



Rayat Shikshan Sanstha's
R. B. Narayanrao Borawake College, Shrirampur
(Autonomous)

(Affiliated to Savitribai Phule Pune University, Pune)

Department of Chemistry

FYUG (Chemistry) Syllabus as per NEP-2020

Implemented
From
Academic Year: 2023-24

F.Y.B.Sc. (Chemistry) Core Subjects (Semester-I)

Year	Semester	Course Type	Course Code	Course Title	Theory/ Practical	Credits	No. of Lectures/ Practical to be conducted	Page No.
1 st	I	DSC (Major)	CH-MJ-111T	Physical Chemistry	Theory	2	30L	4-5
			CH-MJ-112T	Organic Chemistry	Theory	2	30L	6-7
			CH-MJ-113P	Chemistry Practicals - I	Practical	2	12P	8-9
		VSC	CH-VSC-114T	Dairy Chemistry-Paper I	Theory	2	30L	10-11
		SEC	CH-SEC-115T	Instrumental Techniques -Theory	Theory	2	30L	12-13
		IKS	CH-IKS-116T	Agricultural Chemistry	Theory	2	30L	14-16

F.Y.B.Sc. (Chemistry) Core Subjects (Semester-II)

Year	Semester	Course Type	Course Code	Course Title	Theory/ Practical	Credits	No. of Lectures/ Practical to be conducted	Page No.
1 st	II	DSC (Major)	CH-MJ-121T	Inorganic Chemistry	Theory	2	30L	18-20
			CH-MJ-122T	Analytical Chemistry	Theory	2	30L	21-22
			CH-MJ-123P	Chemistry Practicals - II	Practical	2	12P	23-24
		VSC	CH-VSC-124P	Dairy Chemistry-Paper II	Practical	2	12P	25-26
		SEC	CH-SEC-125P	Instrumental Techniques – Lab	Practical	2	12P	27-28

Syllabus for F. Y. B. Sc. (Chemistry)

Semester I

DISCIPLINE SPECIFIC CORE COURSE (CH-MJ-111T): Physical Chemistry

Course Code & Title	Credits	Credit Distribution of the Course	
		Theory	Practical
CH-MJ-111T - Physical Chemistry	2	2	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Apply thermodynamic principles to physical and chemical process to predict their feasibility and spontaneity.
- Understand the third law of thermodynamic and its applications.
- Understand the concept of free energy and how it governs the spontaneity of processes.
- Understand the buffering mechanism of solutions, the concept of solubility and realize their applications.

COURSE OUTCOMES:

After completion of this course student will able to;

CO-1: Get familiar and apply mathematical methods which are necessary to understand physical chemistry.

CO-2: Calculate thermodynamic properties like enthalpy, bond energy, resonance energy, entropy etc.

CO-3: Formulate relation between Free energy and equilibrium constant, identify exergonic and endergonic reactions.

CO-4: Calculate equilibrium constant and predict the directionality of reaction with respect to various factors like concentration, pressure, volume, temperature etc.

CO-5: Calculate ionization pH, pKa of acidic/basic solutions as well as buffer solutions.

CO-6: Calculate solubility and solubility product for different types of salt and explain factors affecting their solubilities.

CO-7: Calculate pH of resultant solution after salt hydrolysis.

SYLLABUS of CH-MJ-111T:**Unit-1: Chemical Mathematics****[06 Hours]**

Inclination and slope of line, curve sketching, functions of a real variable, derivative of a function, differentiation formulas, maxima and minima, partial differentiation, cyclic rule, Method of integration, integration formulas.

Unit-II: Chemical Energetics**[08 Hours]**

Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchoff's equation. Statement of Third Law of thermodynamics of substances, problems.

Unit-III: Chemical Equilibrium**[08 Hours]**

Introduction: Free Energy and equilibrium - Concept, Definition and significance

The reaction Gibbs Energy, Exergonic and endergonic reaction. The perfect gas equilibrium, the general case of equilibrium, the relation between equilibrium constants, The response of equilibria to conditions- response to pressure, response to temperature, Van't Haff equation, Value of K at different temperature, Problems.

Unit-IV: Ionic Equilibria**[08 Hours]**

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts– applications of solubility product principle.

ESSENTIAL/RECOMMENDED READINGS:

1. Principle of Physical Chemistry, Puri, Sharma and Pathania.
2. Samuel Glasstone, Thermodynamics for Chemists, Affiliated East West Private Limited.
3. B. S. Bahl, G. D. Tuli, Arun Bahl, Essentials of Physical Chemistry.
4. Peter Atkins and Julio de Paula, Elements of Physical Chemistry, Sixth edition (2013), Oxford press.
5. Ball D. W., Physical Chemistry, Thomson Press, India (2007).
6. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
7. Atkins' Physical Chemistry –Thermodynamics and Kinetics, 11th Edition, Oxford Press.
8. Thomas Engel, Philip Reid; Physical Chemistry, Pearson Education (2006).
9. J. N. Gurtu, A. Gurtu; Advanced Physical Chemistry, Pragati Edition.
10. Mortimer R. G., Physical Chemistry, 3rd Edition, Elsevier, Noida (UP).
11. Samuel H. Maron and Carl F. Prutton, Principal of physical Chemistry, 4th Edition, Collier Macmillan Ltd.

DISCIPLINE SPECIFIC CORE COURSE (CH-MJ-112T): Organic Chemistry

Course Code & Title	Credits	Credit Distribution of the Course	
		Theory	Practical
CH-MJ-112T - Organic Chemistry	2	2	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- To understand the fundamentals, principles in organic chemistry.
- To inspire and boost interest of the students towards organic chemistry as the main subject.
- To create foundation for research and development in Chemistry.
- To introduce recent developments in organic chemistry.

COURSE OUTCOMES:

After completion of this course student will able to;

CO-1: Study electronic effects of organic compounds.

CO-2: Study the structure and reactivity of organic compounds.

CO-3: Learn stereochemistry, conformations and configuration of organic compounds.

CO-4: Study of various projection formulae to draw structures of molecule.

CO-5: Understand Aromaticity and Huckel's rule.

SYLLABUS of CH-MJ-112T:**Unit-1: Fundamentals of Organic Chemistry****[06 Hours]**

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

Unit-II: Stereochemistry**[13 Hours]**

Introduction, classification, Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Conformations with respect to ethane, butane and cyclohexane. Configuration: Geometrical – cis-trans, and E / Z Nomenclature (for upto two C=C systems). Optical isomerism Enantiomerism, Diastereomerism and Meso compounds). Concept of chirality (upto two carbon atoms). Threo and erythro; D and L; nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms).

Unit-III: Classification and Nomenclature of Organic Compounds [05 Hours]

Nomenclature of mono and bifunctional aliphatic compounds for following classes of compounds: Alkanes, Alkenes, Alkynes, Haloalkanes, Alcohols, ethers, aldehydes, ketones, carboxylic acids, carboxylic acid derivatives, (acid halides, esters, anhydrides, amides), nitro compounds, nitriles, and amines.

Unit-IV: Alkanes [06 Hours]

Physical Properties, Preparations: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, Synthesis from Grignard reagent, Reactions: Free radical Substitution: Halogenation

ESSENTIAL/RECOMMENDED READINGS:

1. Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
2. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
3. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
4. Eliel, E.L. Stereochemistry of Carbon Compounds, Tata McGraw Hill education, 2000.
5. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.

DISCIPLINE SPECIFIC CORE COURSE (CH-MJ-113P): Chemistry Practicals- I

Course Code & Title	Credits	Credit Distribution of the Course	
		Theory	Practical
CH-MJ-113P - Chemistry Practicals-I	2	--	2

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Understanding of importance of safety measures and precautions in laboratory.
- Conceptual understanding of thermochemical parameters and related concepts.
- Understanding of Purity of Chemicals and parameters to ascertain purity.

COURSE OUTCOMES:

After completion of this course student will able to;

CO-1: Preparation of buffer solutions and significance.

CO-2: Qualitative analysis of organic compounds (non-instrumental).

CO-3: Chromatographic Techniques for separation of constituents of mixtures.

SYLLABUS of CH-MJ-113P:**Section A: Chemical and Lab Safety (Compulsory)**

1. Toxicity of the compounds used in chemistry laboratory.
2. Safety symbol on labels of pack of chemicals and its meaning.
3. What is MSDS sheets? Find out MSDS sheets of at least hazardous chemicals ($K_2Cr_2O_7$, Benzene, cadmium nitrate, sodium metal, etc.).
4. Precautions in handling of hazardous substances like Conc. acids, ammonia, organic solvents, etc.

Section B: Physical Chemistry (Six Experiments)**a. Thermochemistry (Any Three)**

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of enthalpy of hydration of copper sulphate.
5. Study of the solubility of benzoic acid in water and determination of ΔH .

b. Ionic equilibria (Any Two)

1. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.

OR

1. Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

2. Preparation of buffer solutions (Any One)

- Sodium acetate-acetic acid and determine its buffer capacity.
- Ammonium chloride-ammonium hydroxide and determine its buffer capacity.

Section C: Organic Chemistry (Six experiments)

- Organic Qualitative analysis of monofunctional organic compounds like Benzoic acid, β -naphthol, aniline, nitrobenzene, acetone, ethyl acetate, acetanilide etc. **(Any Four)**
- Separation of constituents of mixtures by Chromatography: Measure the R_f value in each case **(Any Two)**.
 - Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acids) / pigments from plant extract/ 2 organic compounds by paper chromatography.
 - Identify and separate the sugars present in the given mixture by paper chromatography.

Note: Combination of two compounds/plant extract to be given

ESSENTIAL/RECOMMENDED READINGS:

- Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
- Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Text book of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
- Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Prof. Robert H. Hill Jr., David C. Finster Laboratory Safety for Chemistry Students, 2nd Edition Wiley ISBN: 978-1-119-02766-9 May 2016.
- Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards, Updated Version, ISBN 978-0-309-13864-2 DOI 10.17226/12654, The National Academies Press Washington, D.C.

VOCATIONAL SKILL COURSE (CH-VSC-114T): Dairy Chemistry Paper- I

Course Code & Title	Credits	Credit Distribution of the Course	
		Theory	Practical
CH-VSC-114T - Dairy Chemistry Paper-I	2	2	--

LEARNING OBJECTIVES:

- Students know basic knowledge and the importance of dairy science.
- Get familiar with different compositions related to dairy products.
- Understand the role microbiology in dairy processes.
- Understand the role of preservatives.

COURSE OUTCOMES

At the end of this chapter, a student should be able to-

CO-1: Know the procedure of preparation of various dairy products.

CO-2: Know and understand the composition of milk, its products and its nutritive value.

CO-3: Know and understand the Microbiology of milk.

CO-4: Develop knowledge about preservatives and adulterants.

CO-5: Know the preparation of various milk products.

SYLLABUS of CH-VSC-114T:**(30 Hours)****Unit-I: Introduction****[06 Hours]**

Definition of milk, compositions of milk, factors affecting the composition of milk, nutrients in milk and Physico-chemical characteristics of milk.

Unit-II: Types of Milk**[06 Hours]**

Pasteurized milk, Sterilized milk, Standardized milk, Boiled milk, Toned milk, Flavoured milk, Homogenized milk, Fermented milk, Ultra-high temperature (UHT) milk, Skimmed milk, Mixed milk.

Unit-III: Manufacture, Storage and Packaging of Milk and Milk Products**[06 Hours]**

Cream separation methods, Pasteurization and standardization of milk.

Unit-IV: Preservatives and Adulterants in Milk**[06 Hours]**

Preservation, Prompt cooling, Action of heat, Sterilization, Adulteration, Detection of Adulterants.

Unit-V: Milk Products**[06 Hours]**

Cream, Butter, Cheese, Ice-cream, Shrikhand, Infant Milk Powder, Cream powder, Basundi, Butter Milk Powder, Chaas, Kulfi, Lassi, Panner, whey powder.

ESSENTIAL/RECOMMENDED READINGS:

1. Textbook of Dairy Chemistry by A.N. Shukla.
2. Practical Dairy Chemistry by P.K. Ghatak and A.K. Bandyopadhyay.
3. A textbook of dairy Chemistry by B.S. Shinde, S.R. Adhav, S.G. Date, H. S. Chatrathand B.R. Khot (Manali Publication).
4. Chemistry and Testing of Dairy Products- H.V. Atherton, J. A. New Lander.

**SKILL ENHANCEMENT COURSE (CH-SEC-115T): Instrumental Techniques –
Theory Course**

Course Code & Title	Credits	Credit Distribution of the Course	
		Theory	Practical
CH-SEC-115T - Instrumental Techniques – Theory	2	2	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Students should get introduced to instrumentation techniques, their purpose and their underlying science.
- Student should be able to demonstrate an understanding of the process of chromatography.
- To introduce students with areas of chemistry where instrumental techniques are essential.

COURSE OUTCOMES:

After completion of this course student will able to;

CO-1: Describe the principles regions of electromagnetic regions.

CO-2: Discuss / explain / derive Beer's law of absorptivity.

CO-3: Explain / define different terms in Colorimetry such as radiant power, transmittance, absorbance, molar, Lambert's Law, Beer's Law, molar absorptivity.

CO-4: Explain construction and working of colorimeter; Hence apply colorimetric methods of analysis to real problem in analytical laboratory.

CO-5: Describe the principles of the IR spectroscopy and its instrumentation.

CO-6: Define chromatography, describe thin layer chromatography.

CO-7: Describe types of electro-analytical methods and interfacial methods of analysis.

SYLLABUS of CH-SEC-115T:**[30 Hours]****Unit-I: UV-Visible Spectroscopy****[08 Hours]**

Regions of electromagnetic Radiation, frequency, energy, wavelength and wavenumber, general features of absorption – spectroscopy, transmittance, absorbance, and molar absorptivity. Beer Lambert's law and its limitations, difference between Colorimetry and Spectrophotometry.

Instruments – Single beam UV- Visible Spectrophotometer, Double beam UV- Visible Spectrophotometer. Lamps used as energy sources. Verification of Beer's law. Estimation of iron

in water samples by thiocyanate method. Estimation of (i) Chromium and (ii) Manganese in steel.

Unit-II: Infra-Red Spectroscopy**[06 Hours]**

IR Spectrophotometer: Principle, Sources of Radiations, Sampling, Block diagram of FT-IR Spectrophotometer.

Unit-III: Chromatography I**[08 Hours]**

Chromatography: Classification of chromatographic methods, principles of differential migration, adsorption phenomenon, nature of adsorbents, solvent systems. Thin layer Chromatography (TLC): Advantages, preparation of plates, development of the chromatogram, Detection of the spots, factors effecting R_f values and applications. Paper Chromatography: Principle, choice of paper and solvent systems, development of chromatogram – ascending, descending, radial and two-dimensional chromatography and applications.

Unit-IV: Electroanalytical Method**[08 Hours]**

Types of Electroanalytical Methods.

a) Interfacial methods – a) Potentiometry: Principle, Electrochemical cell, Electrodes- (i) Indicator and (ii) Reference electrodes – Normal Hydrogen Electrode, Quinhydrone Electrode, Saturated Calomel Electrode. Numerical Problems. Application of Potentiometry – Assay of Sulphanilamide.

b) Voltametry – three electrode assembly; Introduction to types of voltametric techniques, micro electrodes, over potential and Polarization.

ESSENTIAL/RECOMMENDED READINGS:

1. Principles of Physical Chemistry, S.H. Marron and C. F. Pruton^{4th} ed., Oxford and IBH publishing company / CBS, new Delhi.
2. Vogel's Textbook of quantitative Chemical Analysis, 5th Ed. G. H. Jeffry, J. Basset, J. Mendham, R. C. Denney, Longman Scientific and Technical, 1989.
3. Basic Concept of Analytical Chemistry- S. M. Khopkar
4. Vogel's Text Book of Practical Organic Chemistry, Furniss, Hannaford, Smith, Tatchel, 5th Ed., Longman Scientific and Technical, 2004.
5. Analytical Chemistry, G.R. Chatwal, Sham Anand.

INDIAN KNOWLEDGE SYSTEM (CH-IKS-116T): Agricultural Chemistry

Course Code & Title	Credits	Credit Distribution of the Course	
		Theory	Practical
CH-IKS-116T - Agricultural Chemistry	2	2	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Student should realize that the basic methods of doing Agriculture in India is a product of knowledge that has been transferred from generation to generation since ancient times.
- Student should get familiar with chemistry aspects of Agriculture.
- Should be able to correlate his scientific understanding of chemistry with traditional ways of doing Agriculture.
- Student should understand the rationale behind traditional methods of doing Agricultural.

COURSE OUTCOMES:

After completion of this course, a student will able to;

CO-1: Know the role of Agricultural Chemistry and its potential.

CO-2: Understand basic concept of soil, properties of soil & its classification on the basis of pH.

CO-3: Know the different plant nutrients, their functions and deficiency symptoms.

CO-4: Understand the importance of manures as compared to chemical fertilizers.

CO-5: Understand the importance of green manuring.

CO-6: Have the knowledge of various pesticides, insecticides, fungicides and herbicides.

CO-7: Identify the problematic soil and recommend method for their reclamation.

CO-8: Have the knowledge of quality irrigation water, water quality standard and analysis of irrigation water.

SYLLABUS of CH-IKS-116T:**[30 Hours]****Unit-I: Introduction to Agricultural Chemistry****[02 Hours]**

role of Agricultural Chemistry, scope and importance of Agricultural Chemistry and other allied sciences.

Unit-II: Soil Chemistry**[06 Hours]**

definition of soil, soil components - mineral components, organic matter or humus, soil atmosphere, soil water, soil microorganism, physical properties of soil - soil texture, soil structure, soil color, soil temp, soil density, porosity of soil, surface soil and sub-soil, chemical properties of

soil - soil reactions and solutions, factor controlling soil reactions, buffering capacity, importance of buffer action in agriculture, ion exchange.

(Ref 1- Pages 8-12, 92-94, 98-113, 116-146, Ref 3- Pages 28-50)

Unit-III: Problematic Soil and Soil Testing

[04 Hours]

acid soil, formation of acid soil, effect of soil acidity, reclamation of acidic soil, alkali soil - formation of alkali soil, reclamation of alkali soil, classification of alkali soil - saline soil, saline alkali soil, non-saline alkali soil, calcareous soils, introduction to soil testing, objectives of soil testing, phases of soil testing- collection of soil samples, analysis in the laboratory and fertilizer applications.

(Ref 1- 345-370, Ref 3- 301-312, Ref 4- 135-147 and 150-159)

Unit-IV: Quality of Irrigation Water

[06 Hours]

sources of water, atmospheric water, surface water, stored water, ground water, impurities in water, water quality, related problems in public health, environment and agriculture, analysis of irrigation water (ppm, meq/lit.epm), dissolved constituents and their functions major constituents- Ca, Mg, Na, K, carbonates, bicarbonates, sulfates, chlorides and nitrates, minor constituents- B, Si, nitrites, sulfides and fluorides, water quality standards - total soluble salts (TSS), sodium adsorption ratio (SAR), exchangeable sodium percentage (ESP), residual sodium carbonate, salinity classes for irrigation water.

(Ref 8- Pages 293-309)

Unit-V: Plant Nutrients

[06 Hours]

need of plant nutrients, forms of nutrients' uptake, nutrient absorption by plants, classification of essential nutrients, primary nutrients (N, P, K), their role and deficiency symptoms in plants, secondary nutrients (Ca, Mg, S), their role and deficiency symptoms in plants, micronutrients, general functions of micronutrients (Zn, Fe, Mn, Cu, B, Mo, Cl), effect of environmental conditions, nutrient uptake.

(Ref 3- Pages 207-241, Ref 4- Pages 176-195, Ref 7- pages 287-300)

Unit-VI: Fertilizers and Manures

[06 Hours]

fertilizers, introduction, classification of fertilizers, nitrogenous fertilizers, phosphatic fertilizers, potassic fertilizers, complex fertilizers, mixed fertilizers, time and methods of fertilizers, factors affecting efficiency of fertilizers, vermicompost preparation, effect of vermicompost on soil fertility, manures, introduction, definition and classification of manures, effect of bulky organic manures on soil, farm yard manures (FYM), factors affecting on FYM, method of preparation, losses during handling and storage, biogas plant. human waste, sewage and sludge, types of sludge, carbon nitrogen ratio, sewage irrigation and uses, green manuring, types of green manuring, characteristics, advantages and disadvantages of green manuring.

(Ref 2- Pages 205-213, Ref 3- 90-112, 137-149)

ESSENTIAL/RECOMMENDED READINGS:

1. A text book of soil science (Recise Ed) J.A. Daji, Revised by J.R. Adam, N.D. Patil, Media promoters and publishers, Mumabi, 1996.
2. Text book of soil science, T.D. Biswas, S.K. Mukharjee, Tata McGraw Hill Publishing company, New Delhi
3. Introduction to Agronomy and soil, water management, V.G. Vaidya, K.R. Sahashtra Buddhe (Continental Prakashan).
4. Principles of soil science, M.M. Rai, Millian complex of India, Bombay, 1977
5. Manures and fertilizers (sixth ed), K.S. Yawalkar, J.P. Agarwal and Bokde, Agrihorticulture publishing house, Nagpur, India.
6. Chemistry of insecticides and fungicides, U.S. Sree ramula (2nd Ed), oxford and IBH Publishing company, New Delhi
7. Fundamentals of soil sciences, C.E. Millar and L.M. Turk, Bio-Tech- New Delhi (1st Ed 2001)
8. Soil, Plant, Water and fertilizer analysis, P.K. Gupta, Published by Agro Botanica.

Syllabus for F. Y. B. Sc. (Chemistry)

Semester II

DISCIPLINE SPECIFIC CORE COURSE (CH-MJ-121T): Inorganic Chemistry

Course Code & Title	Credits	Credit Distribution of the Course	
		Theory	Practical
CH-MJ-121T - Inorganic Chemistry	2	2	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- To introduce students with periodic table and trends.
- Students should understand atomic structure and wave nature of particles.
- Students should learn chemistry of alkali and alkaline earth metals.
- Student should know ionic and covalent bonding.

COURSE OUTCOMES:

After completion of this course student will able to;

CO-1: Origin of quantum mechanics and its need to understand structure of hydrogen atom.

CO-2: Explain rules for filling electrons in various orbitals- Aufbau's principle, Pauli exclusion principle, Hund's rule of maximum multiplicity.

CO-3: Discuss electronic configuration of an atom and anomalous electronic configurations.

CO-4: Discuss concept of exchange energy and relative energies of atomic orbitals.

CO-5: Design and describe the skeleton of long form of periodic table, blocks, groups, modern periodic law and periodicity.

CO-6: Understand the classification of elements as main group, transition and inner transition elements, know their names, symbol and electronic configurations.

CO-7: Explain periodicity of elements based on various factors.

CO-8: Describe various types of chemical bonds- Ionic, covalent, coordinate and metallic bond.

CO-9: Describe VB approach, Hybridization with example of linear, trigonal, square planer, tetrahedral, TBP, and octahedral.

CO-10: Discuss assumption and need for VSEPR theory.

CO-11: Basic understanding of geometry and effect of lone pairs with examples such as ClF_3 , Cl_2O , BrF_5 , XeO_3 and XeOF_4 .

SYLLABUS OF CH-MJ-121T:**Unit-I: Atomic Structure****[07 Hours]**

Origin of Quantum Mechanics: Why study quantum mechanics? Quantum mechanics arose out of interplay of experiments and Theory Energy quantization- i) Black body radiation ii) The photoelectric effect iii) Wave particle duality-a) The particle character of electromagnetic radiation

b) the wave character of particle, iv) diffraction by double slit v) atomic spectra, Review of-Bohr's theory and its limitations, Heisenberg Uncertainty principle.

Unit-II: Periodic table and Periodicity of Elements [8 Hours]

Periodicity of elements: Rules for filling electrons in various orbitals, electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations

Long form of periodic table-s, p, d and f block elements,

Detailed discussion of following properties of elements with reference to s and p block

- a) Effective nuclear charge, shielding or screening effect
- b) Atomic and ionic radii
- c) Crystal radii
- d) Covalent radii
- e) Ionization energies
- f) Electronegativity, Pauling's / electronegativity scale
- g) Oxidation states of elements

Unit-III: s-Block Elements [07 Hours]

Alkali and Alkaline earth metals-General characteristics, Electronic configuration, Occurrence, Anomalous behaviour of first element of each group, Diagonal relationship, Periodic Trends-Atomic radii, Ionic Radii, Electronegativity, Ionization potential, Electron Affinity. Physical properties, Chemical reactions and Applications.

Unit-IV: Chemical Bonding [08 Hours]

Attainment of stable electronic configurations, Types of Chemical bonds: Ionic, covalent, coordinate and metallic bonds.

Ionic Bond: General characteristics of ionic bonding, Types of ions, Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bond: Valence Bond Approach, Hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. VSEPR theory, Assumptions, need of theory, application of theory to explain geometries of molecules such as i) ClF_3 ii) Cl_2O iii) BrF_5 iv) XeO_3 v) XeOF_4

ESSENTIAL/RECOMMENDED READINGS:

1. Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.

2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
4. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Education India, 2006.
5. Manas Chanda. *Atomic structure and chemical bonding*, Dreamtech press 2019.
6. B.R. Puri, L.R. Sharma, K.C. Kalia, Principles of Inorganic Chemistry, Vishal Publications, 2007-2008.
7. McMahon, D. (2005). *Quantum Mechanics Demystified*. New York: McGraw-Hill Professional.
8. M.C. Day, and J. Selbin, *Theoretical Inorganic Chemistry* Reinhold publication.

DISCIPLINE SPECIFIC CORE COURSE (CH-MJ-122T): Analytical Chemistry

Course Code & Title	Credits	Credit Distribution of the Course	
		Theory	Practical
CH-MJ-122T - Analytical Chemistry	2	2	--

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- To get knowledge about solution preparations.
- To learn about data analysis.
- To study analytical problems.
- To learn importance of fertilizers in crop developments.

COURSE OUTCOMES:

After completion of this course student will able to;

CO-1: To understand the perspectives of analytical Chemistry.

CO-2: To learn the relation between molecular formula and empirical formula.

CO-3: To calculate of no. of moles, molar concentrations and various units of concentrations.

CO-4: To study Stoichiometric calculations.

CO-5: To study analysis of fertilizers.

SYLLABUS of CH-MJ-122T:

Unit-I: Introduction to Analytical Chemistry [02 Hours]

What is analytical Chemistry, the analytical perspectives, Common analytical problems.

Unit-II: Calculations used in Analytical Chemistry [09 Hours]

Some important units of measurements-SI units, distinction between mass and weight, mole, millimole and Calculations, significant figures, Solution and their concentrations- Molar concentrations, Molar analytical Concentrations, Molar equilibrium concentration, percent Concentration, part per million, part per billion, part per thousand, Solution –dilutant volume ration, functions, density and specific gravity of solutions, problems. Chemical Stoichiometry – Empirical and Molecular Formulas, Stoichiometric Calculations, Problems.

Unit-III: Analysis of Fertilizers [07 Hours]

Introduction, Types of Fertilizers, necessity and requirements of good fertilizers, Sample preparation, Analysis of Nitrogen by Kjeldahl's Method, Analysis of Phosphorous by Phosphomolebdate method, Analysis of potassium by sodium tetraphenyl borate method.

Unit-IV: Chromatographic Techniques –Paper and Thin Layer Chromatography [09 Hours]

Introduction to chromatography, IUPAC definition of chromatography. History of Chromatography- paper chromatography, Thin Layer Chromatography, Ion exchange Chromatography, Supercritical fluid chromatography, High Performance Liquid Chromatography, Capillary electrophoresis, Classification of chromatographic methods – according to separation methods, according to development procedures. Thin Layer Chromatography: Theory and principles, outline of the method, surface adsorption and spot shape, Comparison of TLC with other forms of chromatography, adsorbents, preparation of plates, application of samples, development. Paper Chromatography- Origin, overview of technique, sample preparation, types of paper, solvents, equilibrium, development, sample application and detection, Identification, Quantitative methods, applications of paper chromatography

Unit-V: pH meter**[03 Hours]**

Introduction, pH meter, Glass pH electrode, combination of pH electrode-Complete Cell, Standard Buffer –reference for pH measurement, Accuracy of pH measurement, using pH meter –How does it works? Applications of pH meter.

ESSENTIAL/RECOMMENDED READINGS:

1. Textbook of Analytical Chemistry – Manali Prakashan (Unit- I, II, IV, V).
2. Fundamentals of Analytical Chemistry Skoog and West (Unit-III).

DISCIPLINE SPECIFIC CORE COURSE (CH-MJ-123P): Chemistry Practicals-II

Course Code & Title	Credits	Credit Distribution of the Course	
		Theory	Practical
CH-MJ-123P - Chemistry Practicals-II	2	--	2

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- Inorganic Estimations using volumetric analysis.
- Synthesis of Inorganic compounds.
- Analysis of commercial products.
- Gravimetric Analysis.
- Purification of organic compounds.
- Preparations and mechanism of reactions involved.

SYLLABUS of CH-MJ-123P:**Section A: Inorganic Chemistry**

Wherever required standardization of volumetric reagent must be performed.

I] Synthesis of commercially important inorganic compounds (Any two)

- 1) Synthesis of potash alum from aluminium metal (scrap Aluminium metal).
- 2) Synthesis of Mohr's Salt $[(\text{FeSO}_4)(\text{NH}_4)_2\text{SO}_4] \cdot 6\text{H}_2\text{O}$.
- 3) Preparation of Dark red inorganic pigment: Cu_2O .
- 4) Synthesis of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$.

Note:

- i. In synthesized compound student must confirm the particular cation and anion by performing qualitative tests.
- ii. Costing of product for 100 g pack can be calculated on the basis of cost of raw materials used and percent yield of the product.

II] Volumetric Analysis (Any Two)

- 1) Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
- 2) Determination of basicity of boric acid or oxalic acid or citric acid hence determination of their equivalent weight.

- 3) Analysis of Commercial Vinegar.

III] Gravimetric Analysis

- 1) To determine loss in weight, loss per gram and percentage composition of given mixture containing Ammonium chloride and Barium sulphate.
- 2) To determine loss in weight, loss per gram and percentage composition of a given mixture containing zinc carbonate and zinc oxide.

IV] To draw polar plots of s and p orbitals.

Section B: Organic Chemistry

I] Organic Purification Techniques

- 1) Purification of organic compounds by
 - i) Crystallization (from water and alcohol)
 - ii) Distillation (Two Compounds)
 - iii) Sublimation (micro technique).

II] Preparation of Organic Derivatives

- 2) Preparations: Mechanism of various reactions involved to be discussed. Recrystallization, determination of melting point and calculation of quantitative yields to be done (**Any Two**).
 - i) Semicarbazone derivatives of aldehydes and ketones
 - ii) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone
 - iii) Nitration of nitrobenzene

ESSENTIAL/RECOMMENDED READINGS:

- 1) Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
- 2) Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
- 3) Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
- 4) Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
- 5) Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

VOCATIONAL SKILL COURSE (CH-VSC-124P): Dairy Chemistry Paper-II

Course Code & Title	Credits	Credit Distribution of the Course	
		Theory	Practical
CH-VSC-124P - Dairy Chemistry Paper II	2	--	2

LEARNING OBJECTIVES

The Learning Objectives of this course are as follows:

- Students know basic knowledge and the importance of dairy science.
- Get familiar with different compositions related to dairy products.
- Understand the role microbiology in dairy processes.
- Understand the role of preservatives.

COURSE OUTCOMES

At the end of this chapter, a student should be able to-

CO-1: Know basic knowledge and the importance of dairy science.

CO-2: Know and understand the composition of milk, its products and its nutritive value.

CO-3: Know and understand the Microbiology of milk.

CO-4: Know preservatives and adulterants.

CO-5: Know the preparation of various milk products.

PRACTICALS for CH-VSC-124P:**(60 Hours)**

1. Testing of formalin in the Milk by Heber test.
2. Detection of boric acid and borates.
3. Detection of salicylic acid in the milk.
4. Detection of benzoic acid in the milk.
5. Detection of urea in the milk.
6. Detection of starch in the milk.
7. Preparation of Ice-cream.
8. Preparation of Kulfi, Milk Candy.
9. Preparation of Pedha, Burfi.
10. Preparation of Dahi, Lassi and Shrikhand.
11. Preparation of Paneer and preservation.
12. Preparation of Butter and preservation.

ESSENTIAL/RECOMMENDED READINGS:

1. Textbook of Dairy Chemistry by A.N. Shukla.
2. Practical Dairy Chemistry by P.K. Ghatak and A.K. Bandyopadhyay
3. A textbook of dairy Chemistry by B.S. Shinde, S.R. Adhav, S.G. Date, H.S. Chatrathand B.R. Khot (Manali Publication).
4. Chemistry and Testing of Dairy Products- H.V. Athertion, J.A. New Lander

SKILL ENHANCEMENT COURSE (CH-SEC-125P): Instrumental Techniques – Lab Course

Course Code & Title	Credits	Credit Distribution of the Course	
		Theory	Practical
CH-SEC-125P - Instrumental Techniques – Lab Course	2	--	2

LEARNING OBJECTIVES:

The Learning Objectives of this course are as follows:

- To practice instrumental analysis involving, potentiometer, polarimeter, colorimeter & refractometer etc.

COURSE OUTCOMES:

After completion of this course student will able to;

CO-1: Handle electrochemical and optical instruments for analysis.

CO-2: Apply chromatographic techniques for separation and purification of compounds.

CO-3: Explain scientific principals behind instrumental techniques.

CO-1: Observe and interpret instrumental demonstrations and results.

Practicals for Instrumental Techniques – Lab Course (CH-SEC-125P) [60 Hours]

1. Estimation of amino acids by colorimetry.
2. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
3. Study the variation of viscosity of sucrose solution with the concentration of solute.
4. Determination of refractive index of a given organic liquid by Abbe's Refractometer.
5. Determination of percentage purity of an optically active compound by polarimetry.
6. To study the variation of refractive index with composition of a mixture of CCl₄ and ethyl acetate.
7. Separation of amino acids using paper chromatography.
8. Separation of components of a mixture by TLC.
9. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
10. Preparation of buffer solutions of different pH (i) Sodium acetate-acetic acid (ii) Ammonium chloride-ammonium hydroxide.

11. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.
12. Determination of dissociation constant of a weak acid.

ESSENTIAL/RECOMMENDED READINGS:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co., New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry, 8th Ed.; McGraw-Hill, New York (2003).
3. Viswanathan, B., Raghavan, P.S. Practical Physical Chemistry, Viva Books (2009).

