Complementary Chemistry Courses for B.Sc.

Course Outcomes

COURSE OUTCOMES FOR B.SC. CHEMISTRY (COMPLEMENTARY) SEMESTER I CH1CMT01 - BASIC THEORETICAL AND ANALYTICAL CHEMISTRY

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

Unit 1: Atomic Structure and Chemical Bonding

CO 1a To explain the Bohr atom model and its limitations.
CO 1b To comprehend the dual nature of matter and radiation.
CO 1c To understand the photoelectric effect, de Broglie equation, and Heisenberg's uncertainty principle.
CO 1d To grasp the concept of orbitals, quantum numbers, and the shapes of orbitals (s, p, d).
CO 1e To apply the Aufbau principle, Hund's rule of maximum multiplicity, and Pauli's exclusion principle in determining electronic configurations.
CO 1f To introduce and differentiate between various types of chemical bonds.
CO 1g To analyze the factors favoring the formation of ionic bonds, lattice energy of ionic compounds, and its applications.
CO 1h To understand covalent bonding, Lewis theory, valence bond theory, and coordinate bonds.
CO 1i To apply VSEPR theory and hybridization in molecules.

Unit 2: Fundamental Concepts in Chemistry

CO 2a To understand the modern periodic law and the long form of the periodic table.
CO 2b To analyze periodic trends, including atomic radii, ionic radii, ionization enthalpy, electron affinity, and electronegativity.
CO 2c To comprehend atomic and molecular masses, mole concept, molar volume, and oxidation-reduction reactions.
CO 2d To calculate oxidation numbers, valency, equivalent mass, and express concentration using various methods.
CO 2e To understand acids and bases according to Arrhenius, Lowry-Bronsted, and Lewis theories.
CO 2f To analyze the ionic product of water, pH, pOH, strengths of acids and bases, and buffer solutions.

Unit 3: Basic Principles of Analytical Chemistry

CO 3a To practice laboratory safety and first aid.
CO 3b To demonstrate the use of different glassware and laboratory techniques.
CO 3c To understand volumetric methods of analysis, primary and secondary standards, and titration techniques.

CO 3d To comprehend microanalysis, gravimetric methods, and reporting analytical data.
CO 3e To apply separation and purification techniques such as recrystallization, distillation, and solvent extraction.

Unit 4: Chromatographic Techniques

CO 4a To understand the principle of differential migration in chromatography.
CO 4b To classify chromatographic methods and analyze their basic principles.
CO 4c To comprehend and apply the principles of thin-layer chromatography (TLC), paper chromatography (PC), column chromatography, gas chromatography (GC), high-performance liquid chromatography (HPLC), and ion-exchange chromatography (IEC).

COURSE OUTCOMES FOR B.Sc. CHEMISTRY (COMPLEMENTARY)

SEMESTER II
CH2CMT02 - BASIC ORGANIC CHEMISTRY
(Common for students who have opted Life Sciences, Family & Community Science, Physical Sciences and Geology as core)

Unit 1: Fundamental Concepts of Organic Chemistry

CO 1a To understand the origin and uniqueness of organic chemistry, focusing on the role of carbon.
CO 1b To familiarize with homologous series and its significance in organic compounds.
CO 1c To master IUPAC nomenclature for alkyl halides, alcohols, aldehydes, ketones, carboxylic acids, and amines.
CO 1d To comprehend different types of structural isomerism, including chain isomerism, position isomerism, functional isomerism, metamerism, and tautomerism.
CO 1e To interpret arrow formalism in organic chemistry and understand bond fission, distinguishing between homolytic and heterolytic fission.
CO 1f To recognize the polarity of bonds and classify reagents as electrophiles and nucleophiles.
CO 1g To comprehend carbocations, carbanions, and free radicals' preparation, structure, hybridization, and stability.
CO 1h To classify and define different types of organic reactions, including addition, elimination, substitution, rearrangement, and redox reactions, with examples.

Unit 2: Mechanisms of Organic Reactions

CO 2a To understand the meaning of reaction mechanisms and electron displacement effects, including inductive effect and its applications.
CO 2b To explain the mesomeric effect and its applications, including comparing electron density in benzene, nitrobenzene, and phenol.

CO 2cTo define hyperconjugation and recognize its characteristics and applications.
CO 2d To analyze nucleophilic substitution of alkyl halides with SN1 and SN2 mechanisms and understand electrophilic substitutions in benzene.
CO 2e To comprehend electrophilic addition to alkenes and alkynes, incorporating Markownikoff's rule and the peroxide effect.
CO 2f To understand E1 and E2 mechanisms in elimination reactions.

Unit 3: Stereochemistry of Organic Compounds

CO 3a To define stereoisomerism and classify it into geometrical and optical isomerism.
CO 3b To understand the conditions and consequences of geometrical isomerism, specifically in but-2-ene and but-2-ene-1,4-dioic acid.
CO 3c To explain the optical activity, chirality, enantiomers, meso compounds, diastereoisomers, and optical isomerism in specific compounds.
CO 3d To comprehend conformations using Newman and Saw-horse projections, analyzing the stability and energy diagrams of ethane, n-butane, and cyclohexane.

Unit 4: Natural and Synthetic Polymers

CO 4a To classify polymers as natural/synthetic, linear/cross-linked/network, and homopolymers/copolymers.
CO 4b To understand polymerization reactions, exemplified by polyethylene, polypropylene, PVC, phenol-formaldehyde, melamine-formaldehyde resins, polyamides (nylons), and polyesters.
CO 4c To understand the structure, latex processing, vulcanization, and uses of natural rubber.
CO 4d To analyze synthetic rubbers like SBR, nitrile rubber, and neoprene, considering biodegradability, environmental hazards, and recycling of plastics.

PRACTICAL-I
(Semester I and II)
(Common to Physical sciences, Life sciences, Geology and Family & Community sciences)
CH2CMP01 - VOLUMETRIC ANALYSIS
Credit – 2 (72 Hrs)

CO 1 To prepare standard solutions using primary standards
CO 2 To use standard solution to standardise a given solution.
CO 3 To learn the techniques involved in volumetric chemical analysis with emphasis on solution preparation and dilution and chemical calculations involved in volumetric analysis.
CO 4 To learn the principles of acidimetry and alkalimetry
CO 5 To perform acidimetric and alkalimetric titration
CO 6 To learn the principles of complexometric tirations using edta as titrant.
CO 7 To understand the principles of redox titrations, iodometry and iodimetry

SEMESTER III
SEMESTER-III
CH3CMT03 - PHYSICAL CHEMISTRY – I
(For students who have opted Physical Sciences and Geology as Main)

Unit 1:
Solids and Crystalline State

1a.Differentiate: Classify solids into amorphous and crystalline structures.
1b.Compare: Highlight differences between amorphous and crystalline solids.
1c.Define: Explain the concept of lattice and lattice energy.
1d.Describe: Provide a general idea of lattice energy.
1e.Identify: Recognize different types of lattices.
1f.Illustrate: Draw examples of simple cubic, bcc, and fcc lattices.
1g.Calculate: Perform calculations for the number of atoms in a unit cell.
1h.Compute: Determine lattice parameters for a cubic unit cell.
1i.Discuss: Engage in a discussion about band theory.
1j.Differentiate: Differentiate between conductors, semiconductors, and insulators.
1k.Mention: Highlight the existence of superconductors.
1l.Classify: Categorize magnetic properties into diamagnetic, paramagnetic,
1m.antiferromagnetic, ferro and ferrimagnetic.
1n.Explain: Provide explanations for the different magnetic classifications.
1o.Identify: Recognize permanent and temporary magnets.

Unit 3:
Gaseous State:

3a.Define the kinetic molecular model of gases.
3b.Define Maxwell distribution of velocities and its significance.
3cExplain how the kinetic molecular model is used to calculate molecular velocities.
3d.Explain the concept of average velocity, RMS velocity, and most probable velocity.
3e.Apply Maxwell distribution to calculate molecular velocities.
3f.Apply the concepts of Boyle's law and Charles's law in problem-solving.
3g.Describe the behavior of ideal gases according to the ideal gas equation.
3hDescribe the deviation of real gases from ideal behavior.
3i.Demonstrate an understanding of Boyle's law through practical examples.
3jDemonstrate an understanding of Charles's law through practical examples.
3k.Analyze the factors affecting the behavior of real gases.
3l.Analyze the limitations of the ideal gas equation.
3m.Interpret the Van der Waals equation and its significance.
3n.Interpret deviations from ideal behavior in terms of Van der Waals forces.
3o.Compare and contrast the behavior of ideal gases and real gases.
3pCompare Boyle's law and Charles's law in terms of their applications

3qEvaluate the effectiveness of the kinetic molecular model in explaining gas behavior.
3r.Evaluate the applicability of the Van der Waals equation in describing real gas behavior.
3sDiscuss the assumptions and limitations of the kinetic molecular model.
3t.Discuss the practical implications of deviations from ideal gas behaviour

CH3CMT04: INORGANIC AND ORGANIC CHEMISTRY

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

Unit 1: Nuclear Chemistry

1a Explain the concept of nuclear stability, including mass defect, binding energy, and nuclear forces.
1b Calculate packing fraction and n/p ratio in nuclear reactions.
1c Differentiate between natural and induced radioactivity.
1d Describe the detection methods and units of radioactivity.
1e Apply the group displacement law to understand decay modes.
1f Define isotopes, isobars, and isotones with examples.
1g Explain nuclear fission, nuclear fusion, and their applications in atom and hydrogen bombs, as well as nuclear reactors.
1h Discuss the status of nuclear reactors in India.
1i Examine applications such as 14C dating, rock dating, isotopes as tracers, and their use in radio diagnosis and radiotherapy.

Unit 2: Bioinorganic Chemistry (6 Hrs)

2a Discuss the thermodynamics of living cells, emphasizing exergonic and endergonic reactions.
2b Explain coupled reactions in biological systems.
2c Investigate the biochemistry of iron, including its role in metalloporphyrins, hemoglobin, myoglobin, cytochromes, and ferredoxin.
2d Explore the mechanism of O2 and CO2 transportation.
2e Provide an elementary idea of the structure and mechanism of action of the sodium-potassium pump.
2f Examine the role of zinc and cobalt in biological systems.

Unit 3: Chemistry and Agriculture (12 Hrs)

3a Describe various fertilizers, including NPK, superphosphates, triple super phosphate, mixed fertilizers, and micronutrients.
3b Explain the uses of fertilizers and their role in plant growth.
3c Classify pesticides, including insecticides, herbicides, and fungicides.
3d Discuss the preparation and use of pesticides like DDT, BHC, pyrethrin, 2,4-D, 2,4,5-T, and Bordeaux mixture.
3e Evaluate the environmental hazards associated with excessive pesticide use.

Unit 4: Heterocyclic Compounds (12 Hrs)

4a Define aromaticity and Huckel's rule.
4b Apply Huckel's rule to determine the aromaticity of furan, pyrrole, pyridine, and indole.
4c Discuss the preparation, properties, and structure of furan, pyrrole, pyridine, indole, pyrimidines, and purines.

Unit 5: Drugs (6 Hrs)

5a Classify drugs into different categories.
5b Explain the structure, therapeutic uses, and mode of action of antibiotics, sulpha drugs, antipyretics, analgesics, antacids, antimalarials, and anticancer drugs.
5c Discuss psychotropic drugs, including tranquilizers, antidepressants, and stimulants, with examples.
5d Analyze the issues related to drug addiction and abuse, along with prevention and treatment methods.

Unit 6: Food Additives and Cosmetics (6 Hrs)

6a Define and classify food additives, including preservatives, artificial sweeteners, flavors, emulsifying agents, antioxidants, leavening agents, and flavor enhancers.
6b Provide examples of commonly used permitted and non-permitted food colors.
6c Introduce and classify cosmetics.
6d Discuss the composition and health effects of dental cosmetics, shampoos, hair dyes, skin products, shaving cream, talcum powder, perfumes, and deodorants.

SEMESTER IV

SEMESTER-IV

CH4CMT05 - PHYSICAL CHEMISTRY – II

(For students who have opted Physical Sciences and Geology as Main) Credits-3 (54 Hrs)

Unit 1 Introduction to Spectroscopy (9 Hrs)

1a.Analyze the quantization of energy in electronic, vibrational, and rotational energy levels.
1b.Apply the Boltzmann distribution formula to understand energy distribution among levels.
1c.Demonstrate an understanding of the population of electronic, vibrational, and rotational energy levels.
1d.Apply Beer Lambert's law in the context of UV-Visible Spectroscopy.
1e.Utilize the molar extinction coefficient and explain its significance.
1f.Interpret UV spectra, including identifying maxima, chromophores, and auxochromes.
1g.Explain red shift and blue shift phenomena in spectroscopy.
1h.Differentiate between types of transitions in UV-Visible Spectroscopy.
1i.Explain the principles of Infra-red Spectroscopy.
1j.Elaborate on vibrational degrees of freedom and types of vibrations.
1k.Calculate force constants in the context of Infra-red Spectroscopy.
1l.Apply the concept of group frequencies to determine common functional groups in organic compounds.
1m.Identify the fingerprint region in IR spectra and its significance.
1n.Discuss Rotational Spectroscopy in diatomic molecules.
1o.Explain the determination of bond length using Rotational Spectroscopy.

Unit 2:
Nano Chemistry (9 Hrs)

2a.Define key terms related to Nano Chemistry.
2b.Explain fundamental concepts in nanoscience.
2c.Analyze and compare different scales of nanosystems.
2d.Illustrate the importance of size-dependent properties at the nanoscale.
2e.Classify different types of nanoparticles.
2f.Evaluate the significance of nanoparticles in various applications.
2g.Compare and contrast chemical precipitation, mechano-chemical method, micro
2h.emulsion method, reduction technique, chemical vapor deposition, and sol-gel method for nanomaterial synthesis.
2i.Demonstrate proficiency in the selection of synthesis methods based on specific applications.
2j.Analyze the unique properties of fullerenes and carbon nanotubes.
2k.Explore diverse applications of fullerenes and carbon nanotubes in different fields.
2l.Evaluate the functioning of optoelectronic devices in nanochemistry.
2m.Analyze the principles underlying photodetectors, LEDs, and lasers at the nanoscale.
2n.Design and explain the operation of nanochemical devices.
2o.Evaluate the efficiency and applications of optoelectronic devices.
2p.Differentiate between photodetectors, LEDs, and lasers in nanochemical applications.
2q.Propose improvements and optimizations for these devices.
Investigate methods of integrating nanomaterials into optoelectronic devices.
2r.Assess the impact of nanomaterials on the performance and functionality of devices.
2s.Discuss safety protocols in handling nanomaterials.
2t.Analyze ethical considerations in the field of Nano Chemistry.
2u.Propose innovative solutions in nanomaterial synthesis and device fabrication.
2v.Critically analyze recent advancements in Nano Chemistry research.
2w.Effectively communicate complex Nano Chemistry concepts through oral and written means.
2x.Collaborate with peers in group discussions and projects related to Nano Chemistry.

Unit 3: Kinetics, Catalysis & Photochemistry

CO 1: To understand the concept of reaction rates as the change in concentration of reactants or products per unit time.
CO 2: To distinguish between reaction order and molecularity.
CO 3: To classify reactions based on their order, describing the relationship between reactant concentrations and reaction rate.
CO 4: To develop mathematical equations that describe the relationship between reactant concentrations and time for first and second order reactions.
CO 5: To understand the collision theory, which explains how the rate of a reaction is related to the frequency and energy of collisions between reactant molecules.

CO 6: To understand the collision theory, which explains how the rate of a reaction is related to the frequency and energy of collisions between reactant molecules.
CO 7: To understand the basic principles of catalysis.
CO 8: To apply the adsorption theory to analyze and understand catalytic processes on a molecular level.
CO 9: To establish the importance of light absorption in the initiation of photochemical processes.
CO 10: To analyze the subsequent pathways of excited molecules, including emission, energy transfer, or participation in chemical reactions.

CH4CMT06 ADVANCED BIO-ORGANIC CHEMISTRY

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

Unit 1: Natural Products (6 Hrs)

1a Classify terpenoids with examples.
1b Explain the Isoprene rule and its significance.
1c Demonstrate the process of steam distillation for isolating essential oils.
1d Explore the uses of lemongrass oil, eucalyptus oil, and sandalwood oil.
1e Identify the source and structure of citral and geraniol.
1f Discuss the various uses of citral and geraniol.
1g Classify alkaloids and describe their general properties.
1h Explain the isolation methods of alkaloids.

Unit 2: Lipids (6 Hrs)

2a Classify lipids into oils, fats, and waxes.
2b Define the structure, biological functions, and provide examples of each.
2c Explain the processes of hydrogenation and rancidity in lipids.
2d Analyze acid value, saponification value, and iodine value in lipid chemistry.
2e Discuss the biological functions of phospholipids and glycolipids.

Unit 3: Amino Acids and Proteins (12 Hrs)

3a Classify amino acids.
3b Explain the formation of Zwitter ions and isoelectric points.
3c Discuss the synthesis of glycine, alanine, and phenylalanine through at least one method.
3d Explore the peptide bond and synthesis of peptides up to dipeptides.
3e Classify proteins based on their structure.
3f Explain the primary, secondary, and tertiary structure of proteins.
3g Discuss denaturation and tests for proteins.

Unit 4: Enzymes and Nucleic Acids (9 Hrs)

4a Understand enzyme nomenclature, classification, and characteristics.
4b Explain the mechanism of enzyme action and the Michaelis-Menten theory.
4c Explore the role of cofactors and coenzymes.
4d Discuss enzyme inhibitors and their uses.
4e Describe the structure of pentose sugar, nitrogenous base, nucleoside, and nucleotide.
4f Explain the double-helical structure of DNA and the differences between DNA and RNA.
4g Discuss the biological functions of nucleic acids, including replication, protein biosynthesis, transcription, and translation.

Unit 5: Carbohydrates (12 Hrs)

5a Classify carbohydrates with examples.
5b Explain the preparation and properties of glucose, fructose, and sucrose.
5c Understand the cyclic structures and Haworth projections of glucose, fructose, maltose, and sucrose.
5d Discuss mutarotation and conversion between glucose and fructose.
5e Explore the structure of starch and cellulose.
5f Discuss industrial applications of cellulose.

Unit 6: Vitamins, Steroids, and Hormones (9 Hrs)

6a Classify vitamins.
6b Describe the structure, biological functions, and deficiency diseases of vitamins A, B1, B2, B3, B5, B6, B12, C, and D.
6c Introduce steroids and discuss the structure and functions of cholesterol.
6d Provide an elementary idea of HDL, LDL, and bile acids.
6e Classify hormones into steroid hormones, peptide hormones, and amine hormones.
6f Discuss examples, endocrine glands, and biological functions of hormones.
6g Provide an elementary study of artificial hormones.

PRACTICAL – II
(Semesters III and IV)
CH4CMP02 - PHYSICAL CHEMISTRY PRACTICALS
(For students who have opted Physical Sciences and Geology as Main)
Credit – 2 (72 Hrs)

CO 1- to determine Molecular Weight by Victor Meyer's method & Rast's methodCO 2- to determine Heat of solution and neutralization
CO 3- to determine Partition coefficient of a non volatile solute
CO 4- to determine Transition temperature of salt hydrates
CO 5- to determine Critical solution temperature
CO 6-To understand the techniques of conductometric titration and potentiometric titration
CO 7- to determine Phase diagram of two component systems
CO 8- To determine Heat of Solution and neutralization
CO 9- To determine the rate constant of reaction

CH4CMP03 - ORGANIC CHEMISTRY PRACTICALS
(For students who have opted Life Sciences and Family & Community Science as Core)
Credit – 2 (72 Hrs)

CO 1- To recognize the basic practical skills for the analysis of organic compounds.

CO 2- To detect the elements present in organic compounds
CO 3- To enable students to do tests for saturation and aromaticity
CO 4- To understand the reactions of certain functional groups like alcohol, aldehyde, ketone, carboxylic acid, 1,2 dicarboxylic acid, ester, primary and secondary amines. reducing and non-reducing sugars, phenol, tertiary amines, amide, nitro and halogen compounds diamide , anilide, polynuclear hydrocarbons