



ಬೆಂಗಳೂರು ಉತ್ತರ ವಿಶ್ವವಿದ್ಯಾಲಯ

ಟಮಕ, ಕೋಲಾರ – 563103

CHOICE BASED CREDIT SYSTEM

*(Semester Scheme with Multiple Entry and Exit Options for
Under Graduate Course)*

SYLLABUS AS PER NEP GUIDELINES

SUBJECT: CHEMISTRY

2021-22 onwards

Chemistry. Semester 1

Unit – 1

14 hrs

Principles of Analytical Chemistry -I:

Basic laboratory practices, calibration of glassware (pipette, burette and volumetric flask), Sampling (solids and liquids), weighing, drying, dissolving, Acid treatment, Rules of work in analytical laboratory, General rule for performing quantitative determinations (volumetric and gravimetric), Safety in Chemical laboratory, Rules of fire prevention and accidents, First aid. Precautions to be taken while handling toxic chemicals, concentrated/fuming acids and organic solvents.

(4 hrs.)

Language of analytical chemistry: Definitions of analysis, determination, measurement, techniques and methods. Significant figures, Classification of analytical techniques. Choice of an analytical method.

(6 hrs.)

Errors and treatment of analytical data: Limitations of analytical methods – Errors:

Determinate and indeterminate errors, some important terms replicate, outlier, Accuracy, precision, ways of expressing accuracy, absolute error, relative error, minimization of errors. Statistical treatment of random errors, mean, median, range, standard deviation and variance. External standard calibration. Numerical problems.

Titrimetric analysis: Basic principle of titrimetric analysis. Classification, preparation and dilution of reagents/solutions. Equivalent masses of compounds Normality, Molarity and Mole fraction. Use of $N_1V_1 = N_2V_2$ formula, preparation of ppm level solutions from source materials (salts), conversion factors. Numerical problems.

(2hrs)

Acid-base titrimetry: Titration curves for strong acid vs. strong base, weak acid vs. strong base and weak base vs. strong acid titrations. Titration curves, quantitative applications – selecting and standardizing a titrant, inorganic analysis - alkalinity, acidity.

(2hrs)

Unit – 2

(8 Hrs)

Physical Chemistry- Quantum Aspects:

Limitations of classical mechanics. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance. Quantum Mechanics-..Schrödinger's wave equation, derivation (time independent) significance of ψ and ψ . Eigen values and functions Applications of Schrödinger's wave equation - Particals in one-dimension box

(5hrs)

Quantum numbers and their significance. Quantum mechanical operators- (i) Hamiltonian operator; (ii) Laplacean operator Normalized and orthogonal wave functions. Sign of wave functions. Postulates of quantum mechanics Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Contour boundary and probability diagrams. (6hrs)

(3hrs)

Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations- Electronic configurations of the elements ($Z=1-30$), effective nuclear charge, shielding/screening effect, Slater's rules. Variation of effective nuclear charge in Periodic Table.

Unit – 3

14 hrs

Inorganic Chemistry-Periodic Table and Periodic Properties:

(11 hrs)

s, p, d and f-block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s and p-block elements:

- (a) Atomic radii (van der Waals) (b) Ionic and crystal radii. (c) Covalent radii
- (d) Ionization enthalpy, successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. (6 hrs)
- (e) Electron gain enthalpy; trends of electron gain enthalpy.
- (f) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity.

Trends in the chemistry of the compounds of groups 13 to 17 (hydrides, carbides, oxides and halides) are to be discussed. (5 hrs)

(3 hrs)

Unit – 4

14 hrs

Organic Chemistry-I

Classification and nomenclature of organic compounds, hybridization, shapes of organic molecules, influence of hybridization on bond properties. (2hrs)

(6 hrs)

Nature of bonding in Organic molecules: Formation of covalent bond, types of chemical bonding, (Notations used to represent electron movements and directions of reactions- curly arrows, formal charges). localized and delocalized, conjugation and cross conjugation, with examples. Concept of resonance.

Electronic displacements: Inductive effect, electrometric effect, resonance and hyper conjugation, aromaticity, Huckel rule, anti-aromaticity explanation with examples.

Strengths of organic acid and bases: Comparative study with emphasis on factors effecting pKa values. Relative strength of aliphatic and aromatic carboxylic acids - acetic acid and chloroacetic acid, acetic acid and propionic acid, acetic acid and benzoic acid. Steric effect - relative stability of trans and cis-2-butene.

(4hrs)

Types of bond cleavages- homolytic and heterolytic cleavages Types of reagents - electrophiles, nucleophiles, nucleophilicity and basicity. Types of organic reactions - substitution, addition, elimination, and rearrangement explanation with examples.

Chemistry of Aliphatic hydrocarbons: Carbon - carbon sigma bonds, Formation of alkanes: Wurtz reaction, Corey- house synthesis, free radical substitution, halogenation.

(4hrs)

Carbon-carbon pi bonds: Formation of alkenes and alkynes by elimination reaction.

Mechanism of E1, E2, reactions. Saytzeff and Hofmann eliminations. Addition of HBr to propene, free radical addition of HBr to propene. Addition of halogens to alkenescarbocation and halonium ion mechanism. Ozonolysis - ozonolysis of propene, hydrogenation, hydration, hydroxylation and epoxidation of alkenes, explanation with

examples, addition of hydrogen halides to alkynes.

Conjugated Dienes - 1,2 and 1,4- addition reactions in conjugated dienes. Diels-Alder reaction.

Recommended Books/References:

1. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt. Ltd. (2007).
2. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York (2005).
3. Basic concepts of Analytical Chemistry, S M Khopkar, New Age Int. Publishers, New Delhi, 2020.
4. Basic Inorganic Chemistry, F A Cotton, G Wilkinson and P. L. Gaus, 3rd Edition. Wiley. India December 1994
5. Analytical Chemistry, G.D. Christian, 6th edition, Wiley-India (2007).
6. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
7. Inorganic Chemistry, By-James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Pearson Publications, India (2020).
8. Advanced Inorganic Chemistry, Cotton, F.A. & Wilkinson, G., Wiley, VCH, 1999.
9. Concise Inorganic Chemistry: J D Lee, 4th Edn, Wiley, (2021)
10. Fundamentals Concepts of Inorganic Chemistry, Vol 1 and 2, 2nd Edition, Asim K Das, CBS Publishers and Distributors, (2013)
11. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education) (2010)
12. Organic Chemistry (Vol. I), Finar, I. L, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education) (2002)
13. McMurry, J. E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013
14. Organic Reaction mechanism by V. K. Ahluwalia and K. Parashar Oxford, U.K: Alpha Science International, 2011.
15. Organic Chemistry by S. M. Mukherji, S. P. Singh and R. K. Kapoor. New age publishers Publication Date. 2 February 2017
16. A Guide book to mechanism in Organic Chemistry by Peter Sykes. Pearson. (January 2003)
17. Pine S. H. Organic Chemistry, Fifth Edition, McGraw Hill, (2007)
18. F. A. Carey, Organic Chemistry, Seventh Edition, Tata McGraw Hill (2008).
19. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Ed., (2012), Oxford University Press.
20. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, Part A: Structure and mechanism Kluwer Academic Publisher, (2000).

PRACTICALS (SEMESTER I)

PART A-Analytical Chemistry

1. Calibration of glassware, pipette, burette and volumetric flask.
2. Estimation of sodium carbonate and sodium bicarbonate in a mixture.
3. Estimation of alkali present in soaps/detergents.
4. Estimation of iron(II) using potassium dichromate.
5. Estimation of oxalic acid using potassium permanganate solution.
6. Estimation of chlorine in bleaching powder using iodometric method.
7. Estimation of alkali content in antacids.
8. Standardization of silver nitrate and determination of chloride in a water sample (Virtual Expt).

PART- B Organic Chemistry

1. Selection of suitable solvents for purification/recrystallization of organic compounds.
 2. Preparation of m-dinitrobenzene from nitrobenzene.
 3. Bromination of acetanilide with ceric ammonium nitrate and potassium bromide (green method).
 4. Preparation of methyl m-nitro benzoate from methyl benzoate by nitration method.
 5. Hydrolysis of methyl m-nitro benzoate to m-nitro benzoic acid (conventional method).
 6. Bromination - preparation of tribromophenol from phenol.
 7. Preparation of dibenzalacetone (green method).
 8. Separation of organic compounds by column chromatography (Virtual Expt.).
- handling chemical.

Recommended Books/References:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis Sixth Edition, Pearson, 2009.
2. Practical Volumetric Analysis, Peter A C McPherson, Royal Society of Chemistry, Cambridge, UK(2015).
3. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
4. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

BSc Semester I.

OPEN ELECTIVE-1

Title of the Course: OE-1: CHEMISTRY IN DAILY LIFE

Number of Theory Credits 3

Number of lecture hours/ semester 42hrs.

Unit – 1

Dairy Products: Composition of milk and milk products. Analysis of fat content, minerals in milk and butter. Estimation of added water in milk. Beverages: Analysis of caffeine in coffee and tea, detection of chicory in coffee, chloral hydrate in toddy, determination of methyl alcohol in alcoholic beverages.

(6hrs)

Food additives, adulterants, and contaminants - Food preservatives like benzoates, propionates, sorbates, and disulphites. Artificial sweeteners: aspartame, saccharin, dulcin, sucralose, and sodium cyclamate. Flavors: vanillin, alkyl esters (fruit flavors), and monosodium glutamate.

(6hrs)

Artificial food colorants: Coal tar dyes and non-permitted colors and metallic salts.
Analysis of pesticide residues in food.

(2hrs).

Unit - 2

Vitamins: Classification and nomenclature. Sources, deficiency diseases, and structures of vitamin A1, vitamin B1, vitamin C, vitamin D, vitamin E & vitamin K1.

(6hrs)

Oils and fats: Composition of edible oils, detection of purity, rancidity of fats and oil.
Tests for adulterants like argemone oil and mineral oils. Halphen test.

(5hrs)

Soaps & Detergents: Definition, classification, manufacturing of soaps and detergents, composition and uses (3hrs)

Unit - 3

Chemical and renewable energy sources: principles and applications of primary & secondary batteries and fuel cells. Basics of solar energy, future energy storer

(6hrs)

Polymers: basic concept of polymers, classification and characteristics of polymers.
Applications of polymers as plastics in electronic, automobile components, medical fields, and aerospace materials. Problems of plastic waste management. Strategies for the development of environment-friendly polymers.

(8hrs)

Recommended Books/References:

1. B. K. Sharma: Introduction to Industrial Chemistry, Goel Publishing, Meerut (1998)
2. The chemical analysis of foods. . Pearson, David, 1919-1977. Cox and Pearson. 7th ed. Published Edinburgh; New York: Churchill Livingstone, 1976.
3. Foods: Facts and Principles. N. Shakuntala Many and S. Swamy, 4thed. New Age International (1998)
4. Odian; George, Principles of Polymerization, McGraw-Hill Book Co., New York (1970).
5. W. Billmeyer, Text book of polymer science, 3rd Edn., 2007, Wiley.
6. Foods: Facts and Principles. N. Shakuntala Many and S. Swamy, 4thed. New Age International (1998)
7. Subalakshmi, G and Udipi, SA (2006): Food processing and preservation, 1st Ed. New Age International (P)Ltd.
8. Srilakshmi B (2018): Food Science, 7th Colour Ed. New Age International (P) Ltd
9. Potter NN and Hotchkiss JH(1999): Food science,5th Ed , Springer.
- 10.M.P. Stevens, Polymer Chemistry: An Introduction 3rd ed. Oxford University Press (2005).

Chemistry. Semester II
Content of Theory Course 2
Unit – 1

Principles of Analytical Chemistry-II:

Complexometric titrimetry: Indicators for EDTA titrations - theory of metal ion indicators, . (2hrs)
titration methods employing EDTA - direct, back, displacement and indirect determinations,
Application-determination of hardness of water. (3hrs)
Precipitation titrimetry: Titration curves, titrants and standards, indicators for precipitation
titrations involving silver nitrate-Volhard's and Mohr's methods and their differences

Redox Titrimetry: Balancing redox equations, calculation of the equilibrium constant of (3 hrs)
redox reactions, titration curves, Theory of redox indicators. Applications. (2hrs)
Gravimetric Analysis: Requisites of precipitation, mechanism of precipitation, factors
influencing precipitation, co-precipitation, post-precipitation. Advantages of organic
reagents over inorganic reagents, reagents used in gravimetry: 8-hydroxy quinoline (oxine)
and dimethyl glyoxime (DMG).

Regression equation (least squares method), correlation coefficient (R^2), limit of detection (4 hrs)
(LOD), limit of quantification (LOQ), linear dynamic range (working range), sensitivity,
selectivity, method validation, figures of merit of analytical methods.

Unit – 2

14hrs

Physical Chemistry -II

Gaseous state: Molecular velocity, collision frequency, collision diameter, collision cross (4hrs)
section, collision number and mean free path and coefficient of viscosity, calculation of σ
and η , variation of viscosity with temperature and pressure.
Maxwell-Boltzmann distribution law of molecular velocities (most probable, average and
root mean square velocities). Relation between RMS, average and most probable velocity
and average kinetic energies. (mathematical derivation not required), law of equipartition of
energy.

Behaviour of real gases: Deviation from ideal gas behaviour. Compressibility factor (Z) (4hrs)
and its variation with pressure for different gases. Causes of deviation from ideal behaviour,
vander Waals equation of state (No derivation) and application in explaining real gas
behaviour. Critical phenomena - Andrews isotherms of CO_2 , critical constants and their
derivation from van der Waals equation, Experimental determination of critical constants.
Continuity of states, Law of corresponding states. Joule Thomson effect. Inversion
temperature, application of J-T effect, liquefaction of air by Linde's process. Numerical
problems.

Liquid state

(6hrs)

Surface tension: Definition and its determination using stalagmometer, effect of
temperature and solute on surface tension.

Viscosity: Definition, coefficient of viscosity. Determination of viscosity of a liquid using

Oswald viscometer. Effect of temperature, size, weight, shape of molecules and intermolecular forces.

Refraction: Specific and molar refraction- definition and advantages. Determination of refractive index by Abbes Refractometer. Additive and constitutive properties.

Dilute solutions. Review of colligative properties.

Experimental determination of molar mass of solute by: 1. Berkely-Hertely method 2.

Beckmann method 3. Landsbergis method. Numerical problems

Unit-3

Inorganic Chemistry-II

Solids: Forms of solids: Unit cell and space lattice, anisotropy of crystals, size and shape of crystals.

Laws of Crystallography: Law of constancy of interfacial angles, law of rational indices, law of symmetry (symmetry elements), crystal systems, Bravais lattice types and identification of lattice planes.

Miller indices and its calculation, X-Ray diffraction by crystals: Bragg's law and derivation of Bragg's equation, single crystal and powder diffraction methods. Defects in crystals, glasses and liquid crystals. Numerical problems.

(7hrs)

Parachor: Definition, atomic and structure parachor, elucidation of structure of benzene and benzoquinone. Viscosity and molecular structure. Molar refraction and chemical (3hrs)

Distribution Law: Nernst distribution law - Statement. Distribution coefficient, factors affecting distribution coefficient, validity of distribution law, modification of distribution law when molecules undergo a) association b) dissociation. Application of distribution law in Solvent extraction. Derivation for simple and multiple extractions. Principles of distribution law in Parke's process of desilverisation of lead. Numerical problems.

(4hrs)

Unit – 4

Organic Chemistry-II

Nucleophilic substitution at saturated carbon. Mechanism of SN1 and SN2 reactions with suitable examples. Energy profile diagrams, stereochemistry and factors effecting SN1 and SN2 reactions.

(4hrs)

Aromatic electrophilic substitution reactions, mechanisms, σ and π complexes, halogenation, nitration, sulphonation, Friedal Crafts alkylation and acylation with their mechanism. Activating and deactivating groups. Orientation influence, ortho - Para ratio (Cl, NO₂, CH₃, NH₂, OH).

(5hrs)

Aromatic nucleophilic substitution reaction: S_NAr mechanism, ipso substitution. Example -- conversion of 2,4-dinitrochlorobenzene to 2,4-dinitrophenyl hydrazine. Introduction to benzyne. Stability based on Huckel rule of aromaticity. Generation of benzyne with mechanism.

(5hrs)

Recommended Text books/references:

1. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York (2005).
2. Analytical Chemistry, G.D. Christian, 6th edition, Wiley-India (2007).
3. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 8th Ed., Oxford University Press (2006).
4. Physical Chemistry by Samuel Glasstone, ELBS (1982).
5. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
6. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
7. A Text book of Physical Chemistry, A S Negi & S C Anand, New Age International Publishers (2007).
8. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.
9. A Text Book of Physical Chemistry P.L.Soni, O.P. Dharmarhaand and U.N.Dash, Sultan Chand & Sons.
10. Advanced Physical Chemistry, Gurdeep Raj, Goel Publishing House (2018)
11. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
12. Finar, I. L. Organic Chemistry (Volume I), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)

PRACTICALS-(SEMESTER II)**PART-A (Inorganic Chemistry)****a) TITRIMETRY**

1. Estimation of carbonate and hydroxide present in a mixture.
2. Estimation of oxalic acid and sodium oxalate in a given mixture using standard $\text{KMnO}_4/\text{NaOH}$ solution.
3. Standardization of potassium permanganate solution and estimation of nitrite in a water sample.
4. Standardization of EDTA solution and estimation of hardness of water.

b) GRAVIMETRY

1. Determination of Ba^{2+} as BaSO_4 .
2. Estimation of Ni^{2+} as $\text{Ni}(\text{DMG})_2$ complex.
3. Determination of Cu^{2+} as CuSCN .
4. Estimation of Fe^{2+} as Fe_2O_3 .

PART -B (Physical Chemistry)**LIST OF EXPERIMENTS:**

1. Safety practices in the chemistry laboratory, knowledge about common toxic chemicals and safety measures in their handling, cleaning and drying of glasswares.
2. Determination of density using specific gravity bottle and viscosity of liquids using Ostwald's viscometer (ethyl acetate, toluene, chlorobenzene or any other non-hazardous liquids).
3. Study of the variation of viscosity of sucrose solution with varying concentration.
4. Determination of the density using specific gravity bottle and surface tension of liquids using Stalagmometer (ethyl acetate, toluene, chlorobenzene or any other non-hazardous liquids).
5. Determination of molar mass of non-electrolyte by Walker-Lumsden method.
6. Determination of specific and molar refraction by Abbes Refractometer (ethyl acetate, methyl acetate, ethylene chloride).
7. Determination of the composition of liquid mixture by refractometry (toluene & alcohol, water &

sucrose).

8. Determination of partition/distribution coefficient: i) Acetic acid in water and cyclohexane or ii) Acetic acid in water and butanol or iii) Benzoic acid in water and toluene.

Recommended Books/References

1. Practical Volumetric Analysis, Peter A C McPherson, Royal Society of Chemistry, Cambridge, UK (2015).
2. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
3. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
4. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).
5. Athawale V. D. and Mathur P. Experimental Physical Chemistry, New Age International (2001)

BSc Semester II
OPEN ELECTIVE - 2

Title of the Course: OE-2: MOLECULES OF LIFE

Number of Theory Credits 3

Number of lecture hours/ semester 42hrs.

Unit – 1

14 hrs.

Carbohydrates: Classification of carbohydrates, reducing and non-reducing sugars, general properties of glucose and fructose, their open chain structures. Epimers, mutarotation and anomers. Linkage between monosaccharides, structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

(8hrs)

Amino acids, peptides and proteins

Classification of amino acids, Zwitter ion structure and isoelectric point. Overview of primary, secondary, tertiary and quaternary structure of proteins. Determination of primary structure of peptides.

(6hrs)

Unit – 2.

Enzymes and correlation with drug action. Mechanism of enzyme action, factors affecting enzyme action, co-enzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecificity).

Enzyme inhibitors and their importance, phenomenon of inhibition (competitive and noncompetitive inhibition including allosteric inhibition). (10hrs)

Drug action - receptor theory. Structure–activity relationships of drug molecules, binding role of –OH group, -NH₂ group, double bond and aromatic ring.

(2hrs)

Lipids. Introduction to lipids, classification. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol). (2hrs)

Unit - 3

14 hrs

Nucleic acids. Components of nucleic acids: Adenine, guanine, thymine and cytosine (structure only), other components of nucleic acids, nucleosides and nucleotides (nomenclature), structure of polynucleotides: structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic code, biological roles of DNA and RNA: replication, transcription and translation.

(6hrs)

Concept of energy in bio systems. Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change. Conversion of food into energy. Outline of catabolic pathways of carbohydrate - Glycolysis, fermentation, Krebs cycle. Overview of catabolic pathways of fats and proteins. Interrelationships in the metabolic pathways of Proteins, fats and carbohydrates.

(8hrs)

Recommended Books/References

1. W. H. Freeman. Berg, J.M., Tymoczko, J. L. & Stryer, L. Biochemistry, 2002.
2. Morrison R. T. and Boyd R. N. Organic Chemistry, Sixth Edition Prentice Hall India, 2003.
3. Berg, J.M., Tymoczko, J.L, Stryer, L. (2006) Biochemistry. VI the Edition. W.H. Freeman and Co.
4. Nelson, D. L., Cox, M. M. and Lehninger, A. L. (2009) Principles of Biochemistry. 4th Edn. W.H. Freeman and Co.
5. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009) Harper's Illustrated Biochemistry. XXVIII edition. Lange medical Books/ McGraw-Hill Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Crichton R. H. Biological Inorganic Chemistry – An Introduction, Elsevier, 2008.
7. Berg J. M., Tymoczko J. L., Stryer L. Biochemistry, W. H. Freeman, 2008.
8. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed. 2006.

DSC-3: Analytical and Organic Chemistry-II

Contact Hours: 56

Work load: 4 Hours/Week.

Unit-I

Quantitative Analysis-Instrumental methods

Electromagnetic spectrum, absorption of electromagnetic radiation, Definition and units of frequency, wavelength, wave number, Beer's law, Beer-Lambert law derivation, deviations from Beer's law, limitations, construction of calibration graph (Plot of absorbance versus concentration), Evaluation Procedures- standard addition, Internal standard addition, validation parameters-detection limits, sensitivity, dynamic/linearity range, Instrumentation, single beam and double beam spectrophotometers, quantitative applications of colorimetry (determination of Fe, Mo, Cu, Ti and PO_4^{3-}) and numerical problems on application of Beer's law.

10 hrs

Nephelometry and Turbidimetry: Introduction, principle, instrumentations of nephelometry and turbidimetry; effects of concentration, particle size and wavelength on scattering; choice between nephelometry, applications of nephelometry and turbidimetry (determination of SO_4^{2-} and PO_4^{3-}).

4 hrs

Unit-II

Separation methods

Solvent Extraction: Definition of solvent extraction, Types- batch, continuous, efficiency, selectivity, Nernst distribution law, derivation, distribution coefficient, factors affecting the partition, relationship between % extraction and volume fraction, Numerical problems on solvent extraction. Solvent extraction of iron and copper.

4hrs

Fundamentals of chromatography: General description, definition, terms and parameters used in chromatography, classification of chromatographic methods, criteria for selection of stationary and mobile phase and nature of adsorbents. Principles of paper, thin layer, column chromatography. Column efficiency, factors affecting the column efficiency, van Deemter's equation and its modern version.

3hrs

Paper chromatography: Theory and applications.

Thin layer chromatography (TLC): Mechanism, R_f value, efficiency of TLC plates, methodology—selection of stationary and mobile phases, development, spray reagents, identification and detection, qualitative applications.

4 hrs

Ion exchange chromatography: resins, types with examples- cation exchange and anion exchange resins, mechanism of cation and anion exchange process and applications of ion exchange chromatography (softening of hard water, separation of lanthanides, industrial applications).

3hrs

Unit-III

Reaction Intermediates: Generation, Stability and Reactions of,

i) Carbocations: Dienone-phenol; and Pinacol-Pinacolone Rearrangement.

ii) Carbanions : Perkin Reaction, Aldol condensation, Claisen-Schmidt condensation.

iii) Free Radicals: Sandmeyer Reaction

iv) Carbenes and Nitrenes: Singlet and Triplet states, their relative stability and reactions

v) Arynes: Formation and detection

8 hrs

Methods for identifying reaction mechanism:

Product analysis, Isolation and Identification of Intermediates, Stereochemical

Evidences, Effect of Catalyst, crossover Experiments, Isotopic studies, Kinetic Studies.

6 hrs

Unit-IV

Stereochemistry of Organic Compounds:

Fischer projection, Newmann and Sawhorse projection formulae and their interconversions. Geometrical isomerism: Cis-trans and syn-anti isomerism, E/Z notations with C.I.P rules. Optical Isomerism: Optical activity, Specific rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral centres, Diastereoisomers, meso structures, Racemic mixtures and Resolution, Relative and absolute configuration, D/L and R/S designations.

14 hrs

References:

- 1) Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York (2005).
- 2) Analytical Chemistry, G.D. Christian, 6th edition, Wiley-India (2007).
- 3) Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, PHI Learning Pvt Ltd.NewDelhi(2009).
- 4) Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D.Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson EducationPvt. Ltd. 2007.
- 5) Organic Reaction Mechanism by V. K. Ahluwalia and R. K. Parashar (Narosa Publishers) 2007
- 6) Organic Chemistry by S .M. Mukherji, S. P. Sinh and R. K. Kapoor (Narosa Publishers)
- 7) Morrison R.N and Boyd R.N, Organic Chemistry, Darling Kindersley (India) Pvt.Ltd. (Pearson Education) 2016.
- 8)Finar I.L, Organic Chemistry (Volume I); Finar I.L (Volume II) Stereochemistry and the Chemistry of Natural Products., Dorling Kindersley(India)Pvt. Ltd. (Pearson Education) 2002
- 9) Kalsi P.S. Stereochemistry, conformation and Mechanism, New age International, 2005
- 10) Eliel E.L and Wilen S.H, Stereochemistry of Organic Compounds, Wiley, (London),2020.

PRACTICALS

Credit Points: 2

Teaching Hours:4 hrs

PART-A (Analytical Chemistry)

- 1) Colorimetric determination of copper using ammonia solution
- 2) Colorimetric determination of iron using thiocyanate solution
- 3) Colorimetric determination of nickel using DMG solution
- 4) Colorimetric determination of titanium using hydrogen peroxide
- 5) Colorimetric determination of nitrite in a water sample (diazo coupling Reaction/Griess reagent
- 6) Colorimetric determination of phosphate as ammonium phosphomolybdate
- 7) Determination of R_f values of two or three component systems by TLC

8) Separation of different metal ions by paper chromatography/ Solvent extraction of iron using oxine solution (demonstration)

PART-B(Organic Chemistry)

Qualitative analysis of bifunctional Organic compounds such as:

1) Salicylic acid, p-Nitro benzoic acid, Antranilic acid, p-Chloro benzoic acid

2) o-Cresol, p-Cresol, Resorcinol, o-Nitrophenol, p-nitrophenol

3) o-Nitro aniline, p-Nitroaniline, p-Toluidine, p-Chloroaniline, p-Bromoaniline,

4) Ethyl Salicylate, Salicylaldehyde, Acetophenone, p-Dichlorobenzene, p-Nitro toluene, Benzamide etc. (At least 6-8 compounds to be analysed in a semester)

References

1) Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6

th edition, Third Indian Reprint, Pearson Education Pvt.Ltd.(2007)

2) Vogel's Text Book of Qualitative Chemical Analysis, ELBS

OE1: For Science students

Title of the Course: Open Elective-3: ATOMIC STRUCTURE, BONDING AND CONCEPTS IN ORGANIC CHEMISTRY

Contact Hours: 42

Workload: 3 hours per week

Credit Points: 3

Evaluation: Continuous Internal Assessment - 40 marks

Semester End Examination - 60 marks

Unit I: Atomic Structure and Periodic Properties

History of an atom. Idea of de Broglie matter waves. Heisenberg uncertainty principle. Schrödinger wave equation, significance of wave functions, Bohr's model of hydrogen atom and its limitations. Quantum numbers and their importance, atomic orbitals and shapes of s, p, d orbitals, Multi-electron atoms, Aufbau and Pauli exclusion principle and Hund's multiplicity rule- Electronic configurations of the elements (atomic no. up to 30), effective nuclear charge and shielding. **(8 hours)**

Periodic Properties

Atomic radius, Covalent, ionic and van der Waal radii-explanation with examples. Definition and periodicity of the following properties - ionic radii, ionisation potential, electron affinity and electronegativity, methods of determination of electronegativity. Factors affecting the values of ionisation energy. **(6 hours)**

Unit II: Chemical Bonding

Ionic Solids– Ionic structures (NaCl, CsCl, TiO₂, ZnS), radius ratio rule and coordination number, limitation of radius ratio rule, lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarisability of ions, Fajan's rule and their consequences. **(4 hours)**

Covalent Bond – Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization with examples and shapes of simple inorganic molecules and ions. Shapes of NH₃, I₃⁺, I₃⁻, SF₄, ClF₃, IF₅, ICl₂⁻ and H₂O using valence shell electron pair repulsion (VSEPR) theory, linear combination of atomic orbitals (LCAO), bonding, nonbonding and antibonding molecular orbitals, physical picture of bonding and antibonding wave functions. Applications of MO theory to explain the stability of homo dinuclear (He₂, N₂, O₂, F₂, C₂) and hetero dinuclear (NO and CO) molecules. Comparison of M.O. and V.B. Models. **(7 hours)**

Metallic bond-free electron, Band theory-electrical properties of metals, semiconductors and insulators.

Weak interactions – Hydrogen bonding and its consequences, van der Waals forces. **(3 hours)**

Unit III: Bonding and molecular structure and hydrocarbons

Bonding and molecular structure: Introduction to organic chemistry, atomic orbitals, sigma and pi bond formation-molecular orbital [MO] method, sp, sp² and sp³ hybridization, bond length, bond dissociation energies and bond angles (open chain and cyclic compounds). Electronegativity and polarity of the bonds. Classification and reactions of organic compounds (with examples). **(7 Hours)**

Alkanes, Alkenes and Alkynes

Definition, Nomenclature, preparations (any two methods)

Reactions: Electrophilic, nucleophilic and free radical addition reactions

Alicyclic compounds:

Nomenclature, preparation and stability of cyclopropane, cyclobutane, cyclopentane and cyclohexane. **(7Hours)**

Reference Books:

1. Concise Inorganic Chemistry, J. D. Lee, ELBS, 1996.
2. Inorganic Chemistry, A. K. Das
3. Inorganic Chemistry: Principles of Structure and Reactivity, Huheey, J. E., Keiter, E.A., Keiter, R.L. & Medhi, O. K. Pearson Education India, 2006.
4. Inorganic Chemistry, Shriver, D.F. & Atkins, P.W.Oxford University Press.
5. Schaum's Outline Series Theory and Problems of Organic Chemistry.SI (metric) edition Herbert Meislich, Howard Nechamkin and Jacob Sharefkin.
6. Organic chemistry. Robert T.Morrison Robert N. Boyd,6thEdition
7. Organic Chemistry Volume-1, I.L.Finar

DSC-4: Inorganic and Physical Chemistry-II

Contact Hours: 56

Work load: 4 Hours/Week.

Credit Points :4

Evaluation: Continuous Internal Assessment-40 Marks
Semester End Examination -60 Marks

Unit - I

Structure and Bonding -I

The ionic bond: Structures of ionic solids

Radius ratio rules, Calculation of some limiting radius ratio values, Coordination number 3 (planar triangle), Coordination number 4 (tetrahedral and square planar), Coordination number 6 (octahedral), Close packing. **3hrs**

Classification of ionic structures:

Ionic compounds of the type AX (ZnS, NaCl, CsCl)

Ionic compounds of the type AX₂ (Calcium fluoride (fluorite) and Rutile structure Layer structures CdI₂, Cadmium iodide structure

Limitations of radius ratio concept

2hrs

Lattice energy and Born-Haber cycle, Derivation of Born-Landé equation and its drawbacks, Kapustinskii equation, solvation energy and solubility of ionic solids, polarizing power and polarizability, Fajan's rules with applications. Numerical problems **5 hrs**

Covalent bond: Valence bond theory, The Lewis theory, The octet rule, Exceptions to the octet rule, Sidgwick-Powell theory. Valence shell electron pair repulsion (VSEPR) theory, Effect of lone pairs, electronegativity, isoelectronic principle, Examples using VSEPR theory: BF₃ and BF₄⁻, NH₃ and NH₄⁺, H₂O, PCl₅, ClF₃, SF₄, I₃⁻ and I₃⁺, SF₆, and IF₇.

Limitations of VSEPR.

4 hrs

Unit - II

Structure and Bonding -II

Concept of resonance, resonance energy, hybridisation, types of hybridization, sp, sp², sp³dsp²dsp³, sp³, sp³d² with one example each, and energetics of hybridization. Bent's rule,

Limitations of Valence Bond Theory.

3 hrs

Molecular Orbital theory:

LCAO concept: s-s, s-p, p-p, p-d and d-d combinations of orbitals, bonding, nonbonding and antibonding molecular orbitals, non-bonding combinations of orbitals, Rules for linear combination of atomic orbitals

Examples of molecular orbital treatment for homonuclear diatomic molecules H₂ molecule, H⁺ He₂ molecule, He⁺ molecule ion, Li²⁺ molecule, Be²⁺ molecule B²⁺ molecule, C²⁺ molecule, N²⁺ molecule, N₂⁺, O₂ molecule, O⁻ and O₂²⁻.

M.O. energy diagrams of heteronuclear diatomic molecules with examples (NO, NO+CO and HCl). Calculation of bond order, relationship between bond order, bond energy and bond length, magnetic properties based on MOT. **7 hrs**

Metallic Bonding:

General properties of metals: Conductivity, Lustre, Malleability and cohesive force Crystal structures of metals and Bond lengths

Theories of bonding in metals:

Free electron theory, Valence bond theory, Molecular orbital or band theory of solids Prediction

of conducting properties of conductors, insulators and semiconductors, extrinsic and intrinsic semiconductors using M.O. theory.

4 hrs

UNIT III

First Law of Thermodynamics

Thermodynamic Processes, Reversible and Irreversible Processes, Nature of Heat and Work, Internal Energy, First Law of Thermodynamics, Enthalpy of a System, Work done in isothermal and adiabatic expansion of an ideal gas, Numerical problems, Joule-Thomson Expansion, Relation between Joule-Thomson coefficient and other thermodynamic parameters.

Second law of Thermodynamics

Concept of entropy, thermodynamic scale of temperature, Statements of the Second Law of Thermodynamics, molecular and statistical interpretation of entropy, Calculation of entropy change for reversible and irreversible processes, Free Energy Functions: Gibbs and Helmholtz energy, Variation of S, G, A with T, V and P, Numerical problems, Free energy change and spontaneity, Gibbs-Helmholtz equation.

Third Law of Thermodynamics

Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.

9 Hrs

Surface Chemistry

Adsorption: Types of adsorption isotherms. Freundlich adsorption isotherm (only equation), its limitations. Langmuir adsorption isotherm (derivation to be done) and BET equation (derivation not included).

Catalysis: Types of Catalysis and theories with examples (intermediate compound theory and adsorption theory), Theory of acid base catalysis, Michaelis-Menten mechanism.

Heterogeneous catalysis: surface reactions, unimolecular, bimolecular surface reactions.

Autocatalysis with examples. Applications: Design process to removal of toxic compounds from industrial wastewater and treatment of portable water requirements.

5Hrs

UNIT IV

Chemical Kinetics

Differential and integrated form of rate expressions up to second order reactions, Derivation of expression of rate constant of second order reaction ($a=b$ and $a \neq b$), Problems on rate constant ($a=b$), Methods of determination of order of a reaction, temperature dependence of reaction rates; Arrhenius equation, activation energy, Numerical problems on Arrhenius equation in calculating energy of activation and rate constants. Collision theory of reaction rates, Lindemann's mechanism, qualitative treatment of the theory of absolute reaction rates. Experimental determination of kinetics of (i) inversion of cane sugar by polarimetric method (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide.

7 Hrs

Electrochemistry – I

Arrhenius theory of electrolytic dissociation. Merits and Demerits, Conductance, Specific conductance, equivalent and molar conductivity and their variation with dilution. Molar conductivity at infinite dilution. Numerical problems.

Kohlrausch's law of independent migration of ions and its applications, Debye-Hückel-Onsager equation. Ionic mobilities and their determinations, transference numbers and their relation to ionic mobility's, determination of transference numbers using Hittorf and Moving

Boundary methods.

Applications of conductance measurement: (i) degree of dissociation of weak electrolytes (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts (iv) conductometric titrations (acid base titrations only) and (v) Hydrolysis constants of salts.

Numerical problems.

7 Hrs

Reference Books

1. Peter Atkins & Julio De Paula, Physical Chemistry, 9th Ed., Oxford University Press(2010)
2. G W Castellan, Physical Chemistry, 4th Ed., Narosa (2004)
3. R G Mortimer, Physical Chemistry 3rd Ed., Elsevier: Noida, UP (2009)
4. B R Puri, L R Sharma and M S Pathania, Principal of Physical Chemistry, VishalPublishing Co. 2008
5. B S Bahl, G D Tuli and Arun Bahl, Essentials of Physical chemistry, S Chand &Company Ltd. 1994.
6. A S Negi and S C Anand, A textbook of Physical Chemistry, New Age InternationalPublishers, 2022
7. B N Bajpai, Advanced Physical chemistry, S Chand and Company ltd 2012.
8. R L Madan, Chemistry for Degree Students, Semester I, II, III and IV, S Chand andCompany Ltd.
9. P L Soni, O P Dharmarha and U N Dash, Textbook of Physical Chemistry, Sultan Chandand Sons 2021.

PRACTICALS

Credit Points: 2

Teaching Hours:4HrsEvaluation:

Continuous Internal Assessment-20 marks Semester End Examination: 30 marks

Part A- Inorganic Chemistry Practicals

Qualitative semi-micro analysis of mixtures containing 2 anions and 2 cations. Emphasis should be given to the understanding of different reactions.

The following cations and anions are suggested. Cations: NH_4^+ , Pb^{2+} , Bi^{3+} , Cu^{2+} , Al^{3+} , Fe^{3+} , Co^{2+} , Cr^{3+} , Ni^{2+} , Zn^{2+} , Mn^{2+} , Ba^{2+} , Ca^{2+} , Sr^{2+} , Mg^{2+} , Na^+ , K^+ and Li^+ .

Anions: CO_3^{2-} , CH_3COO^- , Cl^- , Br^- , I^- , NO_3^- , BO_3^{3-} , SO_4^{2-} , $\text{C}_2\text{O}_4^{2-}$ and PO_4^{3-}

Spot tests and flame tests to be carried out wherever possible.

Part B- Physical Chemistry Practicals

1. Determination of the enthalpy of neutralization of a strong acid with strong base.
2. The study of kinetics of potassium persulphate and potassium iodide volumetrically.
3. Determination of velocity constant for acid catalyzed hydrolysis of methyl acetate.
4. Determination of equivalent conductivity of strong electrolyte and verification of DHO equation.
5. Determination of dissociation constant of weak acid by conductivity method.
6. Conductometric titration of strong acid and strong base.
7. Conductometric titration of weak acid and strong base.
8. Determination of solubility product of sparingly soluble salt conductometrically.

References

1. Vogel's Qualitative analysis, Revised by G. Svehla, Pearson education, 2002
2. J B Yadav, Advanced Physical Chemistry, Krishna Prakashan Media (P) Ltd, Meerut.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R.Chand & Co.:

New Delhi (2011).

4. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).

5. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003)

Semester 4

B Sc / B Sc (Honors)

Title of the Course: Open Elective: Applications of Chemistry in Industries

Evaluation Scheme for Theory:

**Continuous Internal Assessment (CIA): 40 Marks Semester
End Examination (SEE): 60 marks**

UNIT I

Electrochemical Energy Sources

Batteries- Definition of a Cell and a Battery, Examples to each, Daniel cell, dry Cells - electrolytic and Galvanic cell, Representation of a cell. Standard electrode potential, Nernst equation (No derivation) and its application to chemical cell,

Oxidation -reduction reactions, electrode potential, EMF of an electrochemical cell,

Electrochemical series and its importance.

Primary and Secondary batteries, Battery components and their role. Working of the following

Batteries- Lead acid, Lithium Storage, Batteries, Fuel cells.

12 hrs

Types of Electrodes- Hydrogen, Calomel and Glass electrodes. Determination of pH using glass electrode.

2 hrs

UNIT II

Corrosion: Introduction, definition, damages of corrosion, reasons for corrosion to occur, Types of Corrosion, Corrosion rate, Factors affecting corrosion rate, Metallic factor-purity, electrode potential of metal, hydrogen over voltage, nature of corrosion product. Environmental Factors Temperature, pH of the medium, humidity, presence of impurities, electrical conductivity of the medium, velocity of the medium, concentration of the medium.

5hrs

Prevention of Corrosion: Material selection - Metals and alloys, metal purification, nonmetallic, Alteration of environment - Changing media, inhibitors, Design-wall thickness, design rules, Coating-Metallic and other inorganic coatings, organic coating.

5 hrs

Electroplating: Introduction, Electroplating of chromium (hard and decorative). Electroless plating: Introduction, distinction between electroplating and electroless plating processes.

Electroless plating of copper .

4 hrs

UNIT III

Metallurgy

Introduction: Ore, minerals, important ores of some common elements in India, General Principles of pyrometallurgy, roasting, Calcination, Gangue, Smelting, Flux, Gravity separation, Froth flotation process, leaching. Techniques employed for Purification of metal (Distillation process, Bessemerization, Electro-refining, Van Arkel and De Boer's Filament.

6 hrs

Extraction of metals: Extraction of Manganese (Pyrolusite), Titanium (Ilmanite) and Uranium.

4 hrs

Alloys: Introduction, Classification of alloys, commercially important alloys, gold karats, Production of Ferro alloys; Ferrochrome, Ferro Manganese, Uses of alloys. **4 hrs**

Reference Books

1. Barrow. G.M, Physical Chemistry, Tata McGraw-Hill, (2007)
2. An introduction to electrochemistry, Samuel Glasstone, East-West edition New Delhi, (1942)
3. Text book of physical chemistry, Samuel Glasstone, 2ndEdition, Mac Millan India Ltd, (1991)
4. Principles and applications of Electrochemistry, D. R. Crow, 3rd edition, Chapmanhall London, (1988)
- 28
5. Fundamentals of electrochemical deposition, Milan Paunovic and Mordechay Schlesinger, Wiley Interscience Publications, New York, (1998)
6. Engineering Chemistry, V R Kulkarni and K Ramakrishna Reddy, New Age International,(2015)
7. Electrochemistry and Corrosion Science, Nestor Perez, Springer (india) Pvt. Ltd., (2004)
8. Principles and Prevention of Corrosion, D. A. Jones, Macmillan Publ. Co., (1996)
9. Essential of Materials Science and Engineering, Donald R. Askeland, Thomson Learning,5th Edition, (2006)
10. Introduction to Engineering Materials, B. K. Agarwal, Tata McGraw Hill, 1st Edition
11. Material Science and Engineering, V. Raghavan, PHI Learning, 5th Edition
12. Engineering Materials and Metallurgy, R. K. Rajput, S. Chand - 1st Edition, (2011)