Rayat Shikshan Sanstha's

R. B. Narayanrao Borawake College, Shrirampur (Autonomous)

(Affiliated to Savitribai Phule Pune University, Pune)

Department of Mathematics

M.Sc. I (Mathematics) Syllabus as per NEP-2020

Implemented From

Academic Year: 2023-24

Course Structure of M. Sc. I (Mathematics)
(Semester-I)

Year	Semester	Course Type	Course Code	Course Title	Theory/ Practical	Credits	No. of Lectures/ Practicals to be conducted	Page No.
1st	I	**Major Core**	MT-MJ-511T	Advanced Calculus	Theory	4	60L	**2-4**
			MT-MJ-512T	Ordinary Differential Equation	Theory	4	60L	**5-6**
			MT-MJ-513T+ MT-MJ-513P	Abstract Algebra-I	Theory + Practical	4	30L+15P	**7-9**
			MT-MJ-514P	Programming with Python	Practical	2	15P	**10-13**
		Major Elective	MT-ME-515(A)T + MT-ME-515(A)P	Number Theory & Coding Theory	Theory + Practical	4	30L+15P	**14-15**
			MT-ME-515(B)T + MT-ME-515(B)P	Lattice Theory	Theory + Practical	4	30L+15P	**16-17**
			MT-ME-515(C)T + MT-ME-515(C)P	Operations Research	Theory + Practical	4	30L+15P	**18-20**
		Research Methodology	MT-RM-516T + MT-RM-516P	Research Methodology	Theory + Practical	4	30L+15P	**21-22**

Course Structure of M. Sc. I (Mathematics)
(Semester-II)

Year	Semester	Course Type	Course Code	Course Title	Theory/ Practical	Credits	No. of Lectures/ Practicals to be conducted	Page No
1st	II	**Major Core**	MT-MJ-521T	Complex Analysis	Theory	4	60L	**25-27**
			MT-MJ-522T	General Topology	Theory	4	60L	**28-29**
			MT-MJ-523T+ MT-MJ-523P	Linear Algebra	Theory + Practical	4	30L+15P	**30-31**
			MT-MJ-524P	Machine Learning	Practical	2	15P	**32-34**
		Major Elective	MT-ME-525(A)T+ MT-ME-525(A)P	C and C++ Programming Language	Theory+ Practical	4	30L+15P	**35-37**
			MT-ME-525(B)T+ MT-ME-525(B)P	Classical Mechanics	Theory+ Practical	4	30L+15P	**38-40**
			MT-ME-525(C)T+ MT-ME-525(C)P	Discrete Mathematics	Theory+ Practical	4	30L+15P	**41-43**
		OJT/FP	MT-OJT-526	Field Project or On Job Training		4		**44**

Syllabus for M. Sc. I (Mathematics)

Semester I

DISCIPLINE SPECIFIC CORE COURSE (MT-MJ-511T):
Advanced Calculus

Course Code &Title	Credits	Credit Distribution of the Course	
		Theory	Practical
MT-MJ-511T: Advanced Calculus	4	4	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- To understand advance topics of differential calculus of scalar & vector field, the derivative matrix, real valued function, multiple integral, line integral, surface integral & Green's theorem & Stoke's Theorem.
- To provide the skills of vector calculus operations which are needed for further study in mathematics.

COURSE OUTCOMES:

After completion of this course student will be able:

CO-1: To perform the vector calculus operations by applying addition, subtraction, scalar multiplication, dot product, cross product.

CO-2: To perform vector calculus operations by partial derivatives.

CO-3: To use Green's, Divergence and Stoke's theorem by combining vector differential calculus and vector integral calculus.

CO-4: Apply the integral calculus to find arc length of a curve, arc length of a parametric curves, area under a curve and surface area.

CO-5: To understand concept of integrals of function and vector fields over parameterized surfaces and compute them.

SYLLABUS OF MT-MJ-511T: Advanced Calculus

Unit I : Differential Calculus of Scalar and Vector Fields [20 Hours]

1.1 Functions from $\mathbb{R}^n$ to $\mathbb{R}^m$, Scalar and vector fields; Limits and continuity.

1.2 The derivative of a scalar field with respect to a vector; Directional derivatives and partial derivatives; Partial derivatives of higher order; Inverse function theorem and Implicit Function theorem (without proof).

1.3 Directional derivatives and continuity; The total derivatives; The gradient of a scalar field; Curl and divergence of a vector field; Properties of curl and divergence; A sufficient condition for differentiability.

1.4 A chain rule for derivatives of scalar fields; Applications to geometry; Level Sets, Tangent planes; Derivatives of vector fields; Differentiability implies continuity, The chain rule for derivatives of vector fields; Matrix form of the chain rule.

Unit II: Line Integrals [10 Hours]

2.1 Paths and line integrals; other notations for line integrals; Basic properties of line integrals.

2.2 The concept of work as a line integral; Line integrals with respect to arc length; Further applications of line integrals.

2.3 Open connected sets; Independence of the path; The first and second fundamental theorem of calculus for line integrals; Necessary and sufficient conditions for a vector field to be a gradient; Necessary conditions for a vector field to be a gradient.

Unit III: Multiple Integrals [15 Hours]

3.1 Partitions of rectangles; Step functions; The double integral of a step function; The definition of the double integral of a function defined and bounded on a rectangle; Upper and lower double integrals; Evaluation of double integral by repeated one- dimensional integration; Geometric interpretation of the double integral as a volume; Worked examples.

3.2 Integrability of continuous functions; Integrability of bounded functions with discontinuities; Double integrals extended over more general regions Applications to area and volume; Worked examples.

3.3 Green's theorem in the plane; Some applications of Green's theorem; A necessary and sufficient condition for a two-dimensional vector field to be a gradient.

3.4 Change of variables in a double integral; Special cases of the transformation Formula with proof; General case of the transformation formula with proof; Extensions to higher dimensions; Change of variables in an n-fold integral; worked examples.

Unit IV: Surface Integrals [15 Hours]

4.1 Parametric representation of a surface; The fundamental vector product; The fundamental vector product as a normal to the surface; Area of a parametric surface.

4.2 Surface integrals; Change of parametric representation; Other notations for surface integrals.

4.3 The theorem of Stokes; the divergence theorem (Gauss' theorem) and applications of divergence theorem.

ESSENTIAL / RECOMMENDED READINGS:

1. Tom M. Apostol, Calculus Volume II (Second Edition) Indian Reprint 2016 (John Wiley & Sons, Inc) ISBN: 978-81-265-1520-2.
   Unit I: Chapter 8: 8.1 to 8.22.; Unit II: Chapter 10: 10.1 to 10.11, 10.14 to 10.16.
   Unit III: Chapter 11: 11.1 to 11.15; 11.19 to 11.22, 11.26 to 11.34.;
   Unit IV: Chapter 12: 12.1 to 12.15, 12.19 and 12.21.
2. For "Inverse Function Theorem" and "Implicit Function Theorem", use Tom M.
3. Apostol**,** Mathematical Analysis, 2nd Edition, Narosa Publication 20th Reprint 2002.

ISBN 978-81-85015-66-8.
Unit-I: Chapter 13: Sections 13.3 and 13.4.

4. Gerald B. Folland, Advanced Calculus, Pearson Edn.2012.
5. A Devinatz, Advanced Calculus (Holt, Reinhart & Winston) 1968.
6. James R.Munker's ,Analysis on Manifolds, Massachusettes Institute Of Technology Cambridge, Massachusettes.

DISCIPLINE SPECIFIC CORE COURSE (MT-MJ-512T): Ordinary Differential Equations

Course Code &Title	Credits	Credit Distribution of the Course	
		Theory	Practical
MT-MJ-512T: Ordinary Differential Equations	4	4	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- To solve first order and second order linear differential equations utilizing the standard techniques for separable, exact, linear, homogeneous or Bernoulli cases.
- To understand the Euler's equation, Legendre Equation and Bessel's Equation.

COURSE OUTCOMES:

After completion of this course student will be able:

CO-1: To find solution of linear differential equations of first order.
CO-2: To find solution of homogeneous and non- homogeneous equations of second order.
CO-3: To explain Euler's equation, Legendre equation and Bessel's Equation.
CO-4: To understand Existence and Uniqueness of solution.
CO-5: To find asymptotics at regular singular points.

SYLLABUS OF MT-MJ-512T: Ordinary Differential Equations

Unit I: Linear equations of the first order **[04 Hours]**

1.1 Linear equations of the first order.
1.2 The equation $y'+ay=0$.
1.3 The equation $y'+ay=b(x)$.
1.4 The general linear equations of first order.

Unit II: Linear equations with constant coefficients **[14 Hours]**

2.1 Second order homogeneous equations.
2.2 Initial value problems for second order equations.
2.3 Linear dependence and independence.
2.4 Formula for the Wronskian.
2.5 Non-homogeneous equations of order two.
2.6 Homogeneous equations of order n.

2.7 Non-homogeneous equations of order n.
2.8 Algebra of constant coefficients equations.

Unit III: Linear equations with variable coefficients [14 Hours]

3.1 Initial value problems for the homogeneous equation.
3.2 Solutions of the homogeneous equation.
3.3 Wronskian and linear independence.
3.4 Reduction of order of the homogeneous equation.
3.5 Non-homogeneous equations with analytic coefficients.
3.6 Homogeneous equations.
3.7 Legendre equation.

Unit IV : Linear Equations with regular singular points [14 Hours]

4.1 Euler equation.
4.2 Second order equation with regular singular points.
4.3 Exceptional cases.
4.4 Bessel's equation.
4.5 Regular singular point at infinity.

Unit V: Existence and uniqueness of solutions to first order equations [14 Hours]

5.1 Equations with variables separated.
5.2 Exact equations.
5.3 Method of successive approximations.
5.4 Lipschitz condition.
5.5 Approximation to, and uniqueness of, solutions.

ESSENTIAL / RECOMMENDED READINGS:

1. E. A. Coddington, An Introduction to Ordinary Differential Equations (Prentice- Hall). Chapter- 1.4 -1.7, 2.1-2.12, 3.1-3.8, 4.1- 4 .4, 4.6- 4.8, 5.1 - 5.8.
2. G. F. Simmons & S. G. Krantz, Differential Equations (Tata McGraw Hill).

DISCIPLINE SPECIFIC CORE COURSE (MT-MJ- 513T + MT-MJ-513P): Abstract Algebra-I

Course Code &Title	Credits	Credit Distribution of the Course	
		Theory	Practical
MT-MJ-513T + MT-MJ-513P - Abstract Algebra-I	4	2	2

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- To provide a first approach to the subject of Algebra, which is one of the basic pillars of Modern Mathematics.
- To understand the Fundamental theory of groups and their homomorphisms, Symmetric Group and Symmetries in groups, Lagrange's Theorem.
- To understand the Fundamental theory of rings and their Examples, Homomorphism of rings, ideals of a ring.

COURSE OUTCOMES:

After completion of this course student will be able to:

CO-1: Generalize the groups on the basis of their orders, elements, order of elements and group relations.
CO-2: Identify the various algebraic structures with their corresponding binary operations.
CO-3: Use various canonical types of groups including cyclic groups and group of permutations.
CO-4: Compute the possible subgroups of given group of specific orders and will recognize them.
CO-5: Apply Sylow theorems for groups of finite orders.
CO-6: Develop concepts on ring theory of abstract algebra.

SYLLABUS OF MT-MJ-513T + MT-MJ-513P: Abstract Algebra-I

Syllabus of MT-MJ-513T: Abstract Algebra-I

Unit I: Introduction to Groups **[16 Hours]**

1.1 Basic Axioms and Examples.
1.2 Dihedral Groups.
1.3 Symmetric Groups.
1.4 Matrix Groups.

1.5 The Quaternion Group.
1.6 Homorphisms and Isomorphims.
1.7 Group Actions.

Unit II: Subgroups **[15 Hours]**
2.1 Definition and Examples.
2.2 Centralizers and Normalizers, Stabilizers and Kernels.
2.3 Cyclic Groups and Cyclic Subgroups.
2.4 Subgroups Generated by Subsets of a Group.
2.5 The Lattice of Subgroups of a Group.

Unit III: Quotient Groups and Homomorphims **[15 Hours]**
3.1 Definitions and Examples.
3.2 Cosets and Lagrange's Theorem.
3.3 The Isomorphism Theorems.
3.4 Transpositions and the Alternating Group.

Unit IV: Group Actions **[12 Hours]**
4.1 Group Actions and Permutation Representations.
4.2 Automorphims.
4.3 The Sylow Theorems.
4.4 The Simplicity of A_n(without proof).

Unit V: Direct Product and Abelian Groups **[12 Hours]**
5.1 Direct Product.
5.2 Fundamental Theorem of Finitely generated Abelian Groups.
5.2 Table of Groups of Small Order.
5.4 Recognizing Direct Product.

Unit VI: Introduction to Rings **[20 Hours]**
6.1 Basic Definitions and Examples.
6.2 Examples: Polynomial Rings, Matrix Rings, and Group Rings.
6.3 Ring Homomorphism and Quotient Rings.
6.4 Properties of Ideals.
6.5 Rings of Fractions.
6.6 The Chinese Remainder Theorem.

MT-MJ-513P: 15 Practicals based on MT-MJ-513T: Abstract Algebra-I

ESSENTIAL / RECOMMENDED READINGS:

1. David S. Dummit, Richard M. Foote, Abstract Algebra, 2nd Edition, John Wiley and Sons (Indian Edition).
   Unit-I: 1.1 to 1.7, Unit-II: 2.1 to 2.5, Unit-III: 3.1 to 3.3 and 3.5,
   Unit-IV: 4.1 and 4.4 to 4.6, Unit-V: 5.1 to 5.4, Unit-VI: 7.1 to 7.6.
2. Joseph Gallian, Contemporary Abstract Algebra, 9th Edition, Cengage Learning India Pvt. Ltd. ISBN-10 9353502527.
3. I. S. Luthar, I. B. S. Passi, Algebra (Vol 1), Groups; Narosa Publication House.
4. I. N. Herstein, Topics in Algebra, Wiley Eastern Ltd.
5. M. Artin, Algebra, Prentice Hall.
6. N. S. Gopalkrishnan, University Algebra, Wiley Eastern Ltd.
7. J. B. Fraleigh, A First Course in Abstract Algebra, 7 th Edition, Pearson Edition Ltd.

DISCIPLINE SPECIFIC CORE COURSE (MT-MJ-514P): Programming with Python

Course Code &Title	Credits	Credit Distribution of the Course	
		Theory	Practical
MT-MJ-514P - Programming with Python	2	-----	2

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- To understand why Python is a useful scripting language for developers.
- To learn how to use lists, tuples, and dictionaries in Python programmes.
- To learn and understand looping statements, control statements and string manipulations.
- To acquire programming skills in core Python and in Object Oriented Programming.
- To understand the concept of File Handling in Python.

COURSE OUTCOMES:

After completion of this course student will be able to:

CO-1: Study python on different operating systems, variables, strings and comments.
CO-2: Working with lists and understand difference between lists and dictionaries.
CO-3: Use loops and conditional Statements in Python.
CO-4: Learn functions, classes, files in Python.

SYLLABUS OF MT-MJ-514P: Programming with Python

Unit I: Introduction to Python, Python Objects **[05 Hours]**

1.1 Features of Python: Easy; Type and Run; Syntax; Mixing; Dynamic Typing; Built in Object Types; Numerous Libraries and Tools.
1.2 Chronology and Uses: Chronology; Uses.
1.3 Installation of Anaconda.
1.4 Basic Data Types Revisited: Fractions.
1.5 Strings.
1.6 Lists and Tuples: List; Tuples; Features of Tuples.

Unit II: Conditional Statements **[05 Hours]**

2.1 if, if-else, and if-elif-else constructs.
2.2 The if-elif-else Ladder.

2.3 Logical Operators.
2.4 The Ternary Operator.
2.5 The get Construct.

Unit III: Looping **[05 Hours]**

3.1 while loop and for loop.
3.2 Patterns.
3.3 Nesting and Applications of Loops in Lists.

Unit IV: Functions **[05 Hours]**

4.1 Features of a functions: Modular Programming; Reusability of Code; Manageability.
4.2 Basic Terminology: Name of Functions; Arguments; Return Value.
4.3 Definition and Invocation: Working.
4.4 Type of Functions: Advantage of Arguments.
4.5 Implementing Search.
4.6 Scope of a variable.
4.7 Recursion: Rabbit Problem; Disadvantages of Using Recursion.

Unit V: Iterations, Generators, and Comprehensions **[05 Hours]**

5.1 The Power of "For".
5.2 Iterators.
5.3 Defining an Iterable Object.
5.4 Generators.
5.5 Comprehensions.

Unit VI: File Handling **[05 Hours]**

6.1 The File Handling Mechanism.
6.2 The Open Function and File Access Modes.
6.3 Python Functions for File Handling: The Essential Ones; The OS Methods; Miscellaneous Functions and File Attributes.
6.4 Command Line Arguments.
6.5 Implementation and Illustrations.

Unit VII: Strings **[05 Hours]**

7.1 The Use of "For" and "While".
7.2 String Operators: The Concatenation Operator (+); The Replication Operator; The Membership Operator.
7.3 Functions for String Handling: len(); Capitalize(); find(); count; Endswith();Encode; Decode; Miscellaneous Functions.

Unit VIII: Introduction to Object Oriented Paradigm **[05 Hours]**

8.1 Creating New Types.
8.2 Attributes and Functions: Attributes; Functions.
8.3 Elements of Object- Oriented Programming: Class; Object; Encapsulation; Data Hiding; Inheritance; Polymorphism; Reusability.

Unit IX: Classes and Objects **[05 Hours]**

9.1 Defining a Class.
9.2 Creating an Object.
9.3 Scope of Data Members.
9.4 Nesting.
9.5 Constructor.
9.6 Constructor Overloading.
9.7 Destructors.

Unit X: Inheritance **[05 Hours]**

10.1 Introduction to Inheritance and Composition: Inheritance and Methods, Composition.
10.2 Inheritance: Importance and Types: Need of Inheritance; Types of Inheritance.
10.3 Methods: Bound Methods; Unbound Method; Methods are Callable Objects; The Importance and Usage of Super; Calling the Base Class Function Using Super, Search in Inheritance Tree.
10.4 Class Interface and Abstract Classes.

Unit XI: Operator Overloading **[05 Hours]**

11.1 _init_Revisited: Overloading _init_(Sort of).
11.2 Methods for Overloading Binary Operators.
11.3 Overloading the += Operator
11.4 Overloading the > and < Operators.
11.5 Overloading the _boolEan_ Operators: Precedence of _bool_over _len_.
11.6 Destructors.

Unit XII: Exception Handling **[05 Hours]**

12.1 Importance and Mechanism: An example of Try/Catch; Manually Raising Exception.
12.2 Built in Exceptions in Python.
12.3 The Process: Exception Handling: Try/Except; Raising Exceptions.
12.4 Crafting User Defined Exceptions.
12.5 An Example of Exception Handling.

Practical- 15 Practicals based on above topics

ESSENTIAL / RECOMMENDED READINGS:

1. H. Bhasin**:** Python Basics, MERCURY LEARNING AND INFORMATION Dulles,
   Chapter 1: 1.2, 1.4, 1.5.,
   Chapter 2: 2.2 to 2.4.,
   Chapter 3: 3.2 to 3.7,
   Chapter 4: 4.2 to 4.4.,
   Chapter 5: 5.2 to 5.8.,
   Chapter 6: 6.2 to 6.6.,
   Chapter 7: 7.1, to 7.6,
   Chapter 8: 8.1, to 8.4,
   Chapter 9: 9.1, 9.2, 9.3, 9.4,
   Chapter 10: 10.1, to 10.8.,
   Chapter 11: 11.1to 11.5.,
   Chapter 12: 12.2 to 12.8.,
   Chapter 13: 13.2 to 13.6.
2. Beginning-Python, Second Edition by Magnus Lie Hetland.
3. The Complete Reference Python by Martin C. Brown.
4. Head First Python by Patrick Barry.
5. Learning Python, O‟Reilly by Mark Lutz 5. Python in a Nutshell, O‟Reilly by Alex Martelli.

MAJOR ELECTIVE COURSE [MT-ME-515(A)T+ MT-ME-515(A)P]:
Number Theory and Coding Theory

Course Code &Title	Credits	Credit Distribution of the Course	
		Theory	Practical
MT-ME-515(A)T MT-ME-515(A)P - Number Theory and Coding Theory	4	2	2

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- To develop a micro aptitude for understanding the aesthetic aspect of mathematical instructions and to prepare young minds to ponder such problems.
- To familiarise students with basic number theoretic techniques that can be used in data protection.
- To use algebraic techniques to construct efficient codes and to identify the parameters of the given code.

COURSE OUTCOMES:

After completion of this course student will be able to:

CO-1: Understand the definitions of congruences, residue classes and least residues.

CO-2: Add and subtract integers $modulo\ n$, multiply integers and calculate powers $modulo\ n$.

CO-3: Determine multiplicative inverses modulo n and use to solve linear congruences.

CO-4: Describe some important result including Prime number theorem, Chinese Remainder Theorem and their consequences.

CO-5: Describe arithmetic functions like Euler's φ function, τ-function, σ-function, and their application.

CO-6: Use algebraic Techniques to construct efficient codes, identify the parameters of the given code and the quality of given code.

SYLLABUS OF MT-ME-515(A) T + MT-ME-515(A) P: Number Theory & Coding Theory

Syllabus of MT-ME-515(A) T: Number Theory & Coding Theory

Unit I: Congruence **[12 Hours]**

1.1 Congruence in $\mathbb{Z}$, The congruence $ax \equiv b\ (mod\ m)$.

1.2 Chinese Remainder Theorem.

Unit II: Quadratic Reciprocity [14 Hours]

2.1 Quadratic Residues.

2.2 Quadratic Reciprocity.

Unit III: Some Functions of Number Theory [10 Hours]

3.1 The Greatest Integer Function.

3.2 Arithmetic Functions.

3.3 The Mobius Inversion Formula.

Unit IV: Algebraic Numbers [20 Hours]

4.1 Algebraic Numbers.

4.2 Algebraic Number Fields, Algebraic Integers.

4.3 Quadratic Fields.

Unit V: Error Detection [16 Hours]

5.1 Correction and Decoding: Communication channels, Maximum likelihood decoding.

5.2 Hamming distance, Nearest neighbour/ minimum distance decoding, Distance of a code.

Unit VI: Linear Codes [18 Hours]

6.1 Vector spaces over finite fields, Linear codes, Hamming weight, Bases of linear codes.

6.2 Generator matrix and parity check matrix, Equivalence of linear codes, Encoding with a linear code.

6.3 Cossets, Nearest neighbour decoding for linear codes, Syndrome decoding.

MT-ME-515(A)P: 12 Practicals based on MT-ME-515(A)T

ESSENTIAL / RECOMMENDED READINGS:

1. Kenneth Ireland, Michael Rosen: A Classical Introduction to Modern Number Theory, Springer, 4th Indian Reprint, 2013.
   Unit I: Chapter 3: Articles 1 to 4.
2. Ivan Niven; Herbert Zuckerman; Hugh Montgomery: An Introduction to Theory of Numbers, John Wiley and Sons, 5th Edition.
   Unit II: Chapter 3: Arts 3.1 and 3.2, Unit III: Chapter 4: Arts 4.1 to 4.3,
   Unit IV: Chapter 9: Arts 9.1 to 9.6.
3. San Ling and Chaoing xing, Coding Theory; A First Course (Cambridge University Press, 2004)
   Unit V and Unit VI (Sections 2.1 to 2.5 & Sections 3.1 to 3.4)
4. S. G. Telang: Number Theory, Tata McGraw Hill.
5. M. B. Nathanson: Methods in Number Theory, GTM, Springer 3rd Indian Reprint, 2009.

MAJOR ELECTIVE COURSE [MT-ME-515(B)T+MT-ME-515(B)P]: Lattice Theory

Course Code &Title	Credits	Credit Distribution of the Course	
		Theory	Practical
MT-ME-515(B)T+MT-ME-15(B)P - Lattice Theory	4	2	2

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- To introduce partially ordered sets and their Properties.
- To introduce Lattices and Complete Lattices.
- To introduce Lattices as Algebraic Structures.
- To introduce Modular and Distributive Lattices.
- To introduce Boolean Algebras and their Representation.

COURSE OUTCOMES:

After completion of this course student will be able:

CO-1: To understand Lattices and their algebraic structures, homomorphism between Lattices and Boolean algebra.

CO-2: To learn the existence of maximal elements and the celebrated Zorn's Lemma.

CO-3: To deal with lattices as algebraic structures; to form sublattices; products; homomorphism and congruences.

CO-4: To determine whether the given lattice is modular or distributive; and how to apply the $M3 - N5$ Theorem.

SYLLABUS OF MT-ME-515(B)T + MT-ME-515(B)P: Lattice Theory

Syllabus of MT-ME-515(B)T: Lattice Theory

Unit I: Ordered Sets **[28 Hours]**

1.1 Ordered sets.
1.2 Examples from social science and computer science.
1.3 Diagrams: The art of drawing ordered sets.
1.4 Constructing and de-constructing ordered sets.
1.5 Down-sets and up-sets.

1.6 Maps between ordered sets.

Unit II: Lattices and Complete Lattices [34 Hours]

1.1 Lattice as ordered sets.
1.2 Lattices as algebraic structures.
1.3 Sublattices, products and homomorphism.
1.4 Ideals and filters.
1.5 Complete lattices and Intersection-structures.
1.6 Chain conditions and completeness.
1.7 Join-irreducible elements.

Unit III: Modular, Distributive and Boolean Lattices [28 Hours]

1.1 Lattices satisfying additional identities.
1.2 The characterization Theorems of Modular and Distributive lattices.
1.3 Boolean lattices and Boolean algebras.
1.4 Boolean terms and disjunctive normal form.

MT-ME-515(B)P: 12 Practicals based on MT-ME-515(B)T

ESSENTIAL / RECOMMENDED READINGS:

1. B.V. Davey and H.A. Priestley: Introduction to Lattices and Order, Cambridge University Press, Second edition, 2002. (Chapters 1,2 and 4).
2. S. Greitzer, General Lattice Theory, Academic Press.

MAJOR ELECTIVE COURSE [MT-ME-515(C)T+MT-ME-515(C)P]: Operations Research

Course Code &Title	Credits	Credit Distribution of the Course	
		Theory	Practical
MT-ME-515(C)T+MT-ME-515(C)P - Operations Research	4	2	2

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- To develop linear programming (LP) models for shortest path, maximum flow, critical path, minimum cost flow, and transportation problems.
- To enhance daily operations, fair comparison, building a high-level strategy, and smoother inventory planning and management.

COURSE OUTCOMES:

After completion of this course student will be able:

CO-1: To analyze and solve linear programming models of real-life situations.

CO-2: To find the graphical solution of LPP with only two variables and illustrate the concept of convex set and extreme points.

CO-3: To identify the relationships between the primal and dual problems and their solutions, assignment and transportation problem.

CO-4: To understand fundamentals of Network Analysis using CPM and PERT.

CO-5: To solve sequencing problem for various jobs and machines.

SYLLABUS OF MT-ME-515(C)T + MT-ME-515(C)P: Operations Research

Syllabus of MT-ME-515(C)T: Operations Research

Unit I: Models and Basics of Linear Programming **[14 Hours]**

1.1 Formulation of Models.

1.2 Graphical solutions.

Unit II: Simplex Method **[16 Hours]**

2.1 LP model in equation form.

2.2 Transition from graphical to algebraic solution.

2.3 Simplex Method.

2.4 Special Cases in the Simplex Method.

Unit III: Duality Theory **[10 Hours]**

3.1 Definition of the dual problem.
3.2 Primal-dual relationships.
3.3 Economic interpretation of duality.
3.4 Dual simplex algorithms.
3.5 Duality Theorem.

Unit IV: Game Theory **[10 Hours]**

4.1 Matrix Games.
4.2 Two-person Zero-sum games.
4.3 LPP formulation.
4.4 Minimax Theorem.

Unit V: Transportation Model and its Variants **[14 Hours]**

5.1 Definition of the transportation model.
5.2 Non-traditional transportation models.
5.3 Transportation algorithm.
5.4 Assignment model.

Unit VI: Network Problems **[10 Hours]**

6.1 Scope and definition of network models.
6.2 Maximal flow problem.
6.3 Max-Flow Min-Cut Theorem (without proof).
6.4 Max-Flow algorithm.
6.5 CPM and PERT.

Unit VII: Integer Linear programming **[16 Hours]**

7.1 Illustrative applications.
7.2 Integer programming algorithms.

(NB: Use of suitable software to solve Relevant problems are recommended.)

MT-ME-515(C)P: 15 Practicals based on MT-ME-515(C)T

ESSENTIAL / RECOMMENDED READINGS:

1. Hamy A.Taha, Operations Research, (Eighth Edition, Prentice Hall of India), 2008.
   Unit-I: Chaper 2;
   Unit-II: Sec.1,2,3&5;
   Unit-III: Sec.1 to 4.;

Unit-IV : ;
Unit-V: Chapter 5 Sec.1 to 4,
Unit-VI: Chapter 6 Sec.1,4&5;
Unit-VII: Chapter 8 Sec. 1&5

2. J. K. Sharma, Operations Research, (Third Edition, Macmillan India Ltd.), 2008.
   Unit-III: Chapter 5(Appendix)
   Unit-IV: Chapter 12 Sec.1,2.
3. P. K. Gupta and D. S. Hira, Operations Research, (Fifth Edition, S. Chand), 2014.
4. Frederick S. Hiller and Gerald J. Lieberman, Introduction to Operations Research, (Ninth Edition, McGraw Hill), 2010.
5. M. S. Bazaraa , John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows, (second edition), 2009.

RESEARCH METHODOLOGY COURSE [MT-RM-516T+MT-RM-516P]:
Research Methodology

Course Code &Title	Credits	Credit Distribution of the Course	
		Theory	Practical
MT-RM-516T + MT-RM-516P - Research Methodology	4	2	2

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- This course will help them to select an appropriate research design.
- The Students will develop skills in qualitative and quantitative data analysis and presentation.
- Students will be able to demonstrate the ability to choose methods appropriate to research objectives.

COURSE OUTCOMES:

After completion of this course student will be able:

CO-1: To understand the concept, need and importance of Research.
CO-2: To make them aware of the various methods of types of research.
CO-3: To make them aware of the various research tools.
CO-4: To help the learner to realize the research problem and try to find solutions through Research.

SYLLABUS OF MT-RM-516T + MT-RM-516P: Research Methodology

Syllabus of MT-RM-516T: Research Methodology

Unit I: Introduction to Research Methodology **[20 Hours]**

1.1 Meaning of Objectives and Research.
1.2 Characteristics of Research.
1.3 Types of Research.
1.4 Various Steps in Research Process.
1.5 Research Process versus Methodology.

Unit II: Research Problem and Research Ethics, Plagiarism and Funding Agencies **[20 Hours]**

2.1 Definition and Identification of Research Problem.

2.2 Techniques involved in defining a Research Problem.
2.3 Research Ethics and Plagiarism.
2.4 Use of Plagiarism Detection Softwares.
2.5 Research Opportunity and Funding Agencies.

Unit III: Research Tools [25 Hours]

3.1 Research tools. Searching Google (query modifiers), Math Sci Net, ZMATH, copus, SI Web of Science, Impact factor, h-index, Google Scholar, ORCID, JStor, Online and pen access Journals, Virtual library of various Countries.

Unit IV: Technical Writing and Reporting of Research [25 Hours]

4.1 Scientific writing and presentation. Writing a research paper, survey article, Thesis writing; LaTeX, PSTricks, Beamer, HTMLand MathJaX.
4.2 Software for Mathematics. Mathematica/Matlab/Scilab/GAP.

MT-RM-516P: 15 Practicals based on Research Methodology (MT-RM-516T)

ESSENTIAL / RECOMMENDED READINGS:

1. J. Stillwell, Mathematics and its History, Springer International Edition, 4th Indian Reprint, 2005.
2. L. Lamport, LaTeX, a Document Preparation System, 2nd ed, Addison-Wesley, 1994.
3. Norman E. Steenrod, Paul R. Halmos, Menahem M. Schiffer, Jean A. How Write Mathematics, American Mathematical Society, 1973.
4. Nicholas J. Higham, Handbook of Writing for the Mathematical Sciences, 2ed, SIAM, 1998.
5. Research Methodology Methods and Techniques (Second Revised Edition) C.R.Kothari.

Syllabus for M. Sc. I (Mathematics)

Semester II

DISCIPLINE SPECIFIC CORE COURSE (MT-MJ-521T): Complex Analysis

Course Code &Title	Credits	Credit Distribution of the Course	
		Theory	Practical
MT-MJ-521T: Complex Analysis	4	4	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Study basic properties of complex numbers, arithmetic of complex numbers and fundamental theorem of arithmetic.
- Understand the role of CR Equations in analyticity of functions.
- Study the techniques of complex variables and functions together with their derivatives, Contour integration and transformations.
- Study complex power series, classification of singularities, calculus of residues.
- Understand the applications of Cauchy-Goursat Theorem, Liouville's Theorem in the evaluation of integrals.

COURSE OUTCOMES:

After completion of this course student will be able to:

CO-1: Justify the need for complex number system and explain how is related to other existing number systems.

CO-2: Apply Cauchy Riemann equations and use it to show that a function is analytic.

CO-3: Apply the techniques of complex variables and functions together with their derivatives, Contour integration and transformations.

CO-4: Understand the boundedness of a function in the set of complex number.

CO-5: Define singularities of a function, know the different types of singularities and determine points of singularities of a function.

SYLLABUS OF MT-MJ-521T: Complex Analysis

Unit I: Basic Properties of Complex Numbers **[04 Hours]**

1.1 Arithmetic of Complex Numbers

1.2 The Fundamental Theorem of Algebra

Unit II: Complex Differentiability and Conformality **[10 Hours]**

2.1 Definition and Basic Properties

2.2 Polynomials and Rational Functions

2.3 Analytical Functions: Power Series
2.4 Cauchy- Riemann Equations
2.5 Review of Calculus of Two Real Variables

Unit III: Contour Integration **[14 Hours]**

3.1 Definition and Basic Properties
3.2 Existence of Primitives
3.3 Cauchy-Goursat Theorem
3.4 Cauchy's Theorem via Green's Theorem
3.5 Cauchy's Integral Formulae
3.6 Analyticity of Complex Differentiable Functions
3.7 A Global Implication: Liouville
3.8 Mean Value and Maximum Modulus

Unit IV: Zeros and Poles **[14 Hours]**

4.1 Zeros of Holomorphic Functions
4.2 Open Mapping Theorem
4.3 Singularities
4.4 Laurent Series
4.5 Residues

Unit V: Application to Evaluation of Definite Real Integrals **[12 Hours]**

5.1 Trigonometric Integrals
5.2 Improper Integrals
5.3 Jordan's Inequality

Unit VI: Local And Global Properties **[06 Hours]**

6.1 Schwarz's Lemma
6.2 Local mapping

ESSENTIAL/RECOMMENDED READINGS:

1. Anant R. Shastri, Basic Complex Analysis of One Variable, Macmillan Publishers India, 2010
Ch. 1: 1.1, 1.8.1,
Ch. 2: 2.1,2.2, 2.3(only 2.3.1);
Ch. 3: 3.1, 3.2
Ch. 4: 4.1 to 4.5, 4.7,4.8,
Ch. 5: 5.1 to 5.5,
Ch. 6: 6.1 to 6.3;
Ch. 7: 7.1, 7.2

2. J. W. Brown and R.V. Churchill, Complex Variables and Applications, Indian Edition. (Eighth Edition)
3. John. B. Conway, Functions of One Complex Variable, Springer International Student Edition. (Second Edition)
4. S. Ponnusamy, Foundation of Complex Analysis, Narosa Publications. (Second Edition)
5. L.V. Alfors, Complex Analysis, McGraw Hill, 1979.

DISCIPLINE SPECIFIC CORE COURSE (MT-MJ-522T): General Topology

Course Code &Title	Credits	Credit Distribution of the Course	
		Theory	Practical
MT-MJ-522T: General Topology	4	4	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Provide knowledge of the point set Topology & understand the significance of Topology and Metric Spaces.
- Acquaint students with homeomorphism & same topological properties like Connectedness, Compactness etc.

COURSE OUTCOMES:

After completion of this course student will be able to:

CO-1. Understand the concept of Metric Spaces, Topological Spaces and their role in Mathematics.

CO-2. Prove basic results about Completeness, Connectedness, Compactness, Convergence within these structures.

CO-3. Apply the theory in the course to solve a variety of problem at an approximate level of difficulties.

SYLLABUS OF MT-MJ-522T: General Topology

Unit I: Prerequisite **[10 Hours]**

1.1 Cartesian Products
1.2 Finite Sets
1.3 Countable and Uncountable Sets
1.4 Infinite Sets and Axiom of Choice
1.5 Well Ordered Sets

Unit II: Topological Spaces and Continuous Functions **[20 Hours]**

2.1 Topological Spaces
2.2 Basis for a Topology
2.3 Order Topology
2.4 Product Topology on X× Y
2.5 Subspace Topology
2.6 Closed Sets and Limit Points

2.7 Continuous Functions
2.8 The Product Topology, Metric Topology
2.9 Quotient Topology

Unit III: Connected and Compact Spaces [15 Hours]

3.1 Connected spaces
3.2 Connected Subspaces of Real Line
3.3 Components and Local Connectedness
3.4 Compact spaces
3.5 Compact Subspaces of the Real Line
3.6 Limit point compactness
3.7 Local Compactness

Unit IV:Countablity and Separation Axioms [15 Hours]

4.1 The Countability Axioms
4.2 The Separation axioms and Normal Spaces
4.3 Urysohn Lemma (Statement Only)
4.4 The Urysohn Metrization Theorem (Statement Only)
4.5 Tietze Extension Theorem (Statement Only)
4.6 Tychonoff's Theorem.

ESSENTIAL / RECOMMENDED READINGS:

1. J. R. Munkres, Topology: A First Course, (Prentice Hall, Second Edition), 2000.
   Chapter 1: Sec. 5 to 7, Sec. 9 to 10;
   Chapter 2: Sec.12 to 22;
   Chapter 3: Sec. 23 to 29;
   Chapter 4: Sec. 30 to 35;
   Chapter 5: Sec. 37.
2. Sidney A. Morris: Topology Without Tears.
3. K J anich. Topology Springer, 1984.
4. Viro, O Ivanov, V Kharlamov, and N Netsvetaev. Elementary Topology: Problem Textbook, AMS Publication, 2008.
5. Viro, O Ivanov, V Kharlamov, and N Netsvetaev. Elementary Topology: Problem Textbook, AMS Publication, 2008
6. K. D. Joshi, Introduction to General Topology, John Wiley and Sons.

DISCIPLINE SPECIFIC CORE COURSE [MT-MJ-523T+ MT-MJ-523P]: Linear Algebra

Course Code &Title	Credits	Credit Distribution of the Course	
		Theory	Practical
MT-MJ-523T + MT-MJ-523P: Linear Algebra	4	2	2

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Learn the fundamental notions of vector spaces viz. linear dependence and independence, basis and dimension and linear transformations on these spaces.
- Understand the notion of Diagonalizable, Triangulable, Unitary, Adjoint, Self-Adjoint and Normal linear transformation.

COURSE OUTCOMES:

After completion of this course student will be able to:

CO-1: Explain Vector spaces, Basis and Dimensions, the concept of Linear Transformation and its applications.

CO-2: Find Eigen values and eigen vectors, minimal polynomials.

CO-3: Identify the Inner product spaces, self-adjoint, normal and unitary operators.

CO-4: Understand the notion of Bilinear form and its matrix, Quadratic form, diagonalizable Matrix.

SYLLABUS OF MT-MJ-523T +MT-MJ-523P: Linear Algebra

Syllabus of MT-MJ-523T: Linear Algebra

Unit I: Vector Spaces **[25 Hours]**

1.1 Subspaces
1.2 Basis and dimension
1.3 Linear Transformations
1.4 Quotient spaces
1.5 Direct sum
1.6 The matrix of a linear transformation
1.7 Duality

Unit II: Canonical Forms **[20 Hours]**

2.1 Eigen values and eigenvectors
2.2 The minimal polynomial
2.3 Diagonalizable and triangulable operators
2.4 The Jordan Form

Unit III: Inner Product Spaces **[25 Hours]**

3.1 Inner Products
3.2 Orthogonality
3.3 The adjoint of a linear transformation
3.4 Unitary operators
3.5 Self-adjoint and normal operators

Unit IV: Bilinear Forms **[20 Hours]**

4.1 Definition and examples
4.2 The matrix of a bilinear form
4.3 Orthogonality
4.4 Classification of bilinear forms

MJ-MT-523P: 15 Practicals based on MJ-MT-523T.

ESSENTIAL / RECOMMENDED READINGS:

1. Vivek Sahai, Vikas Bist : Linear Algebra (Narosa Publishing House). Chapter 2 to 5.
2. K. Hoffman and Ray Kunje : Linear Algebra (Prentice - Hall of India private Ltd.).
3. M. Artin : Algebra (Prentice - Hall of India private Ltd.)
4. A.G. Hamilto : Linear Algebra (Cambridge University Press (1989)).
5. N.S. Gopalkrishana : University algebra (Wiley Eastern Ltd.).
6. J.S. Golan: Foundations of linear algebra (Kluwer Academic publisher (1995)).
7. Henry Helson : Linear Algebra (Hindustan Book Agency (1994)) .
8. I.N. Herstein : Topics in Algebra, Second edition (Wiley Eastern Ltd.).

DISCIPLINE SPECIFIC CORE COURSE (MT-MJ-524P): Machine Learning

Course Code &Title	Credits	Credit Distribution of the Course	
		Theory	Practical
MT-MJ-524P: Machine Learning	2	-----	2

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Introduce students to the basic concepts and techniques of Machine Learning.
- Write python programs using machine learning algorithms for solving practical problems.
- Understand about Machine Learning Library and use cases.
- Understand about the process of deploying ML model.

COURSE OUTCOMES:

After completion of this course student will be able to:

CO-1: Recognize the characteristics of machine learning that make it useful to real-world problems.

CO-2: Process available data using python libraries and predict outcomes using Machine Learning algorithms to solve given problem.

CO-3: Able to estimate Machine Learning model's efficiency using suitable metrics.

CO-4: Design application using machine learning techniques.

SYLLABUS OF MT-MJ-524P: Machine Learning

Unit-I: Introduction to Machine Learning **[10 Hours]**

1.1 Introduction to machine learning, Problems Machine Learning Can Solve, Knowing Your Task and Knowing Your Data, Essential Libraries and Tools in python for machine learning: Scikit-learn, NumPy, matplotlib, NumPy, pandas, matplotlib.

1.2 Types of Machine Learning Systems.

1.3 Main Challenges of Machine Learning: Insufficient Quantity of Training Data, Non-representative Training Data, Poor-Quality Data, Irrelevant Features, Over fitting the Training Data, under fitting the Training Data.

1.4 Testing and Validating: Hyper parameter Tuning and Model Selection, Data Mismatch.

Unit-II: Supervised Machine Learning **[10 Hours]**

2.1 Classification and Regression Generalization, Over fitting, and Under fitting Relation of Model Complexity to Dataset Size
2.2 Supervised Machine Learning Algorithms: Some Sample Datasets, k-Nearest Neighbours, Linear Models, Naive Bayes Classifiers, Decision Trees, Ensembles of Decision Trees
2.3 Uncertainty Estimates from Classifiers: The Decision Function, Predicting Probabilities, Uncertainty in Multiclass Classification.
2.4 Neural Networks (Deep Learning)

Unit-III: Unsupervised Machine Learning [10 Hours]

3.1 Types of Unsupervised Learning
3.2 Challenges in Unsupervised Learning
3.3 Pre-processing and Scaling: Different Kinds of Pre-processing, Applying Data Transformations, Scaling Training and Test Data the Same Way, The Effect of Pre-processing on Supervised Learning.
3.4 Dimensionality Reduction, Feature Extraction, and Manifold Learning: Principal Component Analysis (PCA), Non-Negative Matrix Factorization (NMF), Manifold Learning with t-SNE.
3.5 Clustering: k-Means Clustering, Agglomerative Clustering, DBSCAN, Comparing and Evaluating Clustering Algorithms

Unit-IV: Training Models [15 Hours]

5.1 Linear Regression: The Normal Equation, Computational Complexity
5.2 Gradient Descent: Batch Gradient Descent, Stochastic Gradient Descent, Mini-batch Gradient Descent
5.3 Polynomial Regression
5.4 Learning Curves
5.5 Regularized Linear Models: Ridge Regression, Lasso Regression, Elastic Net, Early Stopping
5.6 Logistic Regression: Estimating Probabilities, Training and Cost Function, Decision Boundaries, Soft max Regression

Unit-V: End-to-End Machine Learning Project [15 Hours]

5.1 Working with Real Data
5.2 Look at the Big Picture: Frame the Problem, select a Performance Measure, Check the Assumptions
5.3 Get the Data: Create the Workspace, Download the Data, take a Quick Look at the Data Structure, Create a Test Set,
5.4 Discover and Visualize the Data to Gain Insights: Visualizing Geographical Data, Looking for Correlations, Experimenting with Attribute Combinations.

5.5 Prepare the Data for Machine Learning Algorithms: Handling Text and Categorical Attributes, Data Cleaning, Custom Transformers, Feature Scaling, Transformation Pipelines.

5.6 Select and Train a Model: Training and Evaluating on the Training Set, Better Evaluation Using Cross-Validation.

5.7 Fine-Tune Your Model: Grid Search, Randomized Search, Ensemble Methods, Analyze the Best Models and Their Errors.

MT-MJ-524P: 15 Practicals based on above topics.

ESSENTIAL / RECOMMENDED READINGS:

1. Introduction to Machine learning with Python, Andreas C. Müller & Sarah Guido, O'REILLY Publication.
   Unit II: Ch.2,
   Unit III: Ch.3.
2. Hands on machine learning with sci-kit learn, Keras and Tensor flow.Aurelie Geron, O'REILLY Publication.
   Unit I: Ch.1,
   Unit IV: Ch.4,
   Unit V: Ch.2.
3. Mitchell, Tom M. "Machine learning. WCB." (1997).
4. Rogers, Simon, and Mark Girolami. A first course in machine learning. CRC Press, 2015.
5. Friedman, Jerome, Trevor Hastie, and Robert Tibshirani. The elements of statistical Learning. Vol.1. Springer, Berlin: Springer series in statistics, 2001.
6. Witten, Ian H., and Eibe Frank. Data Mining: Practical machine learning tools and techniques. Morgan Kaufmann, 2005.
7. Machine learning course material by Andrew Ng, Stanford university
8. Sutton, Richard S., and Andrew G. Barto. Reinforcement learning: An introduction. Vol. No. 1. Cambridge: MIT press, 1998.
9. Iba, Takashi, et al. "Learning patterns: A pattern language for active learners." Conference on Pattern Languages of Programs (PLoP). 2009.
10. Nikhil Buduma, "Fundamentals of Deep Learning", O"REILLY publication, second Edition 2017, ISBN: 1491925612
11. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioners Approach", O"REILLY, SPD, ISBN: 978-93-5213-604-9, 2017 Edition 1st.

MAJOR ELECTIVE COURSE [MT-ME-525(A)T+MT-ME- 525(A)P]: C and C++ Programming Language

Course Code &Title	Credits	Credit Distribution of the Course	
		Theory	Practical
MT-ME-525(A)T + MT-ME-525(A)P - C and C++ Programming Language	4	2	2

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Programming basics and the fundamentals of C and C++.
- Data types in C and C++.
- Mathematical and logical operations.
- Using if statement and loops.
- Arranging data in arrays.
- Implementing pointers.
- File management and dynamic memory allocation.
- The basic programming and OOPs concepts.
- Classes and objects in C++
- Constructors and destructors in C++

COURSE OUTCOMES:

After completion of this course student will be able to:

CO-1: Understand the Programming basics and the fundamentals of C and C++.
CO-2: Work with textual information, characters and strings.
CO-3: Work with arrays of complex objects.
CO-4: Understand the concept of object thinking within the framework of functional Model, functional hierarchical code organization.
CO-5: Understand tokens, expressions, and control structures.
CO-6: Explain arrays, strings and create programs using them.
CO-7: Describe and use constructors and destructors.

SYLLABUS OF MT-ME-525(A)T+MT-ME- 525(A)P: C and C++ Programming Language

Syllabus of MT-ME-525(A)T: C and C++ Programming Language

Unit I: Fundamentals of C – programming: **[20 Hours]**

1.1 Introduction to C, The character set, Identifier and keywords, Data types, Constants.
1.2 Variables and arrays, Declarations, Expressions, Statements, Symbolic constants, Operators and Expressions.
1.3 Preliminaries. Single character input- the getchar() function, the putchar()function, putchar() function, scanf() function printf function, The gets and puts functions.

Unit II: Functions and Arrays: [15 Hours]

2.1 Introduction to a function, Defining a function. Accessing a function, Passing arguments to a function. Function prototypes
2.2 Recursion, defining an array, Passing arrays to functions, Multidimensional Arrays, Arrays and strings.

Unit III: Basics of C + + [20 Hours]

3.1 Structure of main(), Data Types, Variables, Constants and keywords, Operators, Header files.
3.2 Preliminaries of C + +: cin, cout objects, Insertion and Extraction operators, Reference variables.
3.3 Functions in C + +: Function prototyping, Default arguments, Inline functions, Call by reference, Return by reference, Function overloading
3.4 Control flow (if-else, switch, break, while, do-while, for, continue, goto and labels), Arrays, Strings, Structures and unions, Pointers.

Unit IV: Object Oriented Concepts [20 Hours]

5.1 Methodology, Features, Advantages over Procedure Oriented Programming.
5.2 Access specifiers, defining data members & member functions, creating objects, Accessing members of a class, Array of objects, Objects as function arguments, Returning objects, Constant & Static member functions, friend function.
5.3 Constructors &Destructors: Basics, 'this' pointer, Types of constructor (parameterized, copy, default), Memory allocation, Destructors.

Unit V: Operator overloading and Inheritance [15 Hours]

5.1 Operator function definition, overloading all operators, Overloading using friend functions.
5.2 Basics, Single inheritance, Private member inheritance, multiple & multilevel inheritance, overloading new & delete operators
5.3 Pointers to objects, Pointers to derived class, Virtual & pure virtual functions, Command line arguments.

MT-ME- 525(A)P: 15 Practicals based on MT-ME-525(A)T

ESSENTIAL / RECOMMENDED READINGS:

1. Programming with C. By Byron S. Gottfried. Schaum's Outline series.
2. Programming in C by Ajay Mittal
3. The C Programming Language. By Brian W. Kernighan, Dennis M. Ritchie, 2nd Edition.
4. Spirit of C: An Introduction to Modern Programming. By Henry Mullish and Herbert L. Cooper, Jaico Publishers,
5. Stephen Prata : C++ Primer Plus
6. Robert Lafore : Object oriented Programming using Turbo C++
7. Bruce Ekcel : Thinking in C++ Vol. 1
8. Bjarne Stroustrup : The C++ Programming Language

MAJOR ELECTIVE COURSE [MT-ME-525(B)T+MT-ME-525(B)P]: Classical Mechanics

Course Code &Title	Credits	Credit Distribution of the Course	
		Theory	Practical
MT-ME-525(B)T + MT-ME-525(B)P - Classical Mechanics	4	2	2

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Distinguish between 'inertial frame of reference' and 'non-inertial frame of reference.
- Know how to impose constraints on a system in order to simplify the methods to be used in solving problems
- Know what central, conservative and central-conservative forces mathematically, understand the conservative theorems of energy, linear momentum and angular momentum.
- Know the importance of concepts such as generalized coordinates and constrained motion.
- Establish that Kepler's laws are just consequences Newton's laws of gravitation and that of motion.

COURSE OUTCOMES:

After completion of this course student will be able:

CO-6: Define and understand basic mechanical concepts related to advanced problems involving the dynamic motion of classical mechanical systems.

CO-7: Describe and understand the differential equations and other advanced mathematics in the solution of the problems of mechanical systems.

CO-8: Describe and understand the motion of a mechanical system using Lagrange Hamilton formalism.

CO-9: Learn that a particle moving under a central force describes a plane curve and know the Kepler's laws of the planetary motions.

SYLLABUS OF MT-ME-525(B)T+MT-ME-525(B)P: Classical Mechanics

Syllabus of MT-ME- 525(B)T: Classical Mechanics

Unit I: Lagrange's Formulation **[25 Hours]**

1.1 Equation of Motion and conservation Theorems, Equation of Motion of a Particle, Equation of Motion of a System of Particle.

1.2 Conservation Theorem of Linear Momentum of the system of particles, Angular Momentum of the system of Particle, Constraint Motion, Examples of motion under constraints, Holonomic and Non – Holonomic Constraints, Scleronomic and Rheonomic Constraints, Degrees of Freedom and Generalized Co – ordinates

1.3 Transformation Relations, Virtual work, Principle of Virtual Work, D Alembert's Principle, Conservation of Energy, Kinetic Energy as a Homogeneous quadratic Function of generalized velocities, another way of proving conservation Theorem for Energy, Lagrange's Equations for Non-holonomic Constaints

Unit II: Variational Principles [20 Hours]

2.1 Generalization of Theorem, Minimum surface of revolution, Brachistochrine Problem, A case of variable end points along vertical lines, Integrand as a function of more than two dependent variables.

2.2 Isoperimetric problems, variational problems with moving boundaries.

2.3 Functional dependent on functions of two dependent variables.

Unit III: Hamilton's Principle [25 Hours]

3.1 Hamilton‟s Principle for Non – Conservative and Conservative Systems, Configuration Space and Phase Space, Lagrange‟s Equations of Motion from Hamilton‟s Principle, Hamiltonian Formulation, Hamiltonian Function, Hamilton‟s Canonical Equations of Motion for partially

3.2 Conservative and Partially Non – Conservative System, Derivation of Hamilton‟s Equations of Motion from Hamilton‟s Principle, Physical Meaning of the Hamiltonian,

3.3 Conservative and Scleronomic system, Non–conservative and Rheonomic system, partially conservative, Partially Non–conservative system, Cyclic co–ordinates in Hamiltonian, Routh‟s Procedure, Principle of Least Action.

Unit IV: Two Body Central Force Motion [20 Hours]

4.1 Reduction of Two body problem to an equivalent one Body problem, Equation of Motion and the First Integral,

4.2 Kepler's Laws of Planetary Motion, Kepler's First second and Third Law, Deduction of Kepler's Laws, Escape velocity,

4.3 Newton's law of Gravitation from Kepler's Laws of Planetary Motion, Differential Equation of the orbit of a Particle, Virial Theorem

MT-ME- 525(B)P: 15 Practicals based on MT-ME-525(B)T

ESSENTIAL/ RECOMMENDED READINGS:

1. Problems in Classical Mechanics by L. N. Katkar (Narosa Publication)
Chapter 1 To 4

2. Classical Mechanics (3rd Ed.) by Herbert Goldstein, Charles Poole, John Safko (Pearson Education)
3. Classical Mechanics by Gupta, Kumar and Sharma (A Pragati Edition])
4. Classical Mechanics by Rana Joag (Mc Graw Hill India)
5. Classical Mechanics by R. N. Tiwari and B. S. Thakur (PHI)

MAJOR ELECTIVE COURSE [MT-ME-525(C)T+MT-ME- 525(C)P]:
Discrete Mathematics

Course Code &Title	Credits	Credit Distribution of the Course	
		Theory	Practical
MT-ME-525(C)T + MT-ME- 525(C)P - Discrete Mathematics	4	2	2

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Understand and apply the fundamental concepts in graph theory.
- Understand the concept of vertex connectivity and edge connectivity in graphs.
- Understand the concept of matrices in graphs like Incidence matrix, Adjacency matrix, etc.
- Understand the concept of digraphs, Euler digraphs and Hamiltonian digraphs.
- Have an idea of matching in graphs and study some applications of matching in day to day life problems.
- Introduce the idea of coloring in graphs.
- Model problems using graphs and to solve these problems algorithmically
- Construct Mathematical proofs.
- Apply combinatorial principles and techniques to solve counting problems.
- Compute a generating function and apply it to solve combinatorial problems.
- Set up and solve a linear recurrence relation.

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COURSE OUTCOMES:

After completion of this course student will be able to:

CO-1: Understand and explore the basics of graph theory.

CO-2: Achieve command of the fundamental definitions and concepts of graph theory.

CO-3: Find the shortest path through a graph using Dijkstra's Algorithm.

CO-4: Engage with mathematical literature.

CO-5: Analyse combinatorial Problem extract and interpret descriptive statistics from social network and apply resolution techniques for finding the answer for first order query.

CO-6: Use combinatorial statements interpreted in generating function of regular sets.

SYLLABUS OF MT-ME-525(C)T+MT-ME- 525(C)P: Discrete Mathematics

Syllabus of MT-ME-525(C)T: Discrete Mathematics

A] Graph Theory

Unit I: Topics in Graph Theory [20 Hours]

1.1Graphs; Graphs as Models; Matrices and Isomorphism; Decomposition and Special Graphs; Degree of a vertex; Counting and Bijections.

1.2Paths, Cycles, Trails: Connection in Graphs; Bipartite Graphs; Eulerian Circuits; Hamiltonian Cycles.

1.3Directed Graphs: Definition and Examples; Vertex Degrees; Eulerian Digraphs.

Unit II: Trees [15 Hours]

2.1 Trees: Properties of Trees; Distance in Trees and Graphs.

2.2 Enumeration of Trees: Spanning Trees in Graphs; Minimum Spanning Trees; Shortest Paths; Connectivity; Edge Connectivity.

Unit III: Matchings [10 Hours]

3.1 Maximum Matchings; Hall's Matching Condition.

B] Combinatorics

Unit IV: Basic Counting Principles [15 Hours]

4.1 Two Basic Counting Principles.

4.2 Simple Arrangements and Selections.

4.3 Arrangements and Selections with Repetitions.

4.4 Distributions.; Binomial Identities.

Unit V: Generating Functions [15 Hours]

5.1 Generating Functions Models.

5.2 Calculating Coefficients of Generating Functions.

5.3 Partitions.; Exponential Generating Functions.

Unit VI: Recurrence Relations [15 Hours]

6.1 Recurrence Relations Models.

6.2 Solutions of Linear Recurrence Relations.

6.3 Counting with Venn Diagrams.

6.4 Inclusion-Exclusion Formula.

MT-ME- 525(C)P: 15 Practicals based on MT-ME-525(C)T

ESSENTIAL/RECOMMENDED READINGS :

1. Douglas B. West: Introduction to Graph Theory; 2nd Edn; PHI Learning Pvt. Ltd.
   Section 1.1, 1.2, 1.3 (Counting and Bijections) , Section 7.2 (Hamiltonian Cycles)
   Section 1.4 (Definitions, Vertex Degrees, Eulerian Digraphs)
   Section 2.1 (Properties of Trees; Distance) ,
   Section 2.2 (Enumeration of Trees; Spanning Trees)
   Section 2.3 (Minimum Spanning Tree, Shortest Path);
   Section 4.1 (Connectivity, Edge-Connectivity);
   Section 3.1 (Maximum Matchings; Hall‟s Matching Condition)
2. Alan Tucker: Applied Combinatorics 6th Edn; Wiley India.
   Sections 5.1 to 5.5; 6.1 to 6.4; 7.1, 7.3; 8.1 to 8.2.
3. B. Kolman, R. Busby, S.C. Ross: Discrete Mathematical Structures, 6th Edn , Pearson Edn.
4. John Clark, D. A. Holton: A First Look at Graph Theory, World Scientific, 1991.
5. V. Krushnmurthy , Combinatorial Theory and applications, East West Press, New Delhi(1989)Scientific(1996).
6. K.D.Joshi: Foundations of discrete mathematics, Wiley.
7. Marshal Hall: Combinatorial theory, Wiley.

Field Project or On Job Training (MT-OJT-526): Research Methodology

Course Code &Title	Credits	Credit Distribution of the Course	
		Theory	Practical
MT-OJT-526: Field Project or On Job Training	**4**		**4**

In this course, the students are expected to do the On-Job Training (OJT) in appropriate Industries/Government sectors/Institute etc. to get hands on experience. The department may conduct necessary lectures/workshops/seminars as a prerequisite for OJT. The course will be conducted as per the guidelines of the Institute /the University and Government of Maharashtra.