's medium& preparation of fungal stain & mounting medium	1
2	Isolation of aquatic and soil fungi by baiting method	2
3	Isolation of fungi from rhizosphere and non-rhizosphere soil	2
4	Study of fungi from the following groups Myxomycetes- any four Chytridiomycetes- any two Oomycetes- any four Pyrenomycetes- any four Loculoascomycetes- any two Discomycetes- any four Teliomycetes – any eight Gasteromycetes- any four Hymenomycetes- any six Deuteromycetes- any six	10

Note: 1. Compulsory visit to Western Ghats for collection and observation of fungi (2-3 days).

2. Visit to any one Mycology Institute/ Laboratory.

M. Sc II Botany Practical Paper

BODP 234 Practical Paper based on BODT 234

BODP 234 based on BODT 234 b) Angiosperm Taxonomy

Sr. No	Title of practical	No.
1	Microtome technique for study of embryological characters	2
2	Study of wood character, vessels, storied and non storied wood	2
3	Pollen preparations by Acetolysis method (Semi-permanent) and study of different pollen morphotypes.	2
4	Study of chromosomes, chromosome banding and Karyotype analysis (Any two species)	2
5	Analyses and interpretation of data of any two species for taxonomic characterization (4P) (a) flavonoid data based on PC/TLC (b) Seed protein by SDS-PAGE and interpretation of protein profiles	3
6	Study of plant surface attributes with the help of SEM photographs and sieve tube plastid and dilated cisternae of endoplasmic reticulum with the help of TEM photographs	1
7	Identification of wild and cultivated plants represented in local flora.	1
8	Two local excursions to study vegetation, ecology and flowering pattern of the region.	2

Note:

Student should submit minimum 10 conventional herbarium specimens and 20 electronic herbarium specimens. Minimum 5 permanent slides of wood anatomy and 5 slides of floral anatomy (microtomy cut sections of flower specimens).

M. Sc II Botany Practical Paper

BODP 234 Practical Paper based on BODT 234

BODP 234 based on BODT 234 c) Plant Ecology

Sr. No	Title of practical	No.
1	Visit to any one plant diversity hotspots / National Parks/ Wildlife Sanctuary/ coastal area	2p
2	Find out the minimum area of quadrat by species-area curve method	1p
3	Find out the minimum number of quadrats required to study the herbaceous ecosystem	1p
4	Study of biotic structure by List Counts Quadrat method to find out frequency and relative frequency of different plant species and prepare their frequency class diagram; compare them with Raunkiaer's normal frequency diagram.	1p
5	Study of biotic components by List Counts Quadrat method to find out abundance, density and relative density.	1p
6	Study of ecological indicator plants (any five)	1p
7	Determination of water holding capacity, moisture content, color and pH of different soils	1p
8	To study the texture of the soil.	1p
9	Determination of the temperature, pH, dissolved oxygen, and turbidity of polluted and non-polluted water sample	1p
10	Study of wetland plants: submerged, emergent, free floating, marshy (two examples each)	1p
11	Study the map of Phytogeographical regions of India	1p
12	Study of aquatic productivity by light and dark bottle method	1p

Field trip to places for study of vegetation type (including any one plant diversity hotspot/national park/wild life sanctuary/Sacred groove) prescribed in the syllabus for 2 to 5 days under the guidance of teachers. Preparation and submission of field visit report.

M. Sc II Botany Practical Paper

BODP 234 Practical Paper based on BODT 234

BODP 234 based on BODT 234 d) Plant Biotechnology

Sr. No	Title of practical	No.
1	Isolation of Plant genomic DNA using suitable method	2
2	Separation of restriction fragments using Agarose gel Electrophoresis	2
3	Enzymatic isolation of protoplast using suitable plant material	2
4	Evaluation and viability counting of the protoplsts	2
5	Physicochemical Properties of waste water	1
6	Biological assessment of waste water	1
7	Demonstration of Transgenic Plants	1
8	Visit to a Research institute and write a report on Biosafety	1
9	Visit To Commercial Tissue culture Laboratory and write a report	1
10	Visit to Waste water treatment Plant and write a report	1
11	Prepare a case study report on Patenting of any one Biotechnology Product/invention	1

M. Sc II Botany Practical Paper

BODP 234 Practical Paper based on BODT 234

BODP 234 based on BODT 234 e) Genetics and Plant breeding

Sr. No	Title of practical	No.
1	Preparation of C- metaphase / G- banding in suitable material	2
2	Studies on the meiosis in cereals /millets / pulses	1
3	Karyotype studies of any 2 plants and preparation of ideogram	2
4	Detection of polymorphism from any DNA gel photograph or suitable material	1
5	Estimation of gene and gene frequencies	1
6	Preparation of dendrogram from given polymorphic data or by using similarities matrix and explanation and analysis of dendrogram (by suitable software)	1
7	Estimation of heritability and genetic advance (by suitable software)	1
8	Estimation of Correlation Coefficients(manual / by suitable software)	1
9	Problems on Diallel cross analysis	1
10	Effect of salinity on seed germination and morphological characteristics	1
11	Effect of salinity on content of proline and glycine betane	2
12	Study of transposable elements in suitable plant material	1

Compulsory Activities:

1. Preparation of various chemicals to be used for, fixation, dehydration, embedding, different chromosomal staining, cleaning etc. and understanding use of various types of microscopes.

2. Case studies of IPR and Visit to Plant breeding station and Genetic laboratory.

Note: Use suitable software for problem solving in Genetics and Plant breeding

M. Sc II Botany Practical Paper

BODP 234 Practical Paper based on BODT 234

BODP 234 based on BODT 234 f) Seed Science

Sr. No	Title of practical	No.
1	Study of chemical composition and seed structure	1
2	Study of methods of breaking seed dormancy	2
3	Study of Sampling, dividing and mixing equipments	1
4	Grow Out Test	1
5	Study of seed germination (epigeal, hypogeal and viviparous types).	2
6	Study of seed germination testing methods (Paper, soil and sand).	2
7	Study of physical purity test	1
8	Biochemical tests (Quick viability test (Tz), Peroxidase and Phenol colour test)	2
9	Moisture Testing by moisture meter and oven method	1
10	Visit to a seed industry and research institute/apiculture	2

M. Sc II Botany Practical Paper

BOUP 235 based on BOUT 231, BOUT 232, BOUT 233

Sr. No	Title of practical	No.
	BOUT 231 Computational Botany (Any 10 Practical)	
1	Measurement of central tendency (mean, mode and median), variance, standard deviation, coefficient of variance and standard error from the given grouped and ungrouped data.	1
2	Measures of skewness and measures of Kurtosis (grouped and ungrouped data).	1
3	Determination of regression lines and calculation of correlation coefficient – grouped and ungrouped data.	1
4	Examples based on t – test	1
5	Drawing a simple random sample with the help of table of random numbers	1
6	Chi-square test for goodness of fit and independent attributes.	1
7	Analysis of variance on the given data (ANOVA) using R/ SPPS/Excel	1
8	Tukey's test for pairwise comparison of treatments using R/ SPPS/Excel	1
9	Dunnet's test for comparison of treatment means with control using R/ S PPS/Excel	1
10	Duncan's multiple range test for comparing treatment means using R/ SPPS/Excel	1
11	Determination of Karl-Pearson's coefficient of correlation from the given grouped and ungrouped data.	1
12	Databases and database searching and DNA/protein sequence comparisons	1
13	Pair wise comparison of DNA and protein sequences using BLAST	1
	BOUT 232 Developmental Botany	
1	Histochemical analysis of secondary growth primary to secondary axis)	1
2	Histochemical comparison between vegetative And reproductive induced SA	1
3	In-Vitro Germination of Spore/Pollen	1
4	Dissection & Isolation of Developing Embryo	1
5	Dissection Isolation of Endosperm	1
6	Stomatal development and observations on Stomatal types	1
7	Study of Induced Leaf Senescence	2
8	Observations on Microsporogenesis and Development of Male Gametophyte	1
9	Observations on Megasporogenesis and Development of Female Gametophyte	1
	BOUT 233 Plant Physiology (Any 10 Practical)	
1	Preparation of standard solutions(%, ppm, molar, normal) of different concentrations, Preparation of buffers solutions, EC and pH measurements	1
2	Study of deficiency symptoms of essential elements on different crop plants.	1
3	Study of transpiration and stomatal physiology under abiotic stress	1
4	Detection of amino acids/sugars from the phloem sap using paper chromatography	1
5	To determine the chlorophyll a/chlorophyll b ratio in C3 and C4 plants.	1
6	Estimation of soluble proteins in germinating and non-germinating seed by Lowry / Bradford's method	1
7	Survey of C4 plants and CAM plants. Find out C4 pathways from the given plants	1

	by titration method(TAN)	
8	To determine the activity of enzyme amylase in germinating seeds and its induction by GA.1P	1
9	Determination of activity of nitrate reductase.	1
10	Effect of salt /Drought stress on accumulation of proline and its estimation.	1

SEMESTER IV

M.Sc. II Semester IV

BOUT 241 Botany Theory paper 1

BOUT 241: BOTANICAL TECHNIQUES

(4 CREDITS) (60 Lectures)

Credit 1 = (15 Lectures)

Microscopic Techniques

A. Image formation (properties of light), Lens- refraction, dispersion of light, objects, images, image quality, magnification concept, resolution **1L**

B. Optical microscopy- Light microscopy, Confocal microscopy, Phase Contrast microscopy, Fluorescence microscopy, Electron microscopy (SEM TEM and STEM), Flow cytometery and Atomic force microscopy **7L**

C. Dissection, maceration, squash, peeling and whole mount- pretreatment and procedures **1L**

D. Microtomy- serial sectioning, double or multiple staining, Lesser assisted Microtomy **2L**

E. Histochemical and cytochemical techniques- Localization of specific Compounds/ reactions/ activities in tissues and cells **3L**

F. Micrometry and camera lucida **1L**

Credit 2 = (15 Lectures)

A. Chromatography techniques:-

a) Introduction, Types, Peak Area, Solvent systems, immobilized and mobilized phase, retention time **2L**
b) Principle, method and applications of: Paper, TLC, Column Chromatography **2L**
c) Gel filtration, Affinity, Ion exchange **2L**
d) HPLC, Gas chromatography **2L**

B. Elctrophoretic techniques:-

a) History, Principles, Horizontal and Vertical Electrophoresis. **1L**
b) Agarose gel electrophoresis **1L**
c) Pulsed Field Gel Electrophoresis, Polyacrylamide Gel Electrophoresis (PAGE/ Native), Sodium Dodecyl Sulphate polyacrylamide gel electrophoresis (SDS-PAGE/ Denaturing) **4L**
d) Isoelctric focusing, 2 Dimensional Gel Electrophoresis (2-D method) **1L**

Credit 3 = (15 Lectures)

A. Spectroscopic techniques:-

a) General principles, Beer and Lambert's Law, Molar extinction coefficient, Electromagnetic radiations (Dual nature), Wavelength, Frequency, Properties of Electromagnetic radiations, electromagnetic spectra, Light absorption and excitation of spectra **2L**
b) Spectrophotometer **1L**
c) Principle, working and applications of-UV-Visible spectroscopy **1L**
d) Nuclear Magnetic Resonance (NMR) spectroscopy, **2L**
e) X-ray crystallography, **1L**
f) Spectroflurometry, **1L**
g) AAS, MS, IR Spectroscopy **2L**

B. Radioactive techniques:-

a) Radioisotopes used in biology and their properties, Units of radioactivity. **1L**
b) Interaction of radioactivity with matter, **1L**
c) Detection and measurement of radioactivity, Scintillation counter **1L**
d) Autoradiography, Safe handling of radio isotopes, **1L**
e) Flurochromes, Green Fluorescent Proteins **1L**

Credit 4 = (15 Lectures)

A. Centrifugation techniques:-

a) Principles, Rotors, Speed and Unit, Factors affecting centrifugation, **1L**
b) Ultra-centrifugation, Density Gradient Centrifugation **1L**

B. Electrochemical techniques:-
Electrical conductivity, pH meter, Oxygen electrode **2L**

C. Immunological techniques:-
a) Introduction and Principles, **1L**
b) Antigen–antibody interaction, Immuno diffusion, **1L**
c) Immuno precipitation, **1L**
d) Radio-immuno assay, Rocket immumo-electrophoresis, ELISA **2L**

D. Bioinformatics-
a) Introduction to databases and retrieving information from databases: NCBI, EMBEL **2L**
b) Molecular tools in protein and nucleotide sequence analysis; origin of new genes and Proteins, gene duplication and divergence **3L**

E. Herbarium Techniques- Digital herbarium **2L**

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11. **Prasad and Prasad** (1984). Outline of Microtechnique. Emkay Publications, Delhi.

12. **Srivastava S. and Singhal V.** (1995). Laboratory Methods in Microbiology. Anmol Publication Pvt. Ltd. Delhi.

13. **Pal and Ghaskadabi** (2009). Fundamentals of Molecular Biology.Oxford Publishing Co.

M.Sc. II Botany Semester IV

BOUT 242: Theory Paper-2: Advanced Plant Ecology
Semester-IV (4 Credits- 60 Hrs)

Topic Details	Lectures
Credit-I	
Levels of species diversity and its measurement, indices of α-diversity, species rarefaction; β-diversity similarity & dissimilarity indices.	2
Basis of Ecosystem classification. Types of Ecosystem: Desert (hot and cold), forest, rangeland, wetlands, lotic, lentic, estuarine (mangrove), Oceanic.	2
Aquatic Ecology: Freshwater and marine, ecology of estuaries and intertidal zones, mangroves	2
Ecosystem Stability: Concept (resistance and resilience), ecological perturbations (natural and anthropogenic) and their impact on plants and ecosystems	2
Biomes: Concept, basis of classification; Holdrige life zone classification; Characteristics of different biomes: Tundra, Taiga, Grassland, Deciduous forest biome, Alpine Biome, Chapparal, Savanna, Tropical Rain forest; adaptations in plants in various biomes	3
Agro-ecological zones of India: basis of classification and characteristics	2
Forest types of India (Champion and Seth, 1968): basis of classification and characteristics	2
Credit-II	
Methods in field ecology: Methods of estimating population density of plants, ranging patterns through direct, indirect and remote observations, sampling methods in the study of habitat characterization: ground and remote sensing methods.	3
Biodiversity and its conservation: Definition, types, importance of biodiversity and threats to biodiversity; Principles of conservation, major approaches to management; methods of conservation with examples; Indian case studies on conservation and management strategy (Sanctuaries/Sacred groves/National Parks/Botanical Gardens). Concept and basis of identification of 'Hotspots'; hotspots in India.	5

Concepts of gene pool, bio-piracy and bio-prospecting; Concept of restoration ecology; Extinct, Rare, Endangered and Threatened flora of India.	2
Environmental Biotechnology: Phytoremediation – definition, types and role of plants for in-situ and ex-situ remediation; bio-indicators, bio-fertilizers, biofuels and biosensors.	2
Environmental issues: Local, regional and global; air, water, and soil pollution - kinds, sources, quality parameters; climate change and its relationship with plants; Use of plants in mitigation of pollution, effect on plants and ecosystems	3
Credit-III	
Plant relations (eco-physiology) with climatic factors such as water, precipitation, temperature, light and radiation. Plant relations with edaphic factors: types of soil, soil moisture and water holding capacity of the soil, soil nutrients, soil microbes	4
Plant-plant interaction, concept of allelopathy; Plant-animal interaction, herbivory, carnivorous plants; Plant- microbes interaction: Mutualism, parasitism	3
Ecological/Environmental Ethics: Definition, concept, nature and origin of environmental ethics, ecological consciousness, views of developed and developing countries, environment community and equity, integrating ethical values and knowledge, self centered development and environment	4
Restoration ecology, plants in conservation of soils, restoration of land and degraded water bodies	2
Overview of Environmental Laws in India: Wildlife Protection Act, 1972; Forest Conservation Act, 1982 (revised); Biological Diversity Act, 2002: National Forest Policy, 1988; National Environmental Policy, 2006	2
Credit-IV	
Environmental Impact Assessment: Aims and objectives of Environmental Impact Assessment; concept, scope, process and necessity; Environmental Impact Statement (EIS) and Environmental Management Plan (EMP).	4
EIA Guidelines; Impact Assessment Methodologies.	1
Procedure for reviewing EIA of developmental projects. Life-cycle analysis, cost-benefit analysis. Guidelines for Environmental Audit. Environmental Planning as a part of EIA and Environmental Audit;	3
Human impact on ecosystem and its consequences- Agriculture societies, degradation of natural resources. Impact of fertilizers, pesticides, fungicides and weedicides on crops and plants	2
Bio-indicators of environmental degradation- Concept of Bio-indicators, bio indicators plants, role of bio-indicators in pollution control.	2

Concept of carrying capacity; ecological foot print; sustainability	1
Biomass carbon sequestration: above ground, belowground, deadwood, litter, soil organic carbon.	2

References:

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- Ambasht R.S., and N.K. Ambasht (2003). Modern Trends in Applied Terrestrial Ecology. Springer
- Ashish Kothari (1997) Understanding Biodiversity- Life, sustainability and Equity; Orient Longman
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- Chapman, J.L. and Reiss, M.J. (1998). Ecology: Principles and applications. Cambridge University Press.
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- Global Biodiversity: Status of the Worlds Living Resources (1992); WCMC; Chapman and Hall, London
- Hajra P.K. and V. Mudgal (1997) Edt. Plant Diversity Hotspots in India - An Overview, BSI.
- Handbook of the Convention on Biological Diversity (2001), Secretariat of the Convention on Biological Diversity. Earthscan publ., London
- Henderson Peter A., and T.R.E. Southwood (2016). Ecological Methods. (4/E). Wiley-Blackwell Publishers
- Heywood and Watson (1995), (Edt.). Global Biodiversity Assessment UNEP, Cambridge University Press.
- Hill David, Matthew Fasham, Graham Tucker, Michael Shewry and Philip Shaw (2004) (Edt.) Handbook of Biodiversity Methods – Survey, Evaluation and Monitoring. Cambridge
- Jeffries Michael J. (2005). Biodiversity and Conservation, Routledge, London

- Kent Martin (2011). Vegetation Description and Data Analysis: A Practical Approach (2E). Wiley-Blackwell.
- Kormondy Edward (1995). Concepts of Ecology. Pearson Publ.
- Krebs Charles J. (1999). Ecological Methodology (2/E). Pearson Education.
- Krishnamurthy K.V. (2003). An Advanced Textbook on Biodiversity-Principles and Practice, Oxford and IBH Publ. New Delhi
- Krishnmoorthy, Bala (2005). Environmental Management. Prentice-Hall of India, New Delhi.
- Kumar, H.D. (2018). Modern Concept of Ecology (8/E). Vikas Publ. House Pvt. Ldt.
- Lockwood Julie L, Martha F Hoopes, and Michael P Marchetti (2013). Invasion Ecology. Wiley-Blackwell.
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- Mani, M.S. (1974). Ecology and Biogeography of India, 1st Edn. Springer
- Michael J. Jeffries (2005). Biodiversity and Conservation, Routledge, London
- Michael P. (1984). Ecological Methods for Field and Laboratory Investigations. Tata McGraw-Hill Co. Ltd.
- Misra R. (1968). Ecology Workbook. Oxford and IBH, New Delhi.
- Mitsch, William J. and Ames G. Gosselink (2015). Wetlands (5/E). John Wiley & Sons, Inc.
- Ninan, K.N., S. Jyothis, P.Babu and V. Ramkrishnappa (2007). The Economics of Biodiversity Conservation: Valuation in Tropical Forest Ecosystems. Earthscan, London.
- Odum E.P and Gray Barrett (2004) Fundamentals of Ecology. Thomson Brooks
- Puri G.S. (1960) Indian Forest Ecology Vol. I and II. Oxford Books, New Delhi
- Ramchandra T.V., R. Kiran, N. Ahalya (2002). Status, Conservation and Management of Wetlands. Allied Publ. New Delhi.
- Ramkrishnan P.S. (2004). Ecology and Sustainable Development. National Book Trust, New Delhi.
- Rana S.V.S. (2013). Essentials of Ecology and Environmental Science, (5/E). PHI Learning Press.
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- Uma Shaanker, R. Ganeshiah, KN. and Bawa KS (2001). (Eds). Forest Genetic Resources: Status, Threats and Conservation Strategies. Oxford and IBH, New Delhi
- Wheater C Philip, James R. Bell, Penny A. Cook (2011). Practical Field Ecology: A Project Guide. John Wiley

M.Sc. II Botany Semester IV

BODT 243-Botany Paper 3

BODT 243 a) Applied Mycology (2 Cr- 30 Hrs)

Credit I: **15L**

1. Fungi- Colonization strategies in fungi and their ecological role. 3L
2. Agriculture and Forest Pathology:
    a) Fungi as plant pathogens (Mildews- Powdery and Downy, Wilts, Leafspots, Root rots, Smuts and Rusts). 6L
    b) Forest pathology and its significance 1L
    c) Fungi as biopesticides: mycofungicides, mycoweedicides, myconematicides and mycoinsecticides. 2L
    d) Seed and market pathology, its importance 2L
    e) Mycorrhiza types and significance as biofertilizers. 1L

Credit II: **15L**

3. Medical mycology- Superficial, Intermediate and Deep mycosis (Types, symptoms and clinical aspects). 3L
4. Industrial mycology- Medically important Fungal metabolites, production of alcohol, antibiotics, enzymes, organic acids (their production and importance). 4L
5. Fungi as food-
    A) Fermented foods- Mucoprotein, Bread, Cheese, Tempeh, Miso, Sauce. 2L
    B) Mushrooms- types, there food and medicinal value, methods of production of different mushrooms in brief. 3L
6. Fungal food spoilage, Biodeterioration of organic and inorganic materials by fungi with examples. 3L

SUGGESTED READINGS

1. Introduction to Fungi- John Webster and Roland W.S. Weber
2. Introductory Mycology -Alexopoulos C.J., C.W. Mims and M. Blackwell
3. The Mycota- Esser, K. and Bennet J. W. (Eds.)
4. An Introduction to Mycology - Mehrotra, R.S. and Aneja, K.R.

5. Fundamentals of Mycology -Burnett, J. H.

6. Chemical fungal taxonomy - Frisvad, J.C. Bridge, P.D. and Arora, D.K.

7. The Filamentous Fungi - Smith, J.E.

8. Fungal Nutrition and Physiology - Garraway, M. O. and Evans, R. C.

9. Mushroom Biology - Miles, P.G. and Chang, S.T.

10. MycorrhizaeVerma - A. and Hock, B.

11. Ectomycorrhizal Fungi - Cairney, J.W.G. and Chambers, S.M.

12. Industrial mycology - Berry, R.

13. Plant Pathology - Agrios, G.N.

14. Plant Pathology - Mehrotra, R.S.

15. Annual Review of Phytopathology - APS Press

16. Biotechnology in Plant Disease Control- Cheet,I.

17. Post infectional defense mechanisms - Mahadevan, A.

18. Pathogenesis and host specificity in plant diseases. Vol. III.-Rudra P. Singh, Uma S. Singh &KeiisukeKohmoto (eds.) 1995.

19. The nature of disease in plants - Scheffer, R.P.

20. Principles of Plant Pathology -Tarr, S.A.J .

21. Edible mushrooms and their cultivation Change. S.T. and P.G. Miles -

22. MycorrhizaeMosses, B.V.A. -

23. V.A. MycorhizaePowel, C and D. J. Bagyaraj -

24. Industrial mycology (Vol. I) Berry, R. -

25. Biotechnology.Dubey, S.C. -

26. Fungal biotechnology by smith

M.Sc. II Botany Semester IV

BODT 243-Botany Paper 3

BODT 243 b) Advanced Medicinal Botany
(2 CREDITS) (30 Lectures)

Credit I- (15 L)

1. General Pharmacognosy

Definition and scope of Pharmacognosy **1L**
Classification of crude drugs **1L**
Processing of herbal drugs **1L**
Utilization of medicinal and aromatic plants in India **1L**
Indian trade in medicinal and aromatic plants **1L**
Case study of any two Ayurvedic drug industries from India **1L**

2. **Analytical Pharmacognosy**

Drug adulteration **1L**
Drug evaluation –Morphological, microscopical, chemical, physical and biological methods **5L**
Quality control of herbal drugs **1L**
Biosynthesis of glycosides and alkaloids **1L**
Biogenesis of phytopharmaceuticals **1L**

Credit II- (15 L)

3. Plant Drugs **7L**

Pharmacognostic study of the following drugs w.r.t. source, cultivation, collection,macroscopic characters, and application – Isabgol (*Plantago ovata*), Aloes (*Aloe vera)*, *Digitalis (Digitalis purpurea), Dioscorea (Dioscorea bulbifera*), SafedMusli (*Chlorophytum Borivilianum*), Shatavari (*Asparagus racemosus*), Brahmi (*Bacopa monnieri*), Arjuna (*Terminalia arjuna*), Ashwagandha (*Withania somnifera*), *Vinca(Catharanthus roseus)*, Vasaka (*Justicia adhatoda)*, and Turmeric (*Curcuma longa*)

4. Industrial Aspects **8L**

1. Phytopharmaceuticals prospects
2. Marine drugs
3. Nutraceuticals and cosmeceuticals
5. Natural pesticides- Pyrethrum, neem, Deris, tobacco
6. Immunomodulatory medicinal plants
7. Natural excipients

References:

1. Pharmacognosy. Tylor and Brady
2. Pharacognosy. Wallis
3. Pharmacognosy. Trees and Evans
4. Pharmacognosy. Kokate, Gokhale, and Purohit
5. Eonomic Botany. Hill
6. Econoic Botany. Panday
7. Economic Botany. V Verma

8. Medicinal Plants of India and Pakistan. Kirtikar and Basu
9. Medicinal Plants. S K Jain
10. Phytochemistry of Plants. McDaniels
11. Plant Physiology. Salisbury and Ross

M.Sc. II Botany Semester IV

BODT 243-Botany Paper 3

BODT 243 c) Advanced Plant Physiology (2 Credits)

Credit-I: Photosynthesis and Respiration **15L**

1. Organization and functioning of Photosynthetic ETS in pro(bacteria and cyanobacteria) and eukaryotic organism **1L**
2. Determination of PSI and PSII efficiency using chlorophyll fluorescence kinetics and its significance **1L**
3. Influence of light and CO2 concentration on Photosynthesis(Light saturation curve, CO_2 response curve and CO_2 compensation point) **1L**
4. Photoprotection: role of enzymes, pigments and water-water cycle **2L**
5. Evolution of RUBISCO and PEP case **1L**
6. Schematic representation of fixation of atmospheric CO_2in C3,C4, C4- subgroups and CAM pathway(Home assignment), comparative account of C3,C4 and CAM pathway, C3-C4 intermediate pathway, CO_2 assimilation in Diatoms. CAM idling and cycling in desert and aquatic plants. **3L**
7. Partitioning of photosynthetic assimilate during vegetative and reproductive phase. **1L**
8. Regulation of photosynthesis in C3 and C4. **1L**
9. Comparative account of aerobic, anaerobic and cyanide resistant respiration and their significance. **1L**
10. Role of respiration in plant carbon balance **1L**
11. Modern concept of electron transport and ATP synthesis and inhibitors of respiration. **1L**

Credit-II: Post Harvest and Stress physiology **15L**

1. Post harvest physiology-ripening of fruits, storage of vegetables and flowers. **2L**
2. Stress Physiology: **8L**
   a) Biotic and abiotic stress: water, salt, temperature, biotic agents
   b) Responses and tolerance mechanisms
   c) Developmental and physiological mechanisms that protects plants in drought, flooding, salt, light and temperature stress(cold and high temperature) and stress from pathogenic microorganisms, insects and other organisms.

3. Case studies for improvement of stress tolerance by conventional and recombinant DNA technology. **3L**

4. Mechanism of action of herbicides, fungicides and bactericides. **2L**

REFERENCES:

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- Biology of Plants. American Society of Plant Physiologists Maryland, USA.
- Buchanan B.B, Gruissem W. and Jones R.L 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologistsm Maryland, USA.
- Concept in Photobiology; Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
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- Goodwin T.W., Mercer E.I. (1998) Introduction to Biochemistry. CBS Publishers, New Delhi.
- Heldt H. W. (2004) Plant Biochemistry. Academic Press, California.
- Hopkins W. G. 1995. Introduction to Plant Physiology. John Wiley and Sons, Inc., New York, USA
- Lawlor D.W. (2001) Photosynthesis in C3 and C4 Pathway. 3rd Ed. Viva. New Delhi.
- Leninger A.C 1987. Principles of Biochmistry, CBS Publishers and Distributers (Indian Reprint)
- Lincolin Taiz and Eduardo Zeiger (2010) Plant Physiology, Fifth edition. Sinauer Associates, Inc. Publishers. Sunder land, USA.
- Lodish H., Berk A., Zipursky S, L., Matsudaira P., Baltimore D and Darnell J. 2000. Molecular Cell Biology (Iv Edition) W. H. Freeman and Company, New York, USA.
- Metabolism (Second Edition) Longman, Essex, England.
- Moore T.C. 1989. Biochemistry and Physiology of Plant Hormones Springer –Verlag, New York, USA.
- Nelson David and Cox Michael. (2007) Lehninger Principles of Biochemistry.W.H.Freeman and Company. New York.
- Nobel P.S 1999. Physiochemical and Environmental Plant Physiology (Second Edition) Academic Press, San Diego, USA.
- Salibury F.B and Ross C.W 1992. Plant physiology (Fourth Edition) Wadsworth Publishing Company, California,USA.

- Singhal G.S., Renger G., Sopory, S.K. Irrgang K.D and Govindjee 1999. Concept in Photobiology; Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
- Lincolin Taiz and Eduardo Zeiger (2010) Plant Physiology, Fifth edition. Sinauer Associates, Inc. Publishers. Sunder land, USA.
- Thomas B. and Vince-Prue D. 1997. Photoperiodism in Plants (Second Edition) Academic Press, San Diego, USA.
- Verma S.K. and Verma Mohit 2007. A.T.B of Plant Physiology, Biochemistry and Biotechnology, S.Chand Publications.

M.Sc. II Botany Semester IV

BODT 243-Botany Paper 3

BODT-243 d) INDUSTRIAL BIOTECHNOLOGY

Credits: 02 (30 Lectures)

Credit I: Microbial Biotechnology: **(15L)**

1. **Biotechnology**: Scope and importance, Commercial potential of Biotechnology in India. Role of Biotechnology in Fermentation technology, Enzymes and Food supplements **2L**
2. **Microbial Biotechnology**:
   A. **Fermentation Technology**: A brief outline of processes for the production of some commercially important organic acids (Citric acid); amino acids (glutamic acid & tryptophan) and alcohols (ethanol & butanol), Primary metabolites & secondary metabolites: Vitamin production, B12, Riboflavin and β-carotene: occurrence, economic significance, biosynthesis, production process. toxins, antibiotics, Microbial Food : Fermentation processes in dairy and other food products: toffu, kaffir, cheese, buttermilk, yogurt, sour cream etc, Feed production, SCP, fats, amino acid, food additives **7L**

B. **Enzyme technology:** Microbes involved in enzyme production, Immobilization of enzymes, applications of enzymes: Therapeutic, analytical, Manipulative and Industrial. Biosensors and its types, Biochips: Principles and applications. **6L**

Credit II: Environmental Biotechnology: **(15L)**

3. Introduction, Scope and importance, Application of EB in Bioremediation, Biodegradation of Xenobiotics, bioaugmenatation, Bioleaching, Biofuels, Bioplastics, Biocatalysts and Bionanotechnology **2L**
4. **Bioremediation**: Introduction, types: *Insitu* Bioremediation: Intrinsic and Engineered, *Exsitu* Bioremediation: Solid phase treatment, Composting, Composting process, Slurry phase treatment, Aerated lagoons, LSARs. **2L**
5. **Bioremediation of industrial wastes**: types of wastes , role of microorganisms, Bioremediation of heavy metals : Adsorption, Complexation, precipitation, Volatilization, biosorption, role of Am fungi in bioremediataion. **3L**
6. **Bioremediation of other wastes**: Introduction, objectives and pathways of degradation of Xenobiotics, Hydrocarbons, Bioaugmentation, Bioleaching and Biofilteration. **3L**
7. **Nano-Bioremediation**: Applications of Nanomaterials as an effective sorbents, Nanofilteration, Nanocatalysis, use of magnetic nanoparticles in bioremediation. **3L**
8. **Bioplastic in Environment protection**: Definition, sources and types and uses. **2L**

Suggested readings:

1. R. C Dubey. A Textbook of Biotechnology. S. Chand Publications.
2. B.D. Singh. Fundamentals of Biotechnology. Kalyani Publications
3. Peter F. Stanbury, Allen Whitaker, Stephen J. Hall. Principles of Fermentation Technology Second Edition Elsevier Science Ltd

4. Michael J. Waites, Neil L. Morgan, John S. Rockey Gary Higton. Industrial Microbiology: An Introduction. Blackwell Science Ltd
5. M Nduka Okafor odern Industrial Biotechnology & Microbiology., SCIENCE PUBLISHERS, Edenbridge Ltd.,
6. H.J. Peppler and D. Perlman. Microbial Technology .Vol 1&2 . Academic Press.
7. L E Casida Jr. Industrial Microbiology. John Wiley and Sons Inc.
8. Wulf Cruger and Anneliese Cruger, "A Textbook of Industrial Microbiology",Panima Publishing Corporation
9. Michael J. Waites, Neil L.Morgan, John.S. Rockey and Grey Higton, "Industrial Microbiology": An Introduction, Blackwell science publishing house.
10. Presscott. Dunn, "Industrial Microbiology", Agrobios (India).Trevor Palmer "Enzymes", Affiliated East West Press Pvt Ltd, New Delhi,2004
11. Harvey W. Blanch, Douglas S. Clark, "Biochemical Engineering", Marcel Dekker Inc, 1996
12. James M. Lee, "Biochemical Engineering", PHI, USA, 1992
13. James. E. Bailey & David F. Ollis, "Biochemical Engineering Fundamentals", McGraw Hill, 1986
14. Christ of M.Niemeyer,Chad A.Mirkin, "Nanobiotechnology: Concepts", Applications and Perspectives, (eds.), Wiley-VCH, Weinheim, (2004)
15. Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, "Nanotechnology: basic science and emerging technologies" , Overseas Press (2005)
16. B. Roszek,, W.H. de Jong, and R.E. Geertsma: "Nanotechnology in medical applications": state-of-the-art in materials and devices (2005)
17. Tuan Vo-Dinh, "Nanotechnology in Biology and Medicine": Methods, devices and applications, ISBN no. 1249329494
18. Mark Ratner and Daniel Ratner, "Nanotechnology - A Gentle Introduction to the Next Big idea", Pearson Education, Inc.2005
19. Handbook of "Nanostructured Biomaterials and Their Applications in Nanobiotechnology" - Hari Singh Nalwa

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M.Sc. II Botany Semester IV

BODT- 243: BOTANY THEORY PAPER 3 (2 Credit)

BODT- 243: e) SEED TECHNOLOGY

(30 Lectures)

Credit 1= **15 lectures**

1. **Field Inspection:** 2 **L**
   - Seed inspector, powers and duties
   - Number of inspection with reference to stage of crop
   - Procedure and observations during field inspection
2. **Seed Pathology:** **4 L**

- Definition
- Mechanism of seed transmission and entry point of seed infection (soil, air, insect and nematodes)
- Quarantine for seed
- Integrated management of seed borne diseases
- Seed health testing methods

3. Seed entomology: 3 L

- Relation of insects and plants
- Pest of fibre crop, pulses, vegetable and storage grain pest (Any one example from each) with respect to their life cycle, way of infestation and control measures (Physical, Chemical and Biological)

1. **Seed Processing: 6 L**
    1. Objectives of seed processing
    2. General layout of seed processing unit
    3. Steps in Seed Processing (Receiving, Drying, Pre-cleaning, Grading, Treatment, weighing, Packing and Storage)
    4. Study of Seed processing machineries and its working:
        1. Pre-cleaners
        2. Scalper, Debearder and Huller
        3. Seed dryers
        4. Air screen cleaner
        5. Specific gravity separator
        6. Magnetic separator
        7. Colour separator

Credit 2= 15 lectures

1. Seed treatment: 2 L

- Importance
- Seed treating equipment- slurry, mist-o-matic and drum mixer.
- Chemicals used and precautions in seed treatment.

2. Packaging and handling of seeds 4 L

- Bagger weighed machine
- Automatic packing machine
- Material used for packing
- Handling of seeds: Conveyor and Elevators
- Precautions during packaging

3. Seed Deterioration and Seed Storage: 4 L

- Definition, manifestation and causes of seed deterioration.
- Prevention measures of seed deterioration.
- Definition of seed storage
- Factors affecting seed storage
- Ideal ware house for seed storage, sanitation, fumigation and dehumidification
- Cold storage

4. Seed legislation: 2 L

- Seed legislation in India

- Types of seed legislation.

5. Seed Certification and Quality Control: 3 L

- General procedure for seed certification
- Seed certification Board, Central Seed committee and their functions.
- Minimum seed certification Standards (Field and Seed)

Suggested Readings:

1. Ovcharov, K.E. 1977. Physiological Basis of Seed Germination. Amerind Publishing Co., New Delhi and New York.
2. Thompson, J.R. 1977. Advances in Research and Technology of Seeds. Part - 1, 3 & 4. Centre for Agrl. Publishing and Documentation, Washington.
3. Anonmyous. 1997. Seed Technology in Tropics. ISTA Zurich.
4. Sinclair, T.R. and F.P. Gardner. 1997. Principles of Ecology in Plant Production, CAB international, G.K.
5. Rai. M. and S. Mauria. 1995. Hybrid Research and Development. Indian Society of Seed Technology. IARI. New Delhi.
6. Agrawal, R.L. 1996. Seed Technology, IBH publishing Co., New Delhi.
7. Mayer, A.M. and A.P. Mayber. 1989. Germination of Seeds. Pergamon Press, Oxford.
8. Desai. B.B., P.M Kotecha and D.K. Salunkha. 1997. Seeds Hand Book - Biology Production, Processing and Storage. Marcel Dekker. New York.
9. Khairwal. P.S., C. Ram and A.K. Chabra. 1997. Pearl millet Seed Production and Technology. Manohar book service, New Delhi.
10. Jaima Kigel, J. and G. Galili. 1997. Seed Development and Germination. Marcel Dekker, New York.
11. Bewley, J.D. and M. Black. 1982. Physiology and Biochemistry of Seeds in relation to Germination, Vol. I & II. Springer Verlag, Berlin, Heidelberg, New York.
12. Justice, O.L. and L.N. Basu. 1978. Principles and Practices of Seed Storage. Castle House Publications Ltd, Great Britain.
13. Khan, A.A. 1977. The Physiology and Bio-chemistry of seed Dormancy and Germination. North Holland Publishing Co., Amsterdam, New York.
14. Kozlowski, T.T. 1972. Seed Biology, Vol. 1 Academic Press, London.
15. Purseglove, J.W. 1977. Tropical crops of Monocotyledons, Longmans, Green and Co., Ltd., London.

M.Sc. II Semester IV

BODT 244 Botany Theory paper 4

BODT 244 a) Plant Tissue Culture Technology

(2 CREDITS) (30 Lectures)

Credit I: In vitro culture **15 L**

- Totipotency of plant cells, de- and re-differentiation, Organogenesis and somatic embryogenesis, *In vitro* responses of plant cells, tissue and organs- effect of source of explants, nutrient medium constituents, growth regulators and environmental factors. **4L**

- Protoplast culture, somatic hybridization and cybridization, applications. **3L**
- In vitro production of haploids and their applications **2L**
- Physiological and genetic basis of somaclonal variation and their applications **2L**
- Case studies– Banana and Sugarcane: Stages of micro propagation, Factors affecting micro-propagation, Merits and demerits of in vitro propagation, **3L**
- Ex-situ conservation of germplasm **1L**

Credit II: In vitro production of secondary metabolites and genetic transformation **15L**

- Screening and selection of high secondary metabolite producing cell lines. **1L**
- Standardization of Culture media, immobilization of cells, elicitation using biotic and abiotic elicitors, Biotransformation **3L**
- Case studies for production of secondary metabolite: Scaling up and use of Bioreactor **2L**
- Genetic transformation of plants - transfer of foreign DNA into host plant tissues using *Agrobacterium* based vectors, *m*echanism of integration of DNA into plant genomes. **3L**

- Factors affecting transformation, Screening and analysis of transformants.

3L

- Direct DNA transfer to plants – Electroporation, biolistic transfer **2L**
- Modifications of plant secondary metabolism by genetic engineering: case studies

1L

M.Sc. II Semester IV

BODT 244 Botany Theory paper 4

BODT 244 b) Herbal Technology

(2 CREDITS) (30 Lectures)

Credit I: **15L**

a) Herbal Technology: Definition, concept and prospects. 1L

b) Herbal medicines: history and scope, role of medicinal plants in Ayurveda, Siddha, Unani and Homeopathy, Medicinal plant as source of alkaloids, flavonoids, glycosides, tannins, phenolics, 4L

c) Selection, identification and authentication of herbal materials for medicine. 1L

d) Processing of herbal raw material 1L

e) Preparation and standardization of Ayurvedic formulations viz Aristas, Asawas, Ghutika,Churna and Bhasma. 3L

f) Herbal cosmetics: Study and description of herbal plants used in products such as skin care, hair care, dyes,aromatic oil and oral hygiene products via fixed oils, waxes, gums colours, perfumes, protective agents, bleaching agents, antioxidants. 5L

Credit II **15L**

a) Herbal Nutraceuticals: Medicinal mushrooms for human health, Phytochemicals as nutraceuticals, herbs as a source of dietaryfibre, Probiotics, Prebiotics, polyunsaturated fatty acids, antioxidant, vitamins, polyphenols, proteins, amino acids, carotenoids. 5L

b) Evaluation of Drugs: WHO and International Council of Harmonization (ICH) guidelines for the assessment of herbal products, Guidelines of Materia Medica and Charak Samhita. Stability testing of herbal drugs. 3L

c) **Herbal drugs industry**: Present scope and future prospects. A brief account of plant based industries and institutions involved in work on medicinal and aromatic plants in India. 2L

d) **Packaging of Herbal Products:**Introduction of concept and need of packaging, Classification of Herbal Products: Classification based on product texture- dry, liquid, emulsion, aromatic oils, Classification based on product usage- cosmetic, edible, nutraceutical, pharmaceutical 3L

e) **Patenting and Regulatory requirements of natural products:** Definition of the terms: Patent, IPR, Farmers right, Breeder's right, Bioprospecting and Biopiracy. Patenting aspects of Traditional Knowledge and Natural Products. Case study of Curcuma & Neem. 2L

Suggested readings:

Agarwal, S.S. and Paridhavi, M., Herbal Drug Technology Universities Press, Pvt Limited, 2007.

Ambasta SP (1986) Useful Plants of India. CSIR, Delhi.

Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.

Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH publishing Co.

Bogers RJ, Craker LE, Lange D (2006) Medicinal and Aromatic Plants: Agricultural, Commercial, Ecological, Legal, Pharmacological and social aspects. Springer

Chowdhary V (2014) Fundamentals of food processing, packaging, labeling and marketing. Anmol Publications, Pune

Daniel, M., Herbal Technology: Concepts and Advances Satish Serial PublishingHouse, 2008.

Deshmukh LP (2013) Medicinal Plants of India. Oxford Book Co., New Delhi

Drury CH (2006) Ayurvedic Useful Plants in India. Asiatic Publishing House, New Delhi.

Evans, W.C., Trease and Evans Pharmacognosy 15th Edition, Elsevier HealthSciences, 2001.

Glossary of Indian medicinal plants, R.N. Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.

Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.

Hoffmann F, Manning M (2009) Herbal Medicine and Botanical Medical Aids. Viva Books. New Delhi.

Indian System of Medicine and Homeopathy, Planning and Evaluation Cell, Govt.of India, New Delhi, 2001.

Maheshwari JK, Kunkel G, Bhandari MM, Duke J (1993) Ethnobotany in India. Scientific Publishers. Jodhpur, Rajashtan.

Nadkarni KM (2002) Indian Materia Medica Vol. I and II. Popular Prakashan, Mumbai

Pal DC, Jain SK (1998) Tribal medicine. Naya Prakash Publication, New Delhi

Pharmacognosy, Dr.C.K.Kokate et al. 1999. Nirali Prakashan.

Principles of Ayurveda, Anne Green, 2000. Thomsons, London.

Pulok K. Mukherjee., Quality control of Herbal DrugsReprintedn, Business Horizons, New Delhi, 2012.

Quality Control Methods for medicinal plant material, WHO Geneva, 1998

Roseline A (2011) Pharmacognosy. MJP Publishers, New Delhi.

The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.

Wallis, T.E., Textbook of Pharmacognosy 5th Edition, CBS Publishers and Distributors, 2005.

Yoga- The Science of Holistic Living by V.K.Yoga, VKY Prakashna Publishing, Bangalore, 2005.

M.Sc. II Semester IV

BODT 244 Botany Theory paper 4

BODT 244 c) Research Methodology (2 CREDITS) (30 Lectures)

Credit I **15L**

Unit I: Basic Concepts of Research ` **8 L**

Research definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical). Research methods vs methodology. Literature-review and its consolidation; Library research; field research; laboratory research.

Unit II: Data Collection and Documentation of Observations **7 L**

Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissue, specimens and application of scale bars. The art of field photography.

Credit II:

Unit III: Overview of Biological Problems **8 L**

History; Key biology research areas, Model organisms in biology (A brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics-Transcriptional regulatory network.

Unit IV: Ethics and Good Practical's and Art of Scientific Writing **7 L**

Authors, acknowledgements, reproducibility, plagiarism, Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Power-point presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.

Suggested Readings

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Ruzin, S. E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.

M. Sc II Botany

BODP 243 Botany Practical paper

BODP 243 based on BODT 243 a) Applied Mycology (2Cr)

Sr. No	Title of practical (Any 12 practical)	No.
1	Study of plant diseases with reference to histopathology of symptoms, causal organisms of – Any four downy & powdery mildews of crops of local importance, any 3 leaf spot diseases & any 4 rusts & Smuts of local significance.	5
2	Study of any 3 diseases of forest plants for eg. Powdery mildews, rots, spots etc.	1
3	Study of any 6 post harvest diseases or market pathogens of local market.	1
4	Isolation of any 6 seed borne fungi from cereals, pulses, & oil seed crops.	2
5	Cultivation of wheat straw mushroom Pleurotus	2
6	Isolation any one mycorrhizal fungi &trichoderma as biofertilizer.	1
7	Biodeterioration of any 3 inorganic materials & any 4 foods spoilage fungi.	1
8	Isolation of any 1 plant pathogen to study Koch's postulates.	1
9	Study of any 4 fungal industrial metabolites/ antibiotics with their importance.	1

Note: 1. Compulsory visit to mushroom industry &biofertilizer production unit& submission of report.

M. Sc II Botany Semester IV

BODP 243 Botany Practical paper

BODP 243 based on BODT 243 b) Advanced Medicinal Botany (2Cr)

Sr. No	Title of practical (Any 12 practical)	No.
1	Identification of with the help of organoleptic and microscopic evaluation techniques	2
2	Percentage extractives and fluorescence analysis of drugs	1
3	Determination of ash values of drugs	1
4	Histochemical studies of drugs	1
5	Biological activity of any two drugs	2
6	Estimation of alkaloids from suitable medicinal plants	1
7	Estimation of glycosides from suitable medicinal plants	1
8	Extraction of essential oils from suitable medicinal plants	1
9	Estimation of oleoresin from suitable medicinal plants	1
10	Preparation of herbal cosmetics and foods	2
11	Visit to any two pharmaceutical industries and submission of report	1
12	Field visit to study ethnobotany and preparation of report	1

Note:
1. At least one short and one long study tour be arranged for studying medicinal plants and to explore ethnobotanical data. Students must submit the tour report and ethnobotanical data during practical examination.
2. Student must carry out detailed pharmacognostic investigation of at least one drug and should submit a report at the time of practical examination as a project.

M. Sc II Botany Semester IV

BODP 243 Botany Practical paper

BODP 243 based on BODT 243 c) Plant Physiology (2Cr)

Sr. No	Title of practical (Any 12 practical)	No.
1	Estimation of chlorophylls and carotenoids.	1
2	Study of effect of abiotic factors on activity of RuBisco/PEPcase enzyme.	1
3	Separation of pigment using column Chromatography. Determination of absorption spectra of each pigment.	2
4	Demonstration of Hill Reaction.	1
5	Effects of auxins and cytokinin's or gibberellins on growth	1
6	Measurement of CO_2 uptake using IRGA (Demonstration).	1
7	Screening of cultivars for biotic and abiotic stress tolerance using in vitro technique.	1
8	Determination of secondary metabolite.	1
9	Estimation of ascorbic acid in ripe and unripe fruits.	1
10	Measurement of respiration using oxygen electrode (demonstration).	1
11	Enzyme assays – extraction and estimation of enzyme activity- Catalase/acid phosphatase/ amylase/lipase/peroxidase (Any one).	1
12	Estimation of total amino acid in germinating and non germinating seed.	1
13	Separation of flavonoids using chromatography.	1
14	Estimation of MDA content.	1

M. Sc II Botany Semester IV

BODP 243 Botany Practical paper

BODP 243 based on BODT 243 d) Industrial Biotechnology (2Cr)

Sr. No	Title of practical (Any 12 practical)	No.
1	Isolation of *Aspergillus niger* from a suitable medium and its maintenance in pure culture.	2
2	Inoculation of Spore suspension of *Aspergillus niger* on a fermentation medium to prepare citric acid broth	1
3	Estimation of citric acid by Spectrophotometric and titration method	1
4	Recovery of citric acid from fermentated broth.	1
5	Fermentative production of Ethanol	2
6	Demonstration practical on microbial food.	1
7	Study of Biosorption using suitable sample	1
8	Demonstration practical on Biosensors and Biochip	1
9	Study of preparation of Biolastic using suitable material	1
10	Demonstration of various nano materials used in bioremediation	1

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.M. Sc II Botany Semester IV

BODP 243 Botany Practical paper

BODP 243 based on BODT 243 e) Seed Technology (2Cr)

Sr. No	Title of practical (Any 12 practical)	No.
1	Detection and identification of important seed borne fungi by various detection methods- washing, agar and blotter method	2
2	Detection and identification of seed borne bacteria	2
3	Study of important Pest of fibre crop, pulses, vegetable and storage grain (Any two example from each), with reference to their life cycle, damage and control measures	2
4	Demonstration of seed processing and treating equipments	2
5	Demonstration: Aids for varietal identification and Preparation of artificial seed	2
6	Collection, submission of crops and storage pests, different seed varieties of any three-crop plants	2
7	Visit to any two Seed industries and submission of report	2

M. Sc II Botany Semester IV

BOUP 244 Botany Practical paper / PG Dissertation based on BOUP 244

BOUP 244 based on BODT 244 a) Plant Tissue Technology (2Cr)

Sr. No	Title of practical (Any 12 Practical)	No.
1	Study of different Laboratory instruments used in Plant Tissue culture Laboratory	1
2	Study of different sterilization techniques used in Plant tissue culture	1
3	Preparation and sterilization of MS- medium	1
4	Study of different growth regulators and their role in PTC	1
5	Study of dedifferentiation of a suitable plant tissue to induce callus	2
6	Study of *invitro* production of haploid using suitable plant material	2
7	Study of the method of isolation of protoplast from suitable plant material for somatic hybridization	1
8	Study of production of secondary metabolites from suitable plant material using callus culture and qualitative estimation of the secondary metabolites	2
9	Studies on use of any one Biotic/Abiotic elicitor for enhancement of secondary metabolite production through Callus culture	1
10	Visit to any Commercial tissue culture laboratory and write a case study report.	1
11	Visit to *Ex situ Germplasm Bank* and write a visit report.	1
12	Studies on methods of DNA transfer in plant cell (Demonstration)	1

M. Sc II Botany Semester IV

BOUP 244 Botany Practical paper / PG Dissertation based on BOUP 244

BOUP 244 based on BODT 244 b) Herbal Technology (2Cr)

Sr. No	Title of practical	No.
1	To perform preliminary phytochemical screening of crude drugs.	2
2	Determination of Ash value and moisture content of crude drugs	1
3	Determination of the alcohol content of Asava and Arista.	2
4	Preparation of any one herbal cosmetics.	2
5	Preparation and standardization of any oneherbal formulation.	2
6	Monograph analysis of herbal drugs from recent Pharmacopoeias	1
7	Analysis of fixed oils.	1

8	Study of different processes of packaging of dry,liquid and aromatic herbal products.	1
9	Market study of herbal products- cosmetics, medicines, nutraceuticals.	1
10	Visits to industry related to herbal products and quality testing centres related to herbal products.	2

M. Sc II Botany Semester IV

BOUP 244 Botany Practical paper (2Cr)

OR PG Dissertation (2Cr)

BOUP 244 based on BODT 244 c) Research Methodology (2Cr)

Sr. No	**Title of practical (Any 12 Practical)**	**No.**
1	Experiments based on chemical calculations.	1
2	Plant microtechnique experiments.	1
3	The art of imaging of samples through microphotography and field photography.	1
4	Poster presentation on defined topics.	1
5	Technical writing on topics assigned.	1
6	Identification of different type of research in day by day life	1
7	Testing of a formulated hypothesis with type I and type II errors	1
8	Curation of relevant scientific literature from Google Scholar, NCBI PubMed etc	1
9	Poster presentation on defined topics	1
10	Demonstration for checking of plagiarism using recommended software	1
11	Technical writing on topics assigned.	1
12	More Practical may be added depending on the local habitats and available facilities	1

M. Sc II Botany Practical Paper (4 CR)

BOUP 245 based on BOUT 241 and BOUT 242

Sr. No	Title of practical	No.
	BOUT 241 Botanical Techniques (Any 12 Practical)	
1	Use of flurochromes to visualize specific cell components	1
2	Micrometry	2
3	Maceration technique	1
4	Electrical conductivity and pH measurements	1
5	Absorption spectra of BSA/DNA and determination of absorption maxima	1
6	Rocket immune electrophoresis	1
7	Separation of leaf pigments by paper chromatography and TLC	1
8	Separation of isozymes by native polyacrylamide gel electrophoresis	2
9	Microtomy- Processing, double staining, sectioning	2
10	Cytochemical analysis- Nucleus, Golgi bodies, Mitochondria	2
11	Databases and database searching and DNA and protein sequence comparison	1
	BOUT 242 Plant Ecology Ecology (Any 12 Practical, 15th is compulsory)	
1	Study of phytoplanktons and macrophytes from clean and polluted water bodies	1
2	Estimation of chlorides and alkalinity of the water sample	1
3	Prepare shoot/canopy profile of tree stand along the line transect.	1
4	Remote sensing techniques for vegetation/ plant diversity assessment using satellite imagery and aerial photographs	2
5	Methods for estimating above-ground biomass for carbon pool assessment	1
6	Find out various diversity indices with the help of computer software.	1
7	Find out the Simpson's Index of Dominance.	1
8	Find out the β-diversity, similarity and dissimilarity indices.	1
9	Comparison of stomatal index and pollen fertility of any two plants from polluted and non-polluted areas	1
10	Compare protected and unprotected herbaceous stand using community coefficients (similarity indices).	1
11	To find out relationship between two ecological variables using correlation and regression analysis.	1
12	To estimate dissolved oxygen content in eutrophic and oligotrophic water samples by azide modification of Winkler's method.	1
13	To determine percent soil organic carbon and organic matter in soils of cropland, grassland and forest.	1
14	To find out association between important herbaceous species using Chi-square test.	1
15	Visit to different types of ecosystems to understand the species composition and diversity (plateaus/grasslands/forests/wetlands/deserts/mangroves)	1

Note: A survey of a part of the town or city should be carried out by the entire class in batches. Individual student will select one avenue/road and locate the trees planted on the graph paper. They will identify the trees, mention their size, canopy shape, flowering and fruiting period and their status (healthy, diseased, infested, misused or dying) and report the situation of plants. (The purpose of this exercise is to make the students aware of the kinds of trees and value in urban ecosystem and ecological services.) Submission of report on this survey will be assessed and marks out of 15 will be added as internal marks.

Savitribai Phule Pune University

(Formerly University of Pune)

Two Year Degree Program in Botany

(Faculty of Science & Technology)

Revised Syllabi for

M.Sc. (Botany) Part-I

(For Colleges Affiliated to Savitribai Phule Pune University)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2019-2020

Title of the Course: M.Sc. Botany

Preamble :

M Sc Botany program is designed with an objective to encourage and support the growing demands and challenging trends in the educational scenario. Our training focuses on the all-round development of the students to face the competitive World.

OBJECTIVES OF THE M SC BOTANY PROGRAMME:

1. Understand the scope and significance of the discipline.
2. Imbibe love and curiosity towards nature through the living plants.
3. In order to make students open-minded and curious, we try our best to enhance and develop a scientific attitude.
4. We make the students fit for the society by enabling them to work hard.
5. Make the students exposed to the diverse life forms.
6. Make them skilled in practical work, experiments, laboratory equipment and to interpret correctly on biological materials and data.
7. Develop interest in Biological research.
8. Encourage the students to do research in related disciplines.
9. Develop a thirst to preserve the natural resources and environment.
10. Develop the ability for the application of acquired knowledge in various fields of life so as to make our country self-sufficient
11. Appreciate and apply ethical principles to biological science research and studies

PROGRAM SPECIFIC OUTCOMES (PSO) OF MSc BOTANY:

Plant science is now an amalgamation of basic and applied science. Plants besides being the unique capability of plants to trap solar energy and provide food to all cannot be replicated by any system. Conventional studies like plant identification are now being supplemented with molecular techniques like DNA Barcoding. The courses have been designed to benefit all Botany students to study various aspects of plant science including its practical applications. Keeping in mind that these students can take up teaching at different levels, research work in research institutes and or industry, doctoral work,

environment impact assessment, biodiversity studies, entrepreneurship, scientific writing relevant topics have been included in the curriculum.

PSO 1: Understanding the classification of plants from cryptogams to Spermatophyte. Identification of the flora within field enhances basics of plants. Study of biodiversity in relation to habitat will correlates with climate change, land and forest degradation. Application of Botany in agriculture is through study of plant pathology.

PSO 2: Understand the ultra structure and function of cell membranes, cell communications, signaling, genetics, anatomy, taxonomy, ecology and plant Physiology and biochemistry. To understand the multi functionality of plant cells in production of fine chemicals and their wide spread industrial applications.

PSO 3: Molecular and Physiological adaptations in plants in response to biotic and abiotic stress. Genes responsible for stress tolerance genetic engineering of plants.

Structure for M. Sc. Botany First Year:

Year	Semester	Course Type	Course code	Course Name	Credits
1	1	Core Compulsory Theory paper	BOUT 111	Botany Theory Paper 1-Plant Systematics I	4
			BOUT 112	Botany Theory Paper 2- Cell Biology and Evolution	4
			BOUT 113	Botany Theory Paper 3- Cytogenetics and Plant Breeding	4
		Choice Based optional paper	BODT 114	Botany Theory Paper 4- a) Biofertilizer and Algal Technology OR b) Pomoculture and Fruit Processing Technology	2
			BODP 114	Botany Practical Paper 4-based on BO 114	2
		Core Compulsory practical paper	BOUP 115	Botany Practical Paper based on BOUT 111, BOUT 112 and BOUT 113	4
1	2	Core Compulsory Theory paper	BOUT 121	Botany Theory Paper 1-Plant Systematics II	4
			BOUT 122	Botany Theory Paper 2- Molecular Biology	4
			BOUT 123	Botany Theory Paper 3- Biochemistry	4
		Choice Based optional paper	BODT 124	Botany Theory Paper 4- a. Floriculture and Nursery Management OR b. Mushroom Cultivation and Biopesticide Technology	2
			BODP 124	Botany Practical paper 4- based on BODP 124	2
		Core Compulsory practical paper	BOUP 125	Botany Practical paper based on BOUT 121, BOUT 122 and BOUT 123	4

Semester I

BOUT 111: Botany Theory Paper I-Plant Systematics I

(4 Credit- 60 Lectures)

Credits-1.5: Algae **22 Lectures**

1. Systematics and Taxonomy – Principles, Concept of species and hierarchical taxa, Classification of algae up to order level as per Fritsch system (1935). **3 L**
2. Algological studies – Algal habitats, Pigment constitution in algae, Reserve food, Modes of perennation in algae, Origin and evolution of sex, Contribution of algal studies in India and world (any three Phycologists). **4 L**
3. Cyanophyta – Distinguishing characters, thallus organization, ultra-structure of heterocyst and its significance. **3 L**
4. Chlorophyta- Thallus organization, reproduction – asexual and sexual **3 L**
5. Introduction, Comparative structure and reproduction in Charophyta, Euglenophyta, Xanthophyta, Bacillariophyta and Chrysophyta. **4 L**
6. Phaeophyta and Rhodophyta–Morphology, Reproduction and life cycle pattern in any one from each. **3 L**
7. Applications of algae- Commercial applications of algae- Biofertilizer, Medicine, and Pollution. **2 L**

Credit-1.5: Fungi **23 Lectures**

1. Thallus structure, Nutrition, Cell structure, Hyphal modifications in Fungi. Classification of fungi as per Ainsworth et al system (1973), Contribution of fungal studies in India and world. **3 L**
2. Myxomycotina- Distinguishing characters, types of Plasmodium and fruit bodies, Life cycle pattern **3L**
3. Mastigomycotina- Distinguishing characters, Thallus structure in Chytridiomycetes and Oomycetes. **3 L**
4. Zygomycotina - Distinguishing characters, Thallus structure, Heterothallism and sexual reproduction. **3 L**
5. Ascomycotina- Thallus structure, Fructifications, Comparative study of Hemiascomycetes and Euascomycetes. **3 L**

6. Basidiomycotina – Distinguishing characters, thallus structure, types and structure of basidia and basidiocarps. **3 L**
7. Deuteromycotina – Distinguishing characters, thallus structure, fructifications, types of conidia, conidial ontogeny. **3 L**
8. Applications of fungi- Biofertilizers, biocotrol, food and medicine. **2L**

Credit -1: Bryophytes **15 Lectures**

1. Introduction, characters, Affinities with thallophytes and pteridophytes,Contributions of bryologists in world and India (any three), system of classification according to G.M. Smith 1955. Pteridophytean and algal hypothesis, evolution of sporophyte, theory of sterilization and reduction, apogamy and apospory. **3 L**

2. Distribution, Distinguishing characters, morphology and anatomy of gametophyte and sporophytes of following orders **11 L**

Takakiales, Calobryales and Sphaerocarpales (1L), Marchantiales (1L), Jungermanniales (2L), Anthocerotales (1L), Sphagnales (1L), Polytrichales (1L), Funariales (1L), Andreaeales (1L), Eubryales (2L).

3. Applications of bryophytes- Antimicrobial properties, secondary metabolites, therapeutical, horticultural applications. **1 L**

References:

Algae:

1. Brodie J. and Lewis J. (2007). (Ed.) Unravelling the algae: the past, present and future of algal systematics. CRC press, New York, pp 335.
2. Bellinger E.G. and Sigee D.C. (2010). Freshwater algae: Identification and use as bioindicators, Willey-Blackwell, UK, pp. 271.
3. Cole K.M. and Sheath R.G. (1990). Biology of the red algae. Cambridge University Press.USA. pp. 503.
4. Desikachary T.V. (1959). Cyanophyta. ICAR, New Delhi.
5. Graham L.E. and Wilcox L.W. (2000). Algae.Penticce-Hall,Inc, pp. 640
6. Krishnamurthy V. (2000). Algae of India and neighboring countries I.Chlorophycota, Oxford & IBH, New Delhi.
7. Lee R.E. (2008). Phycology. Cambridge University Press, pp.547.
8. Misra J.N. (1996). Phaeophyceae in India. ICAR, New Delhi.
9. Prescott G.W. (1969). The algae.
10. Smith G.M. (1950). The fresh water algae of the United States, Mc-graw Hill

NewYork.

11. Srinivasan K.S. (1969). Phycologia India.Vol.I & II, BSI, Calcutta.
12. Das Dutta and Gangulee.College Botany Vol I, Central Book Depot.
13. Vashista B.R, Sinha A.K and Singh V.P. (2005). Botany for degree students – Algae, S. Chand's Publication.
14. Sharma O.P. Algae

Fungi :

1. Ainsworth, Sussman and Sparrow (1973). The fungi. Vol IV A & IV B. Academic Press.
2. Alexopolous C.J., Minms C.W. and Blackwell M. (1999). (4th edn) Introductory Mycology. Willey, New York, Alford
3. R.A.Deacon J.W. (2006). Fungal Biology (4thEd.) Blackwell Publishing, ISBN. 1405130660.
4. Kendrick B. (1994). The fifth kingdom (paperback), North America, New York Publisher: 3rd edn, ISBN- 10: 1585100226.
5. Kirk et al. (2001). Dictionary of fungi, 9th edn, Wallingford: CABI, ISBN: 085199377X.
6. Mehrotra R.S. and Aneja K.R. (1990). An introduction to mycology. New Age Publishers, ISBN 8122400892.
7. Miguel U., Richard H., and Samuel A. (2000). Illustrated dictionary of the Mycology.Elvira Aguirre Acosta, Publisher: St. Paul, Minn: APS press, ISBN 0890542570.
8. Webster J. and Rpland W. (2007). Introduction to fungi (3rd Edn) Cambridge UniversityPress,978-0-521-80739-5.

Bryophytes:

1. Cavers F. (1976). The interrelationships of the Bryophytes. S.R. Technic, Ashok Rajpath, Patana.
2. Chopra R.N. and Kumar P.K. (1988).Biology of Bryophytes. John Wiley & Sons, New York, NY.
3. Kashyap S.R. (1929). Liverworts of the Western Himalayas and the Punjab Plain.Part 1, ChronicaBotanica, New Delhi.
4. Kashyap S.R. (1932). Liverworts of the Western Himalayas and the Punjab Plain (illustrated): Part 2. ChronicaBotanica, New Delhi.
5. Parihar N.S. (1980). Bryophytes: An Introduction to Embryophyta. Vol I. Central

Book Depot, Allahabad.

6. PremPuri(1981). Bryophytes: Morphology, Growth and Differentiation. Atma Ram and Sons, New Delhi.
7. Udar R. (1975). Bryology in India.ChronicaBotanica, New Delhi.
8. Udar R. (1970). Introduction to Bryophytes.ShashidharMalaviyaPrakashan. Lucknow.
9. Watson E.V. (1971). Structure and Life of Bryophytes.3rd Edn. Hutchinson University Library, London.
10. Vashista B.R., Sinha A.K., Kumar A. (2008). Botany for degree students – Bryophyta, S.Chands Publication.

Semester I

BOUT 112: Botany Theory Paper II- Cell Biology and Evolution

(4 Credit- 60 Lectures)

Credit-I : Dynamic organization of the cell **15 L**

1. Universal features of cells: cell chemistry and biosynthesis, chemical organization of cells. 1L
2. Internal organization of the cell:
   - i. Cell Wall**:** Biogenesis, Ultra Structure and functions, primary and secondary wall, glycocalix. 1L
   - ii. Cell membrane: structure of cell membranes and concepts related to compartmentalization in eukaryotic cells. 1L
   - iii. Biogenesis, ultra structure and functions of endoplasmic reticulum and Golgi apparatus, lysosomes, vacuoles, glyoxysomes and peroxisomes, ribosomes, cellular cytoskeleton, mitochondria, chloroplasts and cell energetics; nuclear compartment: nucleus, nucleolus and chromosomes . 10L
   - iv. Giant chromosomes- lampbrush chromosomes, polytene chromosomes 2L

Credit-II : Cellular signaling, transport and trafficking **15L**

1. Types of receptors, G-proteins and G-protein coupled receptors, Phospholipid signaling, $Ca^{2}+$, Calmodulin cascade. 2L
2. Diversity in protein kinases and phosphatases, secondary messengers,

regulation of signaling pathways. 2L

3. Specific signaling mechanisms with suitable examples- Biotic and abiotic stress, ABA induced stomatal closure, Stomatal guard cells signaling. 3L
4. Receptor Serine/ Threonine kinase, Ethylene mediated two component systems. 1L
5. Molecular mechanisms of membrane transport, nuclear transport, transport across mitochondria and chloroplasts; intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior. Communication between cells and environment. 4L
6. Signaling at cell surface, signaling molecules, hormones and receptors signaling pathways that control gene activity, signal transduction and second messengers. 3 L

Credit-III : Cellular Processes **15L**

1. Cell cycle and its regulation; cell division: mitosis, meiosis and cytokinesis; cell differentiation: stem cells, their differentiation into different cell types and organization into specialized tissues. 3 L
2. Phases of cell cycle, functional importance of each phase, Molecular events during cell cycle, Regulation of cell cycle, Cyclins and protein kinase, MPF (Maturation promoting factor). 4 L
3. Method of study of cell cycle- labeled mitotic curve, flow cytometry, use of mutants, Cell aging and cell senescence. 4 L
4. Programmed cell death-molecular aspects, regulation of cell death, PCD in response to stress, Apoptosis- Role of different genes, cell organelles during apoptosis, genetic control of apoptosis. 4 L

Credit-IV (1 Cr): Evolution **15 L**

1. Theories of Evolution: (3 L)

Steps and preview of evolution, Lamarckism, Darwinism- Concepts of variation, adaption, struggle for fitness and natural selection; Neo-Darwinism, Spontaneity of mutations, the evolutionary synthesis,

2. Origin of cells and cellular evolution:(3L)

Origin of basic biological molecules, abiotic synthesis of organic monomers and polymers, Concepts of Oparin and Haldane, Experiment of Miller (1953), The first cell, evolution of prokaryote, origin of eukaryotic cells, evolution of unicellular

eukaryotes, anaerobic metabolism, photosynthesis and aerobic metabolism, RNA world theory

3. Molecular Evolution: (3L)

Concepts of natural evolution, molecular clocks, molecular tools in phylogeny, classification and identification, protein and nucleotide sequence analysis, origin of new genes and proteins, gene duplication and divergence

4. Paleontology and Evolutionary History: (3 L)

Evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Multicellular evolution, Major groups of plants & Animals; Fossils-Formation, Nature, Types, Geological time scale

5. The Mechanisms: (3 L)

Population genetics – Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution. 4L

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26. Tomar & Singh Evolutionary Biology, Rastogi Publications
27. Darbeshwar Roy Crop Evolution & Genetic Resources

Semester I

BOUT 113: Botany Theory Paper III-Cytogenetics and plant breeding

(4 Credits- 60 Lectures)

Credit I: Classical Genetics **15 Lectures**

1. Principles of Mendelian inheritance and Interaction of genes: 3 L

- Introduction,
- Mendel's Laws- Dominance, Segregation, Independent assortment
- Chromosomal theory of inheritance
- Interaction of genes- Complementary, epitasis, inhibitory, polymeric and additive
- Concept of gene, allele, multiple alleles
- Applications of mendelian genetics
- . Introduction to Model systems in Genetics- E.*coli*, Yeast, *Drosophila*, *Arabidopsis*

2. Cytoplasmic inheritance: 3 L

- Maternal effect (*Limaneaperegra*)
- Plastid Inheritance (*Mirabilisjalapa* and *Zeamays*)
- Mitochondrial Inheritance (Yeast petite and Maize-Cytoplasmic male sterility)
- Interaction between nuclear and cytoplasmic genes

3. Quantitative inheritance: 3 L

- Multiple Factor Hypothesis, Polygenic Inheritance
- Quantitative traits, Continuous variation
- Inheritance of quantitative traits, (Corolla length in *Nicotiana*, Cob length in Maize)
- Heritability and its measurement
- QTL mapping

4. Linkage, Recombination and Crossing Over: 4 L

- Linkage and crossing over
- Linkage maps, lod score for linkage testing, mapping by 3 point test cross
- Mapping by tetrad analysis in Yeast and *Neurospora*
- Recombination: RecA, RecB, RecC, RecD; homologous and non-homologous
- Somatic cell Genetics
- Sex linkage, sex limited and sex influenced characters

5. Mutation: 2 L

- Mutation- types, causes and detection
- Mutant type- lethal, conditional, biochemical; loss of function, gain of function
- Germinal versus somatic mutants
- Insertional mutagenesis, Point mutagenesis

Credit-II: Microbial Genetics & Cytogenetics **15 Lectures**

1. Microbial & Phage Genetics: 5 L

- Methods of genetic transfers- transformation, conjugation and transduction in bacteria and genetic recombination
- Mapping of bacterial genome by interrupted mating
- Lytic and lysogenic cycles in phages, Types of transduction: Generalized and Specialized
- Site specific recombination in phage, Mapping the bacteriophage genome
- Fine structure analysis of rII gene in T_4 bacteriophage

2. Karyotype and Chromosome Banding: 2 L

- Preparation of chromosome for karyotype; Ideogram
- Role of karyotype in chromosome evolution and plant species identification
- Chromosome Banding Techniques

4. Structural alterations of chromosomes: 4 L

- Deletion, duplication, inversion, translocation,
- Complex translocation heterozygotes
- Robertsonian translocations, BA translocations,

3. Numerical alterations of chromosomes: 4 L

- Aneuploids: method of production, meiotic behavior, applications
- Polyoploids: cytological and genetical method of identification of autopolyploids and allopolyploids, Applications.
    - Evolutionary advantages of autopolyploids versus allopolyploids and their maintenance and utilization in gene mapping and gene.

Credit-III (1 Cr): Plant breeding **15 Lectures**

1. Plant Breeding: 3 L

Concept, Objectives and applications of plant breeding,Patterns of evolution in cultivate crop species**,** modern concepts in plant breeding : Targeting induced local lesions in genomes (TILLING), Unigenes, Pyramiding of genes and Phenomics

2. Plant Genetic Resources 5L

Historical perspectives and need for PGR conservation; Importance of plant genetic resources; Gene pool: primary, secondary and tertiary;Centres of origin and global pattern of diversity; Basic genetic resources and transgenes. Principles, strategies and practices of exploration, collection, characterization, evaluation and cataloging of PGR; Plant quarantine and phytosanitary certification; Principles of *in vitro* and cryopreservation. Germplasm conservation- *in situ, ex situ*, Registration of plant genetic resources and importance of NBPGR.

3. Methods in plant breeding: 4 L

Introduction, Selection, Hybridization, Back Cross, Test Cross,modes of pollination- Self & cross pollination mechanism,Pure line theory, pure line selection and mass selection methods; Line breeding, pedigree, bulk, single seed descent and multiline method; Inter-varietal and wide/distant crosses, Principles of combination breeding and its application.

4. Asexual reproduction in crop plants-

Reproduction and apomixes. Types and Applications of Apomixis, Selection methods in asexually propagated crops, *In vitro* Double haploids, Triploids 3 L

Credit IV : **15 lectures**

5. Mutation Breeding: 6 L

Mutation Breeding and its history - Nature and classification of mutations: spontaneous and induced mutations, micro and macro mutations,- Detection of mutations in lower and higher organisms – paramutations.

Mutagenic agents: Physical mutagens, Chemical mutagens mechanism of action of mutagens. Dose determination and factors influencing chemical mutagenesis, - Treatment methods using physical and chemical mutagens, Mutagen effects in M1 generation: plant injury, lethality, sterility, chimeras *etc*., - Observing mutagen effects in M2 generation - Estimation of mutagenic efficiency and effectiveness. *In vitro* mutagenesis – callus and pollen irradiation; Handling of segregating genrations and selection procedures; Validation of mutants.

6. **Mutation breeding** for various traits (disease resistance, insect resistance,quality improvement,etc) in different crops- Procedures for micromutations(oligogenic) breeding/polygenic mutations. Use of mutagens in genomics, allele mining, TILLING 4 L

7. **Breeding for nutritional traits** 5 L

Breeding for special traits viz. oil, protein, vitamins, amino acids, elimination of toxic substances ; Concept of biopharming and development of varieties producing targeted compounds, nutraceuticals and industrial products; Success stories in vaccines, modified sugars, gums and starch through biopharming.

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Semester I

BODT 114: Botany Theory paper 4-Biofertilizer and Algal Technology

(2 Credits- 30 Lectures)

Credit I (1 Cr): Biofertilizer **15 Lectures**

1. Introduction, Definition, need and significance of biofertlizers in agriculture 2 L
2. Types and scope of biofertilizers: Rhizobium, Azotobactor, Azospirillum, Phosphate solubilizing microorganisms, Cyanobacteria, Azolla, Mycorrhizae. 5 L
3. Production technology: Strain selection, multiplication, sterilization, large-scale biomass production of various strains. 3 L

4. Methods of Applications: Application for field and other crops, methods of application, quality control, agronomic importance. Application methods for different biofertilizers. 4 L
5. Use of Genetically Engineered Microorganisms for improvement of biofertilizers. 1 L

Credit II (1 Cr): Algal Technology **15 Lectures**

1. Introduction to Algal Technology 2 L
2. Potential of algae as food and feed, pigments, pharmaceuticals and neutraceuticals, fine chemicals and fuel. 4 L
3. Algal biofertilizers, seaweed fertilizers – method of preparation and application 2 L
4. Biodiesel from algae- cultivation and extraction methods 2 L
5. Biohydrogen production from algae. 1 L
6. Algal Products- SCP-Spirulina mass cultivation & applications, Agar production. 4 L

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Semester I

BODT 114: Botany Theory paper 4- Pomoculture and Fruit Processing Technology

(2 Credits- 30 Lectures)

Credit-I (1 Cr): Introduction to Pomology **15 Lectures**

1. Scope and Importance of Fruit crops, Nutritive value of fruits in human nutrition, Classification of Fruits based on : climate adaptability, fruit morphology, Botanical Classification 3L

2. Present status of fruit growing :- In India and Maharashtra, Scope of fruit growing in India and Maharashtra, Importance of fruit growing 2L
3. Planning and Lay out of orchards: Location & site, Soil, Climate, Planning, Layout: Square system, Rectangular system, Hexagonal system, Quincunx system, Contour system 2L
4. Growth & Fruiting Habits: Growth & fruiting habits, Fruit bud differentiation, fruit setting, fruit drop, Seedlessness, cracking of fruits, problems of fruiting, Bahar treatment, Unfruitfulness, Pruning and Training, role of plant growth substances. 5L
5. Methods of Propagation: Vegetative and sexual Methods of propagation of Fruit trees, its advantages & Disadvantages 3L

Credit-II (1 Cr): Fruit Processing Technology 15 Lectures

1. Harvesting: Maturity indices, Estimation of Maturity, Harvesting, Method of harvesting technology for ripening, greening, Post-Harvest Handling, Packaging, Storage 5L
2. Preservation of Fruits : 2L
   Principles of Preservation, Methods of Preservation
3. Processing of Fruits : 6L
   a. Value addition:
   Preparation and preservation of Fruits: JAM, Jelly, Marmalade, Candy, Sauce & Ketchup, Pickle, fruit based carbonated juices, canning, pulp extraction, chutney, beverages like squashes, ready to serve (RTS) drinks and appetizer etc. from different fruits
   b. Fermented products:
   Production of alcoholic drinks like cider, wine, vermouth, vinegar etc is now an accepted practice for utilization of different fruits.Manufacture of champagne (sparkling wine), still wine and brandy from grapes
   c. By Product Waste Utilization:
   Pomace, Seeds, Stones/Pits skin, Peel : I)Pomace II) Vinegar Extracted from Mango peel, High fibre biscuits, Peel oil, pectin powder, peel candy and animal feed are some of the citrus peel products. Oil and fiber from oil palm.

4. Marketing of fruits: systems of marketing, export potential, air transport, transport by sea, cold storage of fruits 2L

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1. D. P Singh 2015. Fruit Crops : Published by Agrotech Press, Jaipur & New Delhi
2. Jitendrasingh 2014. Basic Horticulture, Published by Kalyani Publishers
3. S. N Gupta 2015. Instant Horticulture, 11th Edition, published by Jain Brothers.
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Semester I

BODP 114: Botany practical4 based on BODT 114Biofertilizer and Algal Technology

Practical (2 Credits) **60 Hours**

1. Study of microorganisms used in biofertilizer production 1P
2. Isolation of Nitrogen fixing cyanobacteria 1P
3. Isolation of Phosphate solubilizing micro-organisms from rhizosphere 1P
4. Isolation of Rhizobium from root nodules of leguminous crop 1P
5. Culture establishment and production of Azolla biofertilizers. 2P
6. Mass multiplication of Rhizobium, Azotobacter, and Azospirillum inoculum 2P
7. Estimation of Phycobiliproteins from Cyanobacteria 1P
8. Study of production of algal fertilizers. 1P
9. Study of any six sea weeds with applications 1P
10. Isolation and culture of Spirulina. 1P

Semester I

BODP 114: Botany practical 4 based on BODT 114 Pomoculture and Fruit Processing Technology

1. Study of Growth and Fruiting habit in any one locally cultivated fruit crop. 1P
2. Study of methods of Pruning and Training of fruit plants. 1P
3. Study of effect of Growth regulators in fruit ripening in Banana/Grapes/Mango. 1P
4. Study of methods of Propagation of fruit trees. 1P
5. Study Maturity indices and estimation of Maturity in locally grown Fruit plant. 1P
6. Study of Methods of Harvesting. 1P
7. Preparation of Jam, Jelly & Marmalade from Locally available fruits. 1P
8. Preparation of Squash, Candy. 1P
9. Demonstration of any one by-product of wastes of fruits. 1P
10. Visit to Fruit Processing Industry and preparation of Case study report on any one. 1P
11. Visit to fruit market and prepare report. 1P
12. Visit to Vineyard preparation of case study report on Vine Industry. 1P

Semester I

BOUP 115: Botany practical paper based on BOUT 111, BOUT 112, and BOUT 113

Practical based on BOUT 111-Plant Systematics I

Practical on Algae:

1. Morphological observations, documentation (description and illustrations) and classification according to Fritsch (1935) with reasons of taxa belonging to:

a. Any one member from Charophyta, Euglenophyta, Bascilariophyta and Chrysophyta, Cyanophyta. 1 P

b. Any three members from Phaeophyta, Chlorophyta and Rhodophyta. 2 P

Practical on Fungi:

2. Study of the representative genera belonging to following sub-divisions of fungi with respect to vegetative, reproductive structures and classification with reasons according to Ainsworth *et al* (1973).

a. Any one member from each Sub-divisions: Myxomycotina, Mastigomycotina and Zygomycotina 1P

b. Any three members of each Sub-divisions: Ascomycotina and Basidiomycotina and Deuteromycotina. 2P

Practical on Bryophytes:

3. Morphological, anatomical and reproductive studies of the following members:

a. Any three members from Hepaticopsida and one member from Anthocerotopsida 1 P

b. Any four members from Bryopsida (Musci). 1 P

Practical based on BOUT 112: Cell Biology and Evolution

4. Study of mitosis and meiosis 2P
5. Study of polytene chromosome from Chironomous larvae 1P
6. Differential centrifugation for isolation of cell fractions- Nuclear fraction 1P
7. Isolation of Chloroplasts to study 1P
   a. Hill reaction to measure intactness,
   b. Chlorophyll estimation
8. Isolation of mitochondria for: 1p
   a. Estimation of succinic dehydrogenase activity
   b. Microscopic observations using MitoTracker Green FM/ MitoTracker Red 580/ Janus green B
9. Isolation of Lysosomal fraction and estimation of acid phosphatase activity 1P
10. Study of induced cell senescence in leaf discs &Study of programmed cell death in plants 1P
11. Study of different plant fossils & Geological Time Scale. 1P

Practical based on BOUT 113: Cytogenetics and Plant Breeding

12. Karyotype analysis, preparation of C- metaphase chromosomes of appropriate material (*Allium / Aloe*). 1P
13. Study of Meiotic configuration in *Rhoeo* buds 1P
14. Study of polygenic inheritance in any suitable material (Wheat/Maize etc.) 1P
15. Problems of population genetics: Estimation of gene and genotypic frequencies, PTC testing ability in humans 1P
16. Gene mapping, *Neurospora* tetrad analysis 1P
17. Problems on Mendelian Inheritance and analysis of F_2 data by Chi-quare Test. 1P
18. Study of Polytene / Salivary gland Chromosomes from *Drosophilla / Chironomous* larva, with Balbiani rings, puff balls, bands & inter bands. 1P
19. Floral Biology, Study of Pollen Viability (any two major crops). Use of Colchicine for induction of polyploidy in appropriate plant material. 1P

Note: Visit to different plant diversity regions and visit to any plant breeding centre. Submission of report is Compulsory.

Semester II

BOUT 121: Botany Theory Paper 1- Plant Systematics II

(4 Credit- 60 Lectures)

Credit I (1 Cr): Pteridophytes **15 Lectures**

1. Distinguishing Characters, Classification as per Sporne System (1975), Apospory, Apogamy, Stelar evolution, Heterospory and seed habit, Contributions of Indian and world Pteridologist (any three) **3L**
2. Distribution, Distinguishing Characters, Morphology and anatomy of sporophyte and gametophyte of following orders **11L**
   Psilotales, Lycopodiales, Selaginellales, Isoetales, Equisetales, Ophioglossales, Marattiales, Osmundales, Filicales, Marsileales and Salviniales.
3. Applications of Pteridophytes: medicinal, horticultural, biotechnological and secondary metabolites **1L**

Credit II (1.5 Cr) Gymnosperms **22 Lectures**

1. Classification of gymnosperms by Raizada and Sahni (1960). 2 L
2. Affinities of gymnosperms with Pteridophytes and Angiosperms. 2 L
3. Distribution of gymnosperms worldwide and India. 1 L
4. Economic aspects of gymnosperms 1 L
5. General characters, morphology and affinities of 10L
   Pteridospermales - *Glossopteris*
   Cycadeoidales - *Cycadeoidea*
   Pentoxylales - *Pentoxylon*
   Cordaitales - *Mesoxylon*
   Cycadales
   Ginkgoales
   Coniferales
   Gnetales
   Epherales
   Welwitschiales
6. Comparative account of morphology, anatomy, sporogenesis, gametogenesis, embryology, and interrelationship of Cycadales and Ginkgoales 4 L

7. Seed development in Gymnosperms 2 L

Credit 1.5 III Angiosperms 23 Lectures

1. Characteristic features of angiosperms, Angiosperm as a dominant group 2 L
2. Importance and need for classification, hierarchical classification. Criteria used for classification; phases of plant classification. Overview on pre- and post-Darwinian systems of classification. 3 L
3. Phylogenetic systems of classification as per Cronquist (1981). 1 L
4. APG IV system of classification. 1 L
5. Phylogeny of Angiosperms: homology and analogy, parallelism and convergence, monophyly, paraphyly, polyphyly and clades, Phylogenetic tree and cladogram, Origin and evolution of angiosperms. 3 L
6. Study of plant families with respect to general characters, morphology, economic importance and affinities following Bentham and Hooker and APG system of classification
   Amborellaceae, Nymphaeaceae, Hydatellaceae, Magnoliaceae, Araceae, Arecaceae, Papaveraceae, Amaranthaceae, Leguminosae, Malvaceae, Satalaceae, Acanthaceae, Asteraceae 13 L

References-

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32. Stuessy, Tod F. (2009). Plant Taxonomy: The Systematic Evaluation of Comparative Data, second edition. Columbia University Press.
33. Swingle D.B. (1946). A Text book of Systematic Botany. McGraw Hill Book Co. New York.
34. Takhtajan A. (1969). Flowering Plants: Origin and Disposal.

IMPORTANT WEBSITES

THE FAMILIES OF FLOWERING PLANTS- L. Watson and M.J. Dallwitz
https://www.delta-intkey.com/angio/index.htm

ANGIOSPERM PHYLOGENY WEBSITE, version 14.
http://www.mobot.org/MOBOT/research/APweb/

THE PLANTS OF THE WORLD ONLINE PORTAL
http://www.plantsoftheworldonline.org/

INTERNATIONAL PLANT NAME INDEX (IPNI)
https://www.ipni.org/

TROPICOS
https://www.tropicos.org/home

BIODIVERSITY HERITAGE LIBRARY
https://www.biodiversitylibrary.org/

BOTANICUS DIGITAL LIBRARY
https://www.botanicus.org/

INTERNET ARCHIVE- DIGITAL LIBRARY
https://archive.org/

DATABASE OF PLANTS OF INDIAN SUBCONTINENT
https://sites.google.com/site/efloraofindia/

BOTANICAL SURVEY OF INDIA
https://bsi.gov.in/content/1416_1_FloraofIndia.aspx

FLOWERS OF INDIA
http://www.flowersofindia.net/

eFLORAS OF WORLD
http://www.efloras.org/

Semester II

BOUT 122: Botany Theory Paper II- Molecular Biology

(4 Credit- 60 Lectures)

Credit I (1 Cr): Techniques and Tools in Molecular Biology 15 Lectures

1. Introduction, Scope and Applications 1 L
2. Enzymes in molecular Biology 3 L

   1.1: DNA Degrading Enzymes: Nucleases- Endo-nucleaes and Exo-nucleases
   1.2: DNA modifying enzymes: Polymerases, Ligases, Phosphatases and polynucleotide kinases, Phosphorylase, Methylase

3. Minor equipments: 2 L

   Vortex, magnetic stirrer, Micropipettes, Incubator, Microfuge, microwave oven, pouch sealer and refrigerator.

4. Major equipments: 5 L

   PCR - Thermal Cycler, Gel Documentation System, ELISA reader, Millipore Distillation Apparatus, Lyophilizer, Refractometer, Liquid handling system and Gene sequencer

5. Molecular Techniques: 4 L

   5.1. Polymerase Chain Reaction: quality of template DNA and overall reaction conditions

   5.2 Sequencing Techniques: DNA sequencing 1. Sanger's dideoxy chain termination sequencing method and 2.Maxam –Gilbert sequencing method

   5.3 Blotting techniques- Southern, Northern and Western blotting

Credit –II (1 Cr): DNA – Structure, Functions and Damage 15 Lectures

1. DNA Structure, Forms of DNA (A, B, Z), Properties of DNA: chemical, physical, spectroscopic and thermal properties of DNA (e. g. Buoyant density, effect of acid and alkali, UV- absorption, hyperchromicity and hypochromicity),Dissociation and association kinetics, Cot – curve, C-value paradox. 4 L
2. Packaging of (DNA) genome e.g. Viruses, prokaryotic, eukaryotic, Organelles genome (Mitochondria and Chloroplast), structure of Nucleosome . 4 L
3. Replication: General factors of DNA replication, Replication apparatus, structure of DNA polymerases, Mechanism of replication in Prokaryotes and Eukaryotes, Regulation of replication and fidelity. 4 L
4. DNA damage and repair: Types of DNA damages, multiple repair pathway- Nucleotide excision repair, Base excision repair and Mismatch repair system. 3 L

Credit- III (1 Cr) Gene structure and Function **15 Lectures**

1. Gene Structure 3 L
   a. Organization and structure of Prokaryotic and Eukaryotic gene:
   b. Promotor, Inititiater, Enhancer, Terminater, Classes of Promoter
2. Transcription 6 L
   a. Transcription apparatus, Enzymes and factors involved in transcription
   b. Transcription in Prokaryotes and Eukaryotes
   c. RNA processing - m-RNA, r-RNA and t-RNA editing
   d. Post – transcriptional events : Capping, Methylation, Polyadenylation, Splicing, Structure of spliceosome and Fidelity
3. Translation 6 L
   a. Structure of m-RNA, r-RNA and t-RNA, Ribosomal assembly, Genetic code – Concept and Properties
   b. Coenzymes and factors involved in translation
   c. Mechanism of protein synthesis: Initiation, elongation and termination
   d. Post – translational control, Protein folding and processing, Protein targeting, Chaperons and Post – translational modifications

Credit- IV (1 Cr): **15 Lectures**

1. Gene Regulation: Concept and importance , Positive and Negative regulation,Mechanism of regulation and concept: Lactose, Tryptophan and Arabinose 5 L
2. Transposable elements: Concept of Mobile DNA elements: Prokaryotes and Eukaryotes, Transposons, IS elements, SINES and LINES, Ac-Ds system in Maize, Examples of transposable elements, Importance of Transposons in Transposons mediated gene tagging. 5 L
3. Genomics and Proteomics: The human genome project: Clone by clone Strategy and Shotgun sequencing and applications of genomics, Objectives of Proteomics and Methodologies of proteomics (2D Gel Electrophoresis). 5 L

References

1. Pal Jayanta and Saroj S. Ghaskadabi Fundamentals of Molecular Biology, Oxford Higher Education.
2. Lewin B. (2000). Genes VII. Oxford University Press, New York.
3. Alberts, B., Bray, D Lewis, J., Raff, M., Roberts, K and Walter (1999). Molecular Biology of the Cell.Garland Publishing, Inc., New York.
4. Wolfe S.L (1993) Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA.
5. Buchanan B.B, Gruissm W. and Jones R.L (2000). Biochemistry and Molecular Biology of Plant.American Society of Plant Physiologist, Maryland, USA.
6. Kleinsmith L.J and Kish V.M (1995).Principles of Cell and Molecular Biology (Second Edition).Happer Collins College Publishers, New York, USA.
7. Lodish H., Berk A., Zipursky, S.L Matsudaira P., Baltimore D. and Darnell J. (2000). Molecular Cell Biology (Fourth Edition). W.H. Freeman and Company, New USA.

8. David Freifelder (1996). Essentials of Molecular Biology, Panima Publishing Company, New Delhi.
9. Malacinski G.M (2006) (Fourth Edition).Freifelders Essentials of Molecular Biology, Narosa Publishing House, New Delhi.
10. Rastogi V.B Concepts in Molecular Biology.
11. Twyman R.M (2003) (Third Reprint).Advanced Molecular Biology. Viva Books Pvt. Ltd., New Delhi.
12. Watson J.D. et al. Molecular Biology of Gene. Forth Edition, Benjamin and Cummings Publishing Co., California.

Semester II

BOUT 123: Botany Theory Paper III- Biochemistry

(4 Credit- 60 Lectures)

Credit-I (1 Cr): Fundamental aspects **15 Lectures**

1. Water: Properties of water, Ionization of water 3 L
2. Buffers: pH, weak acids and weak bases, Handerson - Hasselback equation, buffers, buffer concentration & Biological Buffers. 5 L
3. Solutions: Molarity, Normality, Molality 2 L
4. Bioenergetics:Laws of Thermodynamics, free energy, energy changes, Redox reactions, chemical bonds. 5 L

Credit- II (1 Cr): Biomolecules **15Lectures**

1. Carbohydrates: General classification, structure and properties of carbohydrates, synthesis and breakdown of glucose, starch and glycogen. 5 L
2. Lipids: General classification, structure and properties of lipids, types of lipids, biosynthesis and oxidation of lipids. 4 L
3. Nucleic acids: Structure and biosynthesis of purines and pyrimidines, structure of DNA and RNA 6 L

Credit III (1 Cr): Protein Biochemistry **15Lectures**

1. Amino Acids: Classification, structure and properties of amino acids. 2 L
2. Proteins – Structure and Function, General classification, primary, secondary, tertiary and quaternary structures, Structure and function of myoglobin, keratin, haemoglobin, Ramchandran plot. 5L
3. Enzymology: General classification, mechanism of action, factors affecting enzyme activity, enzyme kinetics, Michaelis-Menton equation, competitive, non-competative, uncompetitive inhibition. 4L
4. Nitrogen Metabolism: Nitrate and ammonium assimilation, nitrogen uptake, biological nitrogen fixation, NOD factors, *nif* genes, root nodulation and nitrogen fixation, leg heamoglobin. 4L

Credit-IV (1 Cr): Phytochemistry and Metablomics 15Lectures

1. Metabolomics: Overview of primary and secondary metabolites, integration of metabolism. 5L
2. Phytochemistry: Primary metabolites as precursors of secondary metabolites, study of secondary metabolites – structure, classification, properties and therapeutic plant sources, biosynthetic pathways - alkaloids, phenols, terpenes, glycosides, pigments. 6L
3. Phytochemical investigation: Extraction methods, qualitative and quantitative analysis of alkaloids, glycosides, terpenes, phenols, pigments. 4L

References:

1. Buchanan B. B., Gruissem W. and Jones R. L. (2000), Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, Maryland, USA.
2. Dennis D. T., Turpin D. H., Lefebvre D. D. and Layzell D. B. (eds) (1997), Plant Metabolism (second edition), Longman, Essex, England.
3. Galstone A. W. (1989), Life Processes in Plants, Scientific American Library, Springer - Verlag, New York, USA.
4. Moore T. C. (1989), Biochemistry and Physiology of Plant Hormones, Springer – Verlag, New York, USA.
5. Nobel P. S.(1998), Physiochemical and Environmental Plant Physiology (Second Edition), Academic Press, San Diego, USA.
6. Salisbury F.B. and Ross C. W. (1992), Plant Physiology (Fourth Edition), Wadsworth Publishing Company, California, USA.
7. Singhal G. S., Renger G., Sopory S.K., Irrgang K.D. and Govindjee (1999), Concept in Photobiology; Photosynthesis and Photomorphogenesis, Narosa Publishing House, New Delhi.
8. Taiz L. and Zeiger E. (2010), Plant Physiology (Fourth Edition), Sinauer Associates Inc. Publishers, Massachusetts, USA.
9. Thomas B. and Vince – Preu D. (1997), Photoperiodism in Plants (Second Edition), Academic Press, San Diego, USA.
10. Verma S. K. and VermaMohit (2007), A Textbook of Plant Physiology, Biochemistry and Biotechnology, S Chand Publications.
11. Lehninger A. L. (1987), Principles of Biochemistry, CBS Publishers and Distributors (Indian Reprint).
12. Hapse and Acharya (1999), Treaties on AgroElectronics and Agrophysics, VSI.

Semester II

BODT 124: Botany Theory paper 4- Floriculture and Nursery Management

(2 Credits- 30 Lectures)

Credit-I (Cr 1): Floriculture 15 Lectures

1. Floriculture : Concept, definition, Scope and Importance of floriculture, global scenario of flowers, scope of floriculture in India 2L
2. Pre-requisites of commercial floriculture: soil and climate requirements, field preparation, systems of planting, water and nutrient management, weed management, rationing, training and pruning, pinching and disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies 3L
3. Harvesting and processing of flowers: harvesting indices, harvesting techniques, postharvest handling and grading, pre cooling, packing and storage, value addition, concrete and essential oil extraction, transportation and marketing, export potential, agri-export zones 5L
4. Commercial production of flowers: varietal wealth and diversity, climate, soil preparation, aftercare and manuring, pruning and training, harvesting, yield, important pests and diseases, control measures, harvesting, grading, packing and marketing , storage and transport, export potential of cut flowers: Chrysanthemum, Gerbera, Tuberose, Anthurium; Loose flowers- Scented Rose and Jasmine 5L

Credit II (Cr 1): Nursery Management 15 Lectures

1. Introduction 1 L
2. Nursery Site: Types of Nurseries, Water, Location, Topography, Size of Nursery, Soil 2 L
3. Preparation of the Site: Clearing of surface, Removal of Top Soil, Erosion Control and Wind Damage, Surface Dressing, Shape, Fencing. 2 L
4. Design and Layout of Nursery: Administration Area, Operations Area, Production Areas, Germination Section, Transplanting Area. 2 L
5. Producing Plants from Seed: Seed Handling, Seed Procurement and Storage, Seed Dormancy and Pre-Treatment, Germination Process, Time of Sowing, Method of Sowing, Care of Seed Bed and Direct Sown Container, Transplanting the Young Seedlings, Light and Shade, Transplanting Natural Regeneration Seedlings, Tending the Seedlings, Watering, Germination Beds and Transplants, Weed Control. 4 L
6. Producing Plants Vegetatively: Cuttings, Air Layering, Grafting and Budding, Cleft or V Grafting, Shield or Inverted T-budding. 2 L
7. Growing Media: Growing Media for Propagation and Germination Beds, Growing Media for Transplant Beds, Growing Media for Container Seedlings, Organic Material, Compost, Mixing the Growing Media, Media Compaction in Pots, Mulching. 2 L

References:

1. Arora JS. 2006. Introductory Ornamental horticulture. Kalyani.
2. Bhattacharjee SK. 2006. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publ.

3. Bose TK & Yadav LP. 1989. Commercial Flowers. NayaProkash.
4. Bose TK, Maiti RG, Dhua RS & Das P. 1999. Floriculture and Landscaping. NayaProkash.
5. Chadha KL & Choudhury B.1992. Ornamental Horticulture in India. ICAR.
6. Chadha KL. 1995. Advances in Horticulture. Vol. XII. Malhotra Publ. House.
7. Chaudhary RC. 1993. Introduction to Plant Breeding. Oxford & IBH.
8. Singh BD. 1990. Plant Breeding. Kalyani.
9. Lauria A &Ries VH. 2001. Floriculture – Fundamentals and Practices. Agrobios.
10. Prasad S & Kumar U. 2003. Commercial Floriculture. Agrobios
11. Keats C. Hall 2012. Manual onNursery Practices, Forestry Department, 173 Constant Spring Road, Kingston 8, Jamaica
12. Evans Julian1992. Plantation Forestry in the Tropics, Ch 10. Clarendon Press. Oxford.
13. Jaenicke, H. 1999.Practical Guidelines for Research Nurseries. International Centre for Research in Agroforestry. Nairobi, Kenya.
14. Mc.Donald, B. 1986. Practical Plant Propagation for Nursery Growers.
15. Schmidt, L. 2000.Guide to Handling of Tropical and Subtropical Forest Seed. DANIDA Forest Seed Centre.

Semester II

BODT 124: Botany Theory paper 4- Mushroom cultivation and Bio-pesticides

(2 Credits- 30 Lectures)

Credit-I (1 Cr): Mushroom culture **15 Lectures**

1. History of mushroom cultivation 1 L
2. Present status of mushroom cultivation in India and abroad 1L
3. Edible and Poisonous mushrooms 1L
4. Nutritional and medicinal values of mushrooms 2L
5. Mushrooms spawn- spawning, running and cropping 1L
6. Cultivation of paddy straw mushroom- *Volvariella* and wood mushroom-Lentinus. 2L
7. Cultivation of Wheat straw mushroom- *Pleurotus* 1L
8. Cultivation of Button mushroom- *Agaricus* 2L
9. Management of pest in mushroom cultivation 1 L
10. Recipes of edible mushrooms 1 L
11. World commerce of mushrooms 2 L

Credit-II (1 Cr): Bio-pesticides **15 Lectures**

1. Biological control of plant pathogens- concept and brief history 2 L
2. Antagonism- Mechanism of biocontrol- Amensalism, Predation, Parasitism 2 L
3. Applications of biological control in field- Crop rotation, irrigation, alteration of soil pH, Organic amendments, Introduction of Antagonists, Seed inoculation, Use of Mycorrhizal fungi and biofertilizers 3 L

4. Bacterial pesticides, Viral pesticides, Mycopesticides, Mycoherbicides, Mycoweedicides, Myconematicides, Insects as biocontrol agents 3 L
5. Botanical pesticides- Pyrethrum, Nicotine, Rotenone, Neem, Karanja 3 L
6. Commercialization of biopesticides 2 L

References

1. A Textbook of Biotechnology - R.C. Dubey
2. Biopesticides and pest management - Dhaliwal and Kaul
3. Introduction to mushroom science - T. N. Kaul
4. Benificial fungi and their utilization - M. C. Nair
5. Benificial fungi - S. K. Sharma
6. Mushroom cultivation - Nita Bahl

Semester II

BODP 124: Practical based on BODT 124 Floriculture and Nursery Management

Practical (2 Credits):

1. Study of methods of post harvest technology for flowers (cut flowers) 1P
2. Study of different protective structures with respect to design, components, orientation and construction for cut flower production 1P
3. Study of special cultural practices for flower crops under protected structure 1P
4. Gerbera–identification and description of species/varieties – propagation and planting –pruning management 1P
5. Study of response of micronutrients and macronutrients on growth of cut flowers. 1P
6. Preparation of project on Cut flower production including diseases and Pests management. 1P
7. Preparation of Bed for nursery 1P
8. Study of different method of seed germination 2P
9. Preparation of growing media 1P
10. Study of Grafting and budding method 1P
11. Study of Air Layering and cutting method 1P

Note: Visit to any Local Nursery and Preparation of report is compulsory

BODP 124: Practical based on BODT 124 Mushroom cultivation and bio-pesticides Practical (2 Credits):

1. Morphology of any six mushrooms 1 P
2. Preparation of spawn for mushroom cultivation 2 P
3. Cultivation of Dhingri mushroom 3 P
4. Any six recipes of mushroom 2 P
5. Visit to mushroom industry and report preparation 1 P
6. Any six botanical pesticides 2 P
7. Mycoherbicides- *Aspergillus, Penicillium* to control *Alternanthera, Fusarium* to control water hyacinth. 2 P
8. Mycofungicides- Mycorrhizal fungi to control soil borne pathogens-*Trichoderma* to control soil borne pathogens. 2 P

Semester II

BOUP 125: Botany practical paper based on BOUT 121, BOUT 122, and BOUT 123

(4 Cr)

Practical based on BOUT 121: Plant Systematics II

1. Studies on the families as per Bentham and Hooker's system of classification– any one example from each series available locally and their identification up to Genus and species level with the help of Regional Flora 4P
   Dicotyledonae:
   a) Polypetalae: Thalamiflorae, Disciflorae, Calyciflorae
   b) Gamopetalae: Inferae, Heteromerae, Bicarpellatae
   c) Monochlamydae: Curvembryae, Microembryae, Unisexuales
   Monocotyledonae:
   Epigynae, Coronariae, Calycinae, Glumaceae
2. Morphological, anatomical and reproductive studies of the following with the help of live material/or herbarium specimens and/or museum specimens and/or permanent slides of the following orders: 2P
   i) Cycadales
   ii) Coniferales
   iii) Gnetales
3. Morphological, anatomical and reproductive studies of the following
   Psilotum, Lycopodium, Selaginella, Equisetum, Pteris, Adiantum, and *Marsilea* 2P
4. Study of available fossils - At least 5 specimens from Gymnosperms and Pteridophytes. 1P

Practical Based on BOUT 122: Molecular Biology

1. Isolation and quantification of plant genomic DNA 2 P
2. Effect of temperature and alkali on absorption of DNA : hyperchromicity 1 P

3. Separation of seed storage proteins from legumes and its quantitative study and qualitative study by SDS-PAGE. 1 P
4. Electrophoretic separation of plasmid isoforms 1 P
5. Restriction digestion study of plasmid DNA and separation by Electrophoresis 2 P
6. Study of instruments or equipment's used in Molecular Biology techniques (by photographs / by power point / by Animation): PCR thermal cycler, Gel documentation system, ELISA reader, Millipore distillation apparatus, Lyophilizer, Refractometer 1 P

Practical Based on BOUT 123: Biochemistry

1. Preparation of solutions and buffers. 1P
2. Thin Layer chromatography- sugars, amino acids. 1P
3. Spectrophotometry: Absorption spectra of protein and nucleic acid. 1P
4. Effect of pH and enzyme concentration on enzyme activity. 1P
5. Defatting and dialysis of proteins 1P
6. Separation of seed storage proteins by SDS PAGE 2P
7. Estimation of proteins by Lowry and Bradford Method 1P