

SYLLABUS - SEMESTER - I

CH1CMT01 - BASIC THEORETICAL AND ANALYTICAL CHEMISTRY

(Common for students who have opted Life Sciences, Family & Community Science, Physical Sciences and Geology as core)

Credits – 2

(36 Hrs)

Unit 1: Atomic Structure and Chemical Bonding

(9 Hrs)

Atomic Structure: Bohr atom model and its limitations, Dual nature of matter and radiation. Photoelectric effect, de Broglie equation, Heisenberg's uncertainty principle, Concept of orbital, Quantum numbers, shapes of orbitals (s, p, d), Electronic configuration of atoms - Aufbau principle, Hund's rule of maximum multiplicity, Pauli's exclusion principle.

Chemical Bonding: Introduction – Type of bonds. Ionic bond: Factors favouring the formation of ionic bonds - Lattice energy of ionic compounds and its applications. Covalent bond: Lewis theory - Valence bond theory – Coordinate bond. VSEPR theory and examples. Hybridisation: - sp³, sp² and sp (ethane, ethene, ethyne).

Intermolecular forces - Hydrogen bonding in H₂O - Dipole-dipole interactions.

Unit 2: Fundamental Concepts in Chemistry

(9 hrs)

Periodic Properties: Modern periodic law – Long form of periodic table. Periodicity in properties: Atomic radii, ionic radii, ionization enthalpy, electron affinity (electron gain enthalpy) and electronegativity (Pauling scale).

Atomic mass - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Oxidation number and valency - Equivalent mass.

Methods of expressing concentration: Weight percentage, molality, molarity, normality, mole fraction, ppm and millimoles.

Concept of Equilibrium: Acids and Bases - Arrhenius, Lowry-Bronsted and Lewis theories. Ionic product of water - pH and pOH, Strengths of acids and bases - K_a and K_b, pK_a and pK_b. Buffer solution. Preparation of buffer solution having a known pH.

Solvation, solubility, solubility product, common ion effect and their applications.

Unit 3: Basic Principles of Analytical Chemistry

(9 Hrs)

Laboratory Operations (Non-evaluative): Laboratory safety and first aid.

Use of different glassware like pipette, burette, standard measuring flask, distillation apparatus; heating methods, filtration techniques, weighing principle in chemical balance, weighing in electronic balance.

Methods of Analysis: Volumetric method of analysis - General principles. Primary and secondary standards, criteria for primary standards, preparation of standard solutions, standardization of solutions, end point. Acid base, redox and complexometric titrations and corresponding indicators. Double burette method of titration: Principle and advantages. Microanalysis and its advantages. Gravimetric method of analysis: General principles.

Reporting of Analytical Data: Units, significant digits, rounding, scientific and prefix notation, graphing of data - Precision and accuracy – Types of errors – Ways of expressing precision – Methods to reduce systematic errors.

Separation and Purification Techniques: Recrystallisation, use of drying agents, sublimation. General principles of distillation, fractional distillation, distillation under reduced pressure. Solvent extraction.

Unit 4: Chromatographic Techniques

(9 Hrs)

Chromatography - Principle of differential migration. Classification of chromatographic methods. Basic principle and uses of Thin layer chromatography (TLC), R_f value, Column chromatography, Partition chromatography, Paper chromatography (PC), [Gas chromatography (GC), High performance Liquid chromatography (HPLC), Ion Exchange chromatography (IEC)

References

1. B.R. Puri, L. R. Sharma, M.S. Pathania, Elements of Physical Chemistry, 3rd edn. Vishal Pub. Co., 2008. 2. C. N. R. Rao, University General Chemistry, Macmillan, 2009.
2. ManasChanda, Atomic Structure and Molecular Spectroscopy.
3. P.L. Soni, Inorganic Chemistry.
4. R.A. Day Junior, A.L. Underwood, Quantitative Analysis, 5th edn. Prentice Hall of India Pvt. Ltd. New Delhi, 1988.
5. J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas, Vogel's Text Book of Quantitative Chemical Analysis, 6th edn. Pearson Education (2003).
6. R. Gopalan, Analytical Chemistry, S. Chand and Co., New Delhi.

SYLLABUS - SEMESTER II

CH2CMT02 - BASIC ORGANIC CHEMISTRY

(Common for students who have opted Life Sciences, Family & Community Science, Physical Sciences and Geology as core)

Credits – 2 (36 Hrs)

Unit 1: Fundamental Concepts of Organic Chemistry

(9 Hrs)

Introduction: Origin of organic chemistry – Uniqueness of carbon – Homologous series, IUPAC nomenclature of alkyl halides, alcohols, aldehydes, ketones, carboxylic acids and amines. Structural isomerism: Chain isomerism, position isomerism, functional isomerism, metamerism and tautomerism. Arrow formalism in organic chemistry. Bond fission - homolytic and heterolytic fission. Types of reagents - Electrophiles and nucleophiles. Polarity of bonds. Reaction Intermediates: Carbocations, carbanions and free radicals (preparation, structure, hybridization and stability). Types of organic reactions: Addition, Elimination, Substitution, Rearrangement and Redox reactions (definition and one example each).

Unit 2: Mechanisms of Organic Reactions

(9 Hrs)

Meaning of reaction mechanism. Polarity of bonds. Electron Displacement Effects: Inductive effect - Definition - Characteristics - +I and -I groups. Applications: Explanation of substituent effect on the acidity of aliphatic carboxylic acids. Mesomeric effect: Definition - Characteristics - +M and -M groups. Applications: Comparison of electron density in benzene, nitrobenzene and phenol. Hyperconjugation: Definition - Characteristics. Applications: Baker-Nathan effect, Comparison of stability of 2-methyl-1-butene & 2-methyl-2-butene. Steric effect (causes and simple examples). Substitution reactions: Nucleophilic substitution of alkyl halides- SN^1 and SN^2 mechanisms. Electrophilic substitutions in benzene - reaction mechanism. Addition reactions: electrophilic addition to alkenes and alkynes - Markwonikoff's rule, Peroxide effect. Elimination reactions: E1 and E2 mechanisms.

Unit 3: Stereochemistry of Organic Compounds

(9 Hrs)

Stereoisomerism – definition, classification. Geometrical Isomerism: Definition – Condition – Geometrical isomerism in but-2-ene and but-2-ene-1,4-dioic acid. cis and trans, E and Z configurations. Methods of distinguishing and interconversion of geometrical isomers. Optical Isomerism: Optical activity – Chirality – Enantiomers - Meso compounds - Diastereoisomers – Optical isomerism in lactic acid and tartaric acid - Racemisation and resolution (elementary idea only). Conformations: Newman projection, Saw-horse projection. Conformations of ethane, nbutane, and cyclohexane - Relative stability and energy diagrams. Conformation of methyl cyclohexane.

Unit 4: Natural and Synthetic Polymers

(9 Hrs)

Introduction. Classification of polymers: Natural, synthetic; linear, cross-linked and network; plastics, elastomers, fibres; homopolymers and copolymers. Polymerization reactions. Typical examples: Polyethylene, polypropylene, PVC, phenol-formaldehyde and melamine- formaldehyde resins, polyamides (nylons) and polyesters. Natural rubber: structure, latex processing methods, vulcanization and uses. Synthetic rubbers: SBR, nitrile rubber and neoprene. Biodegradability of polymers, environmental hazards. Recycling of plastics.

References:

1. L. Finar, Organic Chemistry Vol. I, 6th edn. Pearson.
2. M.K. Jain, S.C. Sharma, Modern Organic Chemistry, Vishal Publishing Co. 2010.
3. S.M. Mukherji, S. P Singh, R. P Kapoor, Organic Chemistry Vol.1, New Age International Pvt. Ltd. 2006.
4. S. Sengupta, Basic Stereochemistry of Organic Molecules, 2014.
5. E. L. Eliel, S.H. Wilen, Stereochemistry of Organic Compounds, Wiley, 1994.
6. Peter Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th edn. Orient Longman, 1988.
7. S. M. Mukherji, S.P Singh, Reaction Mechanism in Organic Chemistry, Macmillan, 3rd edn., 2003.
8. V.R. Gowarikar, N.V. Viswanathan, J. Sreedhar, Polymer Science, 2nd edn., New Age International Pvt. Ltd., 2015.

SYLLABUS - SEMESTER III

CH3CMT04: INORGANIC AND ORGANIC CHEMISTRY

(For students who have opted Life Sciences and Family & Community Science as core)

Credits - 3 (54 Hrs)

Unit 1: Nuclear Chemistry

(12 Hrs)

Nuclear Stability - Mass defect, Binding energy, Nuclear forces, Magic number, Packing fraction, n/p ratio. Natural and induced radioactivity, radioactivity - detection, Units of radioactivity. Modes of decay - Group displacement law. Isotopes, isobars and isotones with examples. Nuclear fission - Atom bomb - Nuclear fusion - Hydrogen bomb - Nuclear reactors - Nuclear reactors in India. Application of radioactive isotopes - ^{14}C dating - Rock dating - Isotopes as tracers - Radio diagnosis and radiotherapy.

Unit 2: Bioinorganic Chemistry

(6 Hrs)

Thermodynamics of Living cell- Exergonic and endergonic reactions, coupled reactions. Metal ions in biological systems - Biochemistry of iron - Metalloporphyrins - Haemoglobin and myoglobin, pH of blood, cytochromes, Ferredoxine - Mechanism of O_2 and CO_2 transportation - Chlorophyll and photosynthesis (mechanism not expected) elementary idea of photophosphorylation. Photosynthesis and respiration - comparison. - Elementary idea of structure and mechanism of action of sodium potassium pump. Biochemistry of zinc and cobalt.

Unit 3: Chemistry and Agriculture

(12 Hrs)

Fertilizers: NPK, superphosphates, triple super phosphate, uses of mixed fertilizers, micronutrients and their role, bio-fertilizers, plant growth hormones. Pesticides: Classifications with simple examples, Biopesticides. Insecticides - stomach poisons, contact insecticides, fumigants. Method of preparation and use of DDT, BHC, pyrethrin. Herbicides - structure and function of 2, 4,-D and 2,4,5 -T, Fungicides- inorganic and organic- Bordeaux mixture. Excessive use of pesticides - environmental hazards.

Unit 4: Heterocyclic Compounds

(12 Hrs)

Aromaticity - Huckel's rule, preparation (any one method), properties, structure and aromaticity of furan, pyrrole, pyridine and indole. Pyrimidines & purines - adenine, guanine, thymine, cytosine and uracil.

Unit 5: Drugs

(6 Hrs)

Classification of drugs. Structure, therapeutic uses and mode of action (synthesis not required) of Antibiotics: Ampicillin, Sulpha drugs: Sulphanilamide, Antipyretics: Paracetamol, Analgesics: Aspirin, Antacids: Ranitidine, Antimalarials: Chloroquine and Anti-cancer drugs: Chlorambucil. Psychotropic drugs: Tranquilizers, antidepressants and stimulants with examples. Drug addiction and abuse. Prevention and treatment.

(6 Hrs)

Unit 6: Food Additives and Cosmetics

Food Additives: Food preservatives, artificial sweeteners, flavours, emulsifying agents, antioxidants, leavening agents and flavour enhancers (definition and examples, structures not required) - Structure of BHT, BHA and MSG - Commonly used permitted and non-permitted food colours (structures not required) - Fast foods and junk foods & their health effects - Soft drinks and their health effects. Cosmetics: Introduction, classification. Dental cosmetics, Shampoos, Hair dyes, Skin products, Shaving cream, Talcum powder, Perfumes and Deodorants (composition and health effects).

References

1. H.J. Arnikaar, Essentials of Nuclear Chemistry (Revised IV edn.), New Age, 1995.
2. B.R. Puri, L. R. Sharma, M.S. Pathania, Elements of Physical Chemistry, 3rd edn. Vishal Pub Co., 2008.
3. I.L. Finar, Organic Chemistry Vol. 1 & 2, 6th edn., Pearson, 2002.
4. C.N.R. Rao, University General Chemistry, Macmillan 2009.
5. B.R. Puri, L.R. Sharma and K.C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers New Delhi. 2013.
6. G.R. Chatwal, Synthetic Drugs, Himalaya Publishing House, Bombay, 1995.
7. J. Ghosh, A Text book of Pharmaceutical Chemistry, S. Chand & Co Ltd., 1997
8. B. Sreelakshmi, Food Science, New Age International Pvt. Ltd, New Delhi, 2015.
9. J.W. Hill, T.W. McCreary, D.K. Kolb, Chemistry for Changing Times, Prentice Hall, 12th edn., 2010.

SYLLABUS - SEMESTER IV

CH4CMT06 ADVANCED BIO-ORGANIC CHEMISTRY

(For students who have opted Life Sciences and Family & Community Science as core)

Credits - 3 (54 Hrs)

Unit 1: Natural Products

(6 Hrs)

Terpenoids: Classification with examples - Isoprene rule - Isolation of essential oils by steam distillation - Uses of lemongrass oil, eucalyptus oil and sandalwood oil - Source, structure and uses of citral and geraniol. Alkaloids: Classification - Isolation, general properties. Source, structure and physiological activity of nicotine, coniine and piperine.

Unit 2: Lipids

(6 Hrs)

Lipids: Classification - Oils, fats and waxes (definition, structure, biological functions and examples). Hydrogenation and Rancidity - Acid value, Saponification value and Iodine value -. Biological functions of phospholipids and glycolipids Soaps and Detergents: Soaps - Types of soaps. Cleansing action of soaps. Synthetic detergents - Classification. Comparison between soaps and detergents. Environmental aspects.

Unit 3: Amino Acids and Proteins

(12 Hrs)

Amino acids: Classification - Zwitter ion formation and isoelectric point- Synthesis of glycine, alanine, and phenyl alanine (any one method). Peptides: Peptide bond. Synthesis of peptides (upto dipeptides). Proteins: Classification of proteins - Primary, secondary and tertiary structure of proteins -- Denaturation of proteins - Tests for proteins.

Unit 4: Enzymes and Nucleic Acids

(9 Hrs)

Enzymes: Nomenclature, classification and characteristics. Mechanism of enzyme action. Theory of enzyme catalysis - Michaelis-Menten theory. Cofactors and coenzymes. Enzyme inhibitors. Uses of enzymes. Nucleic acids: Structure of pentose sugar, nitrogenous base, nucleoside and nucleotide - Double-helical structure of DNA - Differences between DNA and RNA. Biological Functions - Replication and protein biosynthesis. Transcription and Translation. Genetic code. Energy rich molecules: Elementary structure of ATP, ADP and AMP.

Unit 5: Carbohydrates

(12 Hrs)

Carbohydrates: Classification with examples. Preparation and properties of glucose, fructose and sucrose. Cyclic structures and Haworth projections of glucose, fructose, maltose and sucrose (ring size determination not expected). - Mutarotation. Conversion of glucose to fructose and vice versa. - Structure of starch and cellulose (structure elucidation not expected). Industrial applications of cellulose.

Unit 6: Vitamins, Steroids and Hormones

(9 Hrs)

Vitamins: Classification. Structure, biological functions and deficiency diseases of vitamins A, B1, B2, B3, B5, B6, B12 (structure not required), C and D.

Steroids: Introduction. Structure and functions of cholesterol. Elementary idea of HDL and LDL. Bile acids.

Hormones: Introduction. Steroid hormones, peptide hormones and amine hormones (examples, endocrine gland and biological functions, structure not required). Artificial hormones (elementary study only).

References

1. Maya Shankar Singh, L.G.Wade, *Organic Chemistry*, 6th Edition, Pearson Education, New Delhi, 2013.
2. P.Y. Bruice, *Essential Organic Chemistry*, 1st Edition, Pearson Education, New Delhi, 2013.
3. I.L. Finar, *Organic Chemistry Vol. I & II*, 5th Edition, Pearson Education, New Delhi, 2013.
4. M.K. Jain, S.C. Sharma, *Modern Organic Chemistry*, Vishal Publishing Co. 2010.
5. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edition, Vikas Publishing House (P) Ltd., New Delhi, 2004.
6. A. Bahl and B.S. Bahl, *Advanced Organic Chemistry*, 1st Multicolour Edition, S. Chand & Company, New Delhi, 2010.
7. A.C. Deb, *Fundamentals of Biochemistry*, 9th Edn. New Central Book Agency, 2001.
8. Rastogi, *Biochemistry*, Tata McGraw-Hill Publication, 1996.
9. Bhat S.V., Nagasampagi, B.A. & Sivakumar M. *Chemistry of Natural Products*, Narosa, 2005.