B. Sc Chemistry
(Model I)

Programme Outcome

Students would be able to demonstrate an understanding of major concepts in all disciplines of chemistry. Students would be able to employ critical thinking and the scientific method to design, carry out, record and analyze the results of chemical experiments and get an awareness of the impact of chemistry on the environment, society, and other cultures outside the scientific community.

Programme Specific Outcome

The Program enable the students

- To understand basic facts and concepts in Chemistry while retaining the exciting aspects of Chemistry so as to develop interest in the study of chemistry as a discipline.
- To acquire the knowledge of terms, facts, concepts, processes techniques and principles of the subject.
- To develop the ability to apply the of principles of Chemistry.
- To be inquisitive towards advanced chemistry and developments therein.
- To appreciate the achievements in Chemistry and to know the role of Chemistry in nature and in society.
- To develop problem solving skills.
- To be familiarised with the emerging areas of Chemistry and their applications in various spheres of Chemical sciences and to apprise the students of its relevance in future studies.
- To develop skills in the proper handling of apparatus and chemicals.
- To be exposed to the different processes used in industries and their applications.

Course Outcomes

SEMESTER 1

CH1CRT01 GENERAL AND ANALYTICAL CHEMISTRY

Credits 2 (36 hrs)

Unit 1: Methodology of Chemistry

CO 1a Remember the evolution of chemistry as a discipline of Science
CO 1b Identify and assess formulation of hypothesis, experiment, theory and law in scientific methods.
CO 1c To understand the role of chemistry as a central science and assess the interdisciplinary areas like nanotechnology and biotechnology

Unit 2 : Periodic Table and Periodic Properties

CO 2a Explain the organization of elements in the periodic table based on atomic number and electronic configuration

CO 2b Identify periods and groups in the periodic table and their significance
CO 2c Analyse how the properties of elements vary across periods and down groups in the periodic table
CO 2d Relate chemical behaviour to the electronic configuration of elements

Unit 3: Analytical methods in Chemistry

CO 3a Identify and explain fundamental principles of analytical Chemistry
CO 3b Apply various analytical techniques to solve chemical problems
CO 3c Develop critical thinking skills in the context of analytical methods

Unit 4 : Chromatographic methods

CO 4a Explain the principles and fundamental concepts of chromatography including the various types like gas chromatography, liquid chromatography, thin layer chromatography
CO 4b Demonstrate proficiency in handling chromatographic instruments and equipment
CO 4c Understand the components of chromatographic systems, including detectors, columns, and mobile phases

Unit 5: Evaluation of Analytical Data

CO 5a: Analyze and interpret complex chemical experiments.
CO 5b: Evaluate the accuracy and precision of experimental results.
CO 5c: Design experiments and propose strategies for improving analytical methods.

SEMESTER II

CH2CRT02 THEORETICAL AND INORGANIC CHEMISTRY

Credits 2 (36 hrs)

Unit 1: Atomic Structure

CO 1a Demonstrate the knowledge of the historical development of atomic theory from early ideas to the modern atomic model
CO 1b Explain the different atomic models proposed by scientists such as Dalton, Thomson, Rutherford, Bohr
CO 1c Understand the limitations and advantages of each model
CO 1d Explain the principles of quantum mechanics and how they relate to the behavior of electrons
CO 1e Apply electron configurations to represent the distribution of electrons in different atoms

Unit 2 Chemical Bonding I

CO 2a: Recall fundamental concepts related to chemical bonding.
CO 2b: Comprehend the principles of chemical bonding.
CO 2c: Apply knowledge of chemical bonding to predict molecular structures.

Unit 3 Chemical Bonding II

CO 3a: Analyze the geometry of molecules based on bonding theories.
CO 3b: Evaluate the stability of different types of chemical bonds.

CO 3c: Design molecular structures based on given bonding information.

Unit 4: **Chemistry of s and p Block Elements**

CO 4a Understanding periodicity in s and p block elements based on electronic configuration.

CO 4b Analyzing trends in atomic and ionic size across the periodic table.

CO 4c Exploring variations in ionization energy and electronegativity.

CO 4d Discussing the inert pair effect and its impact on the reactivity of certain elements.

Unit 5: Chemistry of d and f Block Elements

CO 5a Developing an understanding of transition metals, including general characteristics such as metallic character, oxidation states, size, density, melting points, boiling points, ionization energy

CO 5b Differentiating between the first row and the other two rows of transition elements.

CO 5c Examining the preparation, properties, structure, and uses of KMnO4 and K2Cr2O7.

CO 5d Studying lanthanides, including their electronic configuration and general characteristics.

CO 5e Investigating the occurrence of lanthanides and the isolation of lanthanides from monazite sand using ion exchange methods.

CO 5f Understanding lanthanide contraction, its causes, and consequences.

CO 5g Highlighting the industrial importance of lanthanides.

SEMESTER I AND II CORE CHEMISTRY PRACTICALS
CH2CRP01 VOLUMETRIC ANALYSIS
Credits: 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

CO 8 To understand the use of external and internal indicators to estimate ferrous ion

CO 9 To use the reduction technique in estimation of ferric ion.

SEMESTER III
CH3CRT03 ORGANIC CHEMISTRY – I
Credits – 3 (54 Hrs)

Unit 1. Fundamentals of Organic Chemistry

CO 1a Nomenclature and Line Diagram Drawing:Students will be able to systematically name and draw line diagrams of common aliphatic and aromatic organic compounds using the IUPAC system.

CO 1b Understand the factors influencing reaction mechanisms, including polarity of bonds, and explain how these factors impact chemical reactions.

CO 1c Describe and differentiate between various electronic displacements in organic molecules,

CO 1d Explain the processes of homolysis and heterolysis with suitable examples. Apply curly arrow rules and formal charges in the context of bond cleavage.

CO 1e Identify and categorize reagents as nucleophiles and electrophiles. Understand their roles in organic reactions.

CO 1f Classify and describe the types, shapes, and relative stability of reactive intermediates, including carbocations, carbanions, free radicals, and carbenes.
CO 1g Define and provide one example each of addition, elimination, substitution, rearrangement, and redox reactions. Understand the key characteristics of each type.

Unit 2. Stereochemistry

CO 2a To Define and explain the concept of stereochemistry
CO 2b To define chirality and identify chiral centers in organic molecules.
CO 2c To recognize the criteria for a molecule to exhibit chirality
CO 2d To describe the relationships between enantiomers and diastereomers.
CO 2e To explain the phenomenon of optical activity
CO 2f To represent three dimensional molecular structures using Newman projections, Fischer projections, and wedge dash diagrams.
CO 2g To Understand the concept of chiral resolutions
CO 2h To define conformational isomerism and differentiate it from constitutional isomerism and stereochemistry.
CO 2i To Explain the concept of torsional strain and steric hindrance
CO 2j To Apply conformational analysis to study the different conformations of butane., substituted cyclohexanes

Unit 3: Aliphatic Hydrocarbons and Alkyl Halides

CO 3a to describe and apply various methods for the preparation of alkanes,
CO 3b To Understand and apply the mechanism of free radical substitution reactions, specifically halogenation, in alkanes.
CO 3c To Describe the elimination reactions leading to the formation of alkenes.
CO 3d – To Understand and apply regioselectivity in reactions involving alkenes, considering Saytzeff's and Hofmann's rules.
CO 3e To Understand and apply the mechanisms of cis addition (alkaline KMnO4 and trans addition (bromine reactions in alkenes.
CO 3f To Apply Markovnikov's and anti Markovnikov's rules in predicting the outcomes of addition reactions to alkenes
CO 3g To Understand and describe the hydration of alkenes, including the addition of water to the double bond.
CO 3h To Explain the process of ozonolysis and its application in breaking double bonds.

Unit 4: Aromatic Hydrocarbons and Aryl Halides

CO 4a To define aromaticity and apply hückel's rule.
CO 4b To describe the molecular orbital picture and resonance energy of benzene, naphthalene and anthracene.
CO 4c To explore methods for preparing benzene, naphthalene and anthracene.
CO 4d To understand electrophilic and nucleophilic aromatic substitution reactions of benzene and naphthalene.
CO 4e To identify and classify ring activating and deactivating groups in aromatic compounds.
CO 4f To explain methods for preparing aryl halides.

Unit 5: Pericyclic Reactions

CO 5a To understand pericyclic reactions and classification.
CO 5b To understand the mechanism of the diels alder reaction and its significance in organic synthesis.
CO 5c To investigate sigmatropic rearrangements, focusing on the claisen rearrangement.

SEMESTER IV

CH4CRT04 ORGANIC CHEMISTRY –II
Credits – 3 (54 Hrs)

Unit 1: Alcohols, Phenols and Ethers

CO 1a Understand and apply methods for the preparation of alcohols
CO 1b Explore reactions of alcohols.
CO 1c Explain the preparation of diols through the hydroxylation of alkenes and hydrolysis of
epoxides.
CO 1d Understand reactions involving the oxidative cleavage of diols using lead tetraacetate and
periodic acid.
CO 1e Describe methods for the preparation of phenols,
CO 1f Explore electrophilic substitution reactions of phenols,
CO 1g To understand the mechanisms of Reimer Tiemann reaction and Fries rearrangement.
CO 1h To Discuss the preparation, reactions and uses of nitrophenols, picric acid, resorcinol, and quinol.
CO 1i To Understand the preparation and reactions of ethers and epoxides
CO 1j To understand Zeisel's method for the estimation of alkoxy groups.

Unit 2: Aldehydes and Ketones

CO 2a To understand the preparation, properties, and reactions of formaldehyde, acetaldehyde, acetone, benzaldehyde, benzophenone:
CO 2b To discuss the structure of the carbonyl group.
CO 2c To analyze the acidity of α hydrogens in carbonyl compounds.
CO 2d To explore addition reactions with carbonyl compounds:
CO 2e To analyze various condensation reactions with mechanisms.
CO 2f To examine oxidation and reductions reactions of carbonyl compounds
CO 2g To analyze beckmann and benzil benzilic acid rearrangements with mechanism.

Unit 3: Carboxylic Acids, Sulphonic Acids and their Derivatives

CO 3a To learn the preparations and reactions of Carboxylic acids
CO 3b To learn the preparations and reactions of Esters
CO 3c To learn the preparations and reactions of amides
CO 3d To learn the preparations and reactions of anhydrides: formed by the elimination of a water molecule between two carboxylic acid molecules.
CO 3e To learn the preparations and reactions of Acyl halides (or acid halides)
CO 3f To understand the preparation , reactions and uses of benzene sulphonic Acids

SEMESTER III AND IV ORGANIC CHEMISTRY
PRACTICALS I
CH4CRP02 QUALITATIVE ORGANIC ANALYSIS
Cridit 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 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.
CO 5 To determine the physical constants of solids and liquids.

SEMESTER V
CH5CRT05 ENVIRONMENTAL STUDIES AND HUMAN RIGHTS

Credits – 4 (72 Hrs)

Unit 1:

Introduction to Environmental Studies: Natural resources

CO 1a Understand the meaning and significance of environmental studies.
CO 1b Explore the scope of environmental studies in addressing global challenges.
CO 1c Recognize the importance of sustainable practices in preserving natural resources
CO 1d Identify the role of public awareness in environmental conservation.
CO 1e Appreciate the significance of community involvement in sustainable resource management
CO 1f Differentiate between renewable and non renewable resources.
CO 1g Evaluate the impact of human activities on the availability of these resources.
CO 1h Analyze the utilization patterns of forest resources.
CO 1i Assess the consequences of over exploitation and deforestation on ecosystems.
CO 1j Explore sustainable forestry practices
CO 1k Understand the usage patterns of surface and groundwater resources.
CO 1l Evaluate the environmental implications of over utilization.
CO 1m Analyze the causes and consequences of floods, droughts, and conflicts over water.
CO 1n Examine the advantages and disadvantages of dam construction.
CO 1o Understand the environmental and social impacts associated with dams.
CO 1p Identify global food challenges.
CO 1q Examine the impact of agricultural practices and overgrazing on food resources.
CO 1r Explore the extraction and utilization of mineral resources.
CO 1s Assess the environmental effects of mining and mineral resource exploitation.
CO 1t Understand the effects of modern agricultural practices.
CO 1u Evaluate the environmental implications of fertilizer and pesticide use
CO 1v Recognize land as a valuable resource.
CO 1w Analyze land degradation, man induced landslides, soil erosion, and desertification.
CO 1x Explore strategies for sustainable land management

UNIT - 2 Environment: pollution and social issues

CO-2a: Demonstrate a foundational understanding of various forms of environmental pollution, including air pollution, water pollution, soil contamination, and noise pollution.
CO-2b: Analyze and identify sources and causes of environmental pollution, considering natural processes, industrial activities, and anthropogenic influences.
CO-2c: Study the impact of pollution on ecosystems, biodiversity, and the natural balance of environments, recognizing the interconnectedness of living organisms.
CO-2d: Evaluate air quality parameters, including the concentration of pollutants such as particulate matter, gases, and volatile organic compounds, and understand their health implications.
CO-2e: Assess water quality parameters, including the presence of contaminants, nutrients, and pathogens, and understand the effects on aquatic ecosystems and human health.
CO-2f: Analyze soil contamination, including the presence of heavy metals, pesticides, and industrial pollutants, and understand their impact on soil fertility and food safety.
CO-2g: Study noise pollution, evaluate its sources, and understand its effects on human health, wildlife, and the overall quality of life.

UNIT - 3 POPULATION AND ENVIRONMENTAL ISSUES

CO 3a: To understand the basic theories addressing population and its impacts
CO 3b: To identify global challenges arising from population growth.
CO 3c: To analyze environmental problems associated with increased human population.

CO 3d: To explore methods to measure poverty and assess its impact on communities.
CO 3e: To understand the prominent environmental movements in India.

Unit 4: Ecological Chemistry

CO4a Define ecological chemistry and recognize its importance in assessing the impact of chemicals on ecosystems.
CO4b Identify the various ecological stresses caused by the presence of chemicals in natural environments.
CO4c Differentiate between natural sources and anthropogenic sources of chemicals in the environment.
CO4d Understand the origin of chemical toxicants and their effects on ecosystems.
CO4e Classify chemicals based on their nature as xenobiotic (foreign to an organism), essential (required for life), or nonessential.
CO4f Discuss the roles and implications of each category in ecological systems.
CO4g Analyze the mechanisms involved in the release of chemicals into the environment.
CO4h Understand the transport processes of chemicals, including their classification into biotic and abiotic pathways.
CO4i Classify transformation processes, including general, hydrolysis, oxidation, reduction, photochemical degradation, microbial degradation, and phytodegradation.
CO4j Investigate structure-activity relationships in the degradation and biodegradation of organic chemicals.
CO4k Explain the environmental fate-determining processes, such as bioavailability, exposure, uptake (accumulation), metabolism, biomagnification, and distribution in organisms.
CO4l Evaluate the potential toxic effects of chemicals on different species within ecosystems.
CO4m Apply risk assessment methodologies to evaluate the impact of chemicals on soil quality.
CO4n Understand the regulatory frameworks and protocols for assessing contaminated soils.
CO4o Define POPs and differentiate between natural and anthropogenic sources.
CO4p Analyze the characteristic properties of POPs, including half-lives, Kow, Kaw, and Koa.
CO4q Investigate the adverse effects of persistent chemicals on ecosystems and human health.
CO4r Understand international legislation related to the use and control of POPs, including the identification of twelve persistent organic pollutants.
CO4s Examine the sources, uses, physico-chemical properties, and environmental half-lives of priority POPs, such as polychlorinated biphenyls, dieldrin, aldrin, DDT, Mirex, heptachlor, and polychlorinated furans.

CO4t Discuss regulatory frameworks, including the ATSDR list, ATSDR 2017 Substance Priority List, RoHS directive, MSDS, TSCA, and the list of banned/severely restricted chemicals.

Unit 4: Introduction to Human Rights

CO 4a To comprehend the meaning and concept of human rights, including their historical development.
CO 4b To categorize human rights into three generations, distinguishing civil and political rights from economic, social, and cultural rights.
CO 4c To understand the role of the United Nations in promoting human rights.
CO 4d To analyze the contributions and functions of key UN organs related to human rights, including UNESCO, UNICEF, WHO, and ILO.
CO 4e To examine declarations specifically addressing women's and children's rights.
CO 4f To analyze the Universal Declaration of Human Rights and its significance in promoting a global understanding of human rights.
CO 4g To explore the incorporation of fundamental rights in the Indian Constitution.
CO 4h To analyze the rights afforded to specific groups in India, including children, women, Scheduled Castes, Scheduled Tribes, Other Backward Castes, and Minorities.
CO 4i To understand the right to a clean environment and public safety as integral components of human rights and analyze issues related to industrial pollution and explore measures for prevention, rehabilitation, and safety in new technologies such as chemical and nuclear technologies.
CO 4j To examine issues related to waste disposal and its impact on human right and understand the significance of protecting the environment in the context of human rights.

CH5CRT06 ORGANIC CHEMISTRY III
Credits – 3 (5CO4 Hrs)

Unit 1: Nitrogen Containing Compounds

CO 1a To explore the methods for the preparation and properties of nitro compounds.
CO 1b To describe reduction products of nitrobenzene and principles behind the formation of charge transfer complexes.
CO 1c To discuss various methods for the preparation and reactions of aliphatic and aromatic amines.
CO 1d To separate a mixture of 1°, 2°, and 3° amines
CO 1e To understand Stereochemistry of Amines
CO 1f To conduct a comparative study of aliphatic and aromatic amines
CO 1g To explain the role of quaternary amine salts as phase transfer catalysts in chemical reactions
CO 1h To explore the structure, stability and preparation of benzene diazonium salts
CO 1i To convert benzene diazonium salts to various compounds.
CO 1j To understand the preparation, structure, and uses of phenyl hydrazine, diazomethane, and diazoacetic ester.

Unit 2: Heterocyclic Compounds

CO 2a Classify heterocyclic compounds based on the presence of one heteroatom in 5 numbered and 6 membered rings.
CO 2b Demonstrate proficiency in naming heterocyclic compounds.
CO 2c Understand the structural features and aromaticity of 5 numbered and 6 membered heterocyclic rings.
CO 2d Apply aromaticity rules to determine the aromatic character of heterocycles.
CO 2e Describe the synthesis of heterocycles such as Furan, Thiophene, Pyrrole, Pyridine, Indole, Quinoline, and Isoquinoline.
CO 2f Explain Paal Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis, Fischer's indole synthesis, Skraup synthesis, Friedlander's synthesis, and Bischler Napieralski reaction.
CO 2g Analyze the reactions of heterocycles to understand their reactivity patterns.

Unit 3: Active Methylene Compounds (5 Hrs)

CO 3a Demonstrate the preparation of ethyl acetoacetate through Claisen ester condensation.
CO 3b Explain keto enol tautomerism and its significance.
CO 3c Showcase synthetic applications of ethylacetoacetate, diethyl malonate, and ethyl cyanoacetate for the preparation of non heteromolecules.
CO 3d Illustrate the alkylation of carbonyl compounds via enamines.

Unit CO4: Carbohydrates (11 Hrs)

CO 4a Classify carbohydrates and differentiate between reducing and non reducing sugars.
CO 4b Understand the general properties of Glucose and Fructose.
CO 4c Analyze the open chain structure of Glucose and Fructose.
CO 4d Explore epimers, mutarotation, and anomers in carbohydrate structures.
CO 4e Explain Kiliani Fischer synthesis and Wohl degradation for chain lengthening and shortening of aldoses.
CO 4f Understand the interconversion of aldoses and ketoses.
CO 4g Describe the structure of disaccharides (sucrose, maltose, cellobiose) and their reactions and uses.
CO 4h Examine the structure of polysaccharides (starch and cellulose) and understand their industrial applications.

Unit 5: Drugs (5 Hrs)

CO 5a Classify drugs into different categories.
CO 5b Explain the therapeutic uses and mode of action of antibiotics, sulpha drugs, antipyretics, analgesics, antimalarials, antacids, anti cancer drugs, and anti HIV agents.
CO 5c Understand the classifications of psychotropic drugs and their examples.
CO 5d Discuss issues related to drug addiction and abuse, along with prevention and treatment methods.

Unit 6: Dyes (CO4 Hrs)

CO 6a Explain the theories of color and their relationship to chemical constitution.
CO 6b Classify dyes based on chemical constitution and method of application.
CO 6c Describe the synthesis and applications of azo dyes, triphenyl methane dyes, phthalein dyes, indigoid dyes, anthraquinoid dyes, and edible dyes (food colors).

Unit 7: Polymers (6 Hrs)

CO 7a Understand the basics of polymers, their classification, and polymerization reactions (addition and condensation).
CO 7b Explain the mechanisms of cationic, anionic, and free radical addition polymerization.
CO 7c Introduce metallocene based Ziegler Natta polymerization of alkenes.
CO 7d Describe the preparation and applications of thermosetting plastics (phenol formaldehyde, urea formaldehyde, polyurethane) and thermosoftening plastics (polythene, PVC).
CO 7e Discuss synthetic rubbers (SBR, nitrile rubber, neoprene) and their applications.
CO 7f Investigate environmental hazards associated with polymers and discuss biodegradability.
CO 7g Explore recycling methods for plastics

CH5CRT07 – PHYSICAL CHEMISTRY I
Credits – 2 (36 Hrs)

Unit 1: Gaseous State (12 Hrs)

CO 1a Describe the postulates of the kinetic theory of gases.
CO 1b Derive the kinetic gas equation.
CO 1c Explain the deviation of real gases from ideal behavior.
CO 1d Introduce the compressibility factor and understand its significance.
CO 1e Identify the causes of deviation from ideal gas behavior.
CO 1f Derive the van der Waals equation of state for real gases.
CO 1g Discuss the significance of van der Waals parameters.
CO 1h Define Boyle temperature.
CO 1i Understand critical phenomena in gases.
CO 1j Analyze Andrews isotherms of CO2.
CO 1k Calculate critical constants using van der Waals equation.
CO 1l Introduce the virial equation of state.
CO 1m Express van der Waals equation in virial form.
CO 1n Explain the Maxwell Boltzmann distribution laws of molecular velocities.
CO 1o Discuss the graphical representation without requiring derivation.
CO 1p Understand the importance of these distribution laws.
CO 1q Analyze the temperature dependence of Maxwell Boltzmann distribution laws.
CO 1r Define and understand most probable, average, and root mean square velocities.
CO 1s Avoid derivation but focus on applications and implications.
CO 1t Define and discuss collision properties such as collision cross section, collision number, collision frequency, and collision diameter.
CO 1u Introduce the mean free path of molecules.
CO 1v Understand the relationship between mean free path and coefficient of viscosity.

Unit - 2 Liquid State

CO 2a: To develop a qualitative understanding of forces that governs the liquid state.
CO 2b: To understand the fundamental physical properties in liquids.

Unit - 3 Solid State

CO 3a: To develop a qualitative idea of the nature of the solid state.
CO 3b: To understand the basic concepts of crystallography.
CO 3c: To discuss the principles of X-ray diffraction by crystals.
CO 3d: To apply the principles of X- ray diffraction to interpret the structure of crystals.
CO 3e: To understand the imperfections in crystals and its effects on their properties.
CO 3f: To introduce the concept of superconductivity.
CO 3g: To familiarise with the nature and properties of liquid crystals.

Unit CO4: Surface Chemistry and Colloidal State

CO 4a Understanding Adsorption of gases by solids and the factors influencing adsorption.
CO 4b Interpret the Freundlich adsorption isotherm and understand its application.
CO 4c Derive the Langmuir adsorption isotherm and analyze its significance.
CO 4d Apply the BET equation for the determination of surface area in practical scenarios.
CO 4e Analyze the characteristics and properties of each type of solution.
CO 4f Explain the methods of purification of colloids, including ultrafiltration and electrodialysis.
CO 4g Explore the optical properties exhibited by colloids.
CO 4h Apply the Hardy-Schulz rule to predict and understand coagulation behavior.
CO 4i Discuss micelles and critical micelle concentration.
CO 4j Explain the phenomena of sedimentation and streaming potential in colloidal systems.
CO 4k Apply the principles of adsorption to solve practical problems.
CO 4l Critically evaluate the stability of colloidal dispersions.
CO 4m Propose strategies for enhancing or controlling colloidal stability in different environments.

CH5CRT08 – PHYSICAL CHEMISTRY – II
Credits 3 (36 Hrs)

Unit – 1 Quantum Mechanics

CO 1a: To understand the foundational principles and concepts of classical mechanics.
CO 1b: To analyze Max Planck's quantum theory and its role in explaining radiation phenomena.
CO 1c: To learn the key principles that laid the foundations of quantum mechanics.
CO 1d To understand the basic principles of quantum mechanics.
CO 1e: To analyze the quantum mechanical description of a particle with no external potential.
CO 1f: To apply quantum mechanics to simple systems, such as a particle in a one-dimensional box.
CO 1g: To gain an introductory understanding of the Schrödinger equation for the hydrogen atom.
CO 1h: To define the concept of quantum numbers and their importance in describing quantum states.
CO 1i: To understand the basic principles of molecular orbital theory.

Unit 2: Molecular Spectroscopy-I

CO 2a Understanding Electromagnetic Radiation
CO 2b Understand the principles underlying the Born-Oppenheimer approximation.
CO 2c Introduce rotational spectroscopy and its relevance in molecular analysis.
CO 2d Provide an introduction to vibrational spectroscopy.
CO 2e Demonstrate the calculation of force constants for molecular vibrations.
CO 2f Discuss the concept of anharmonicity and its implications in vibrational spectroscopy.
CO 2g Describe the Morse potential and its role in representing molecular potentials.
CO 2h Explore degrees of freedom for polyatomic molecules.
CO 2i Explain the concept of the fingerprint region in molecular spectroscopy.
CO 2j Discuss Fermi resonance and its impact on vibrational spectra.
CO 2k Provide an introduction to Raman spectroscopy.
CO 2l Present classical and quantum treatments of the Raman effect.
CO 2m Discuss the qualitative treatment of rotational Raman effect.
CO 2n Explain the principles underlying vibrational Raman spectra.
CO 2o Describe Stokes and anti-Stokes lines in Raman spectroscopy.
CO 2p Discuss the rule of mutual exclusion in Raman spectroscopy.
CO 2q Apply the principles of molecular spectroscopy to interpret experimental data.
CO 2r Demonstrate an understanding of the applications of molecular spectroscopic techniques in real-world scenarios.

Unit 3: Molecular Spectroscopy-II

CO 3a Understand the principles of electronic spectroscopy.
CO 3b Apply the Franck-Condon principle to analyze electronic spectra.
CO 3c Differentiate between singlet and triplet states in electronic transitions.
CO 3d Provide a qualitative description of σ, π, and n molecular orbitals in polyatomic molecules.
CO 3e Explain Lambert-Beer's law and its application in quantitative analysis using spectroscopy.
CO 3f Understand the principles of NMR spectroscopy.
CO 3g Explain spin-spin coupling in NMR spectroscopy.
CO 3h Understand the principle of Electron Spin Resonance (ESR) spectroscopy.
CO 3i Analyze hyperfine structure in ESR spectra.
CO 3j Apply ESR spectroscopy to study simple radicals, such as the methyl radical.
CO 3k Apply electronic spectroscopy to interpret the electronic transitions in different molecular systems.
CO 3l Utilize NMR spectroscopy for structural elucidation and quantitative analysis of organic compounds.
CO 3m Demonstrate proficiency in data interpretation and presentation.

OPEN COURSE
CH5OPT02 NANOSCIENCE AND NANOTECHNOLOGY

Unit 1: History of Nanotechnology

CO 1a Identify significant events and discoveries that contributed to the evolution of nanotechnology.
CO 1b Explain the role of various scientists and researchers in shaping the field.

CO 1c Explain terms such as nanotechnology, nanoscience, nanomaterials, etc.
CO 1d Demonstrate understanding of specialized vocabulary used in the field.
CO 1e Differentiate between macroscopic, microscopic, and nanoscopic scales.
CO 1f Discuss the challenges and opportunities associated with working at the nanoscale.
CO 1g Explain the concepts of top-down and bottom-up fabrication methods.
CO 1h Evaluate the advantages and limitations of each approach in nanoscale engineering.
CO 1i Summarize Richard Feynman's famous lecture on "There's Plenty of Room at the Bottom."
CO 1j Analyze the impact of Feynman's ideas on the development of nanotechnology.
CO 1k Define Moore's law and its implications for the miniaturization of electronic components.
CO 1l Evaluate the challenges and predictions associated with the continued application of Moore's law.
CO 1m Describe the discovery and production of fullerene.
CO 1n Assess the contribution of fullerene to nanotechnology.
CO 1o Analyze the unusual properties of fullerene and their applications.
CO 1p Explain the synthesis methods of carbon nanotubes.
CO 1q Explore the properties of carbon nanotubes and their significance.
CO 1r Discuss various applications of carbon nanotubes in different fields.
CO 1s Apply knowledge gained in the unit to analyze and solve problems related to nanotechnology.
CO 1t Critically evaluate the ethical implications and societal impact of nanotechnology.
CO 1u Present information on historical landmarks, terminology, scales, and nanomaterials clearly and concisely.
CO 1v Engage in discussions and debates about the future directions and challenges in nanotechnology

Unit 2: Nanoscience: Its Social, Economic and Ethical Perspectives

CO 2a: Demonstrate a foundational understanding of the principles of nanoscience, including quantum mechanics, nanomaterials, and nanoscale phenomena.
CO 2b: Analyze and assess the social implications of nanotechnology, including its impact on healthcare, environment, and societal attitudes toward technology.
CO 2c: Evaluate the economic significance of nanoscience, including the development of nanotechnological industries, job markets, and contributions to GDP.
CO 2d: Explore applications of nanotechnology in medicine, including drug delivery, imaging, and diagnostics, and assess their societal and economic implications.
CO 2e: Study the role of nanomaterials in energy related applications, such as solar cells, batteries, and energy storage, and evaluate their economic and environmental impact.
CO 2f: Analyze ethical considerations in nanoscience research and applications, including issues related to privacy, safety, and responsible conduct in research.
CO 2g: Assess the environmental impact of nanotechnology, including potential risks, life cycle assessments, and sustainable practices in nanomaterial production.

CO 2h: Explore applications of nanotechnology in agriculture, including nanopesticides, nanofertilizers, and smart delivery systems, and assess their societal and economic implications.

CO 2i: Study the role of nanotechnology in electronics, including nanoelectronics, quantum dots, and nanoscale devices, and evaluate their economic and technological significance.

Unit 3: Fundamental Particles and Electromagnetic Radiation

CO 3.1 .To Understand the basic building blocks of matter and the nature of electromagnetic radiation.

CO 3.2.To define fundamental particles and their classification.

CO 3.3.To explain the properties and behavior of quarks, leptons, and bosons.

CO 3.4. To discuss the electromagnetic spectrum and the properties of electromagnetic waves.

CO 3.5 . To Understand the relationship between energy, frequency, and wavelength in electromagnetic radiation.

CO 3.6. To explore the concept of wave-particle duality.

CO 3.7.To derive and understand the De Broglie wavelength equation.

CO 3.8. To Relate the De Broglie wavelength to the behavior of particles.

Co 3.9. To understand colour and constitution

CO 3.10. To define auxochromes and chromophores

CO 3.10. To Introduce various spectroscopic techniques and their applications in nanosystem studies.

CO 3.11.To define UV-Visible spectroscopy and explain its principles.

CO 3.12.To discuss the concept of auxochromes and their role in molecular color.

CO 3.13.To explore X-ray photoelectron spectroscopy (XPS) and its applications.

CO 3.14 To understand the principles of Secondary Ion Mass Spectrometry (SIMS).

Unit CO4: Applications of Nanotechnology

CO4a Understanding the basics of nanobiology.

CO4b Overview of nanomedicines and their significance.

CO4c Applications of nanotechnology in healthcare.

CO4d To Explore applications of nanoparticle drug delivery systems.

CO4e To explore Nasal and ocular drug administration using nanoscale systems.

CO4f Overview of nanomaterials used in medical diagnosis.

CO4g To explore of therapeutic applications of nanotechnology.

CO4h Focus on targeted therapy, gene therapy, and regenerative medicine.

CO4i To illustrate successful therapeutic interventions using nanotechnology through case studies.

CO4j Understanding nanosensors and their applications.

CO4k To Discuss on potential risks and ethical considerations.

CO4l To Explore destructive applications of nanotechnology.

CO4m To understand the role of regulations and safety measures in controlling destructive applications.

SEMESTER VI

CH6CRT09 - INORGANIC CHEMISTRY

UNIT 1 Coordination chemistry-1

CO 1a Understand the Basics of Coordination Compounds
CO 1b Classify Ligands and Understand IUPAC Nomenclature
CO 1c Explore Isomerism in Coordination Compounds:
CO 1d Investigate Chelates and the Chelate Effect:
CO 1e Evaluate Stability of Complexes:
CO 1f Review Werner's Theory and Sidgwick's Concept of Coordination:
CO 1g Apply acquired knowledge to predict and rationalize the properties of coordination compounds.
CO 1h Evaluate the impact of ligand types on the overall stability of coordination compounds.
CO 1i Effectively communicate the nomenclature, isomerism, and stability aspects of coordination compounds.
CO 1j Recognize the interdisciplinary nature of coordination chemistry and its applications in various scientific fields

UNIT 2 Coordination chemistry-II

CO 2a Understanding Valence Bond Theory (VBT):
CO 2b Analyzing Limitations of VBT:
CO 2c Exploring Crystal Field Theory (CFT):
CO 2d Examine the Jahn-Teller distortion in specific examples,
CO 2e Investigating Factors Affecting Crystal Field Splitting:
CO 2f Understanding Spectrochemical Series:
CO 2g Critiquing Crystal Field Theory:
CO 2h Introducing Molecular Orbital Theory (MOT)
CO 2i Constructing MO Diagrams for Octahedral Complexes:
CO 2j Solve problems and predict properties based on the principles of these bonding theories.

UNIT 3 Coordination chemistry-III

CO 3a Interpreting Electronic Absorption Spectra:
CO 3b Calculation of Magnetic Moments:
CO 3c Exploring Reactivity of Complexes:
CO 3d Understanding Trans Effect and its Applications:
CO 3e Explore the application of coordination chemistry in qualitative analysis of metal ions, focusing on Cu^{2+}, Zn^{2+}, Ni^{2+}, and Mg^{2+}.
CO 3f Integrate knowledge of ligand substitution reactions, SN1/SN2 mechanisms, and the trans effect to
CO 3g predict the reactivity of various coordination complexes.
CO 3h Apply coordination chemistry principles to practical scenarios, emphasizing the identification and
CO 3i quantification of metal ions in real-world samples.
CO 3j Critically assess the strengths and limitations of coordination chemistry applications in metal ion
CO 3k analysis.
CO 3l Effectively communicate the results of spectral and magnetic property analyses, as well as the
CO 3m outcomes of ligand substitution reactions.
CO 3n Apply acquired knowledge to solve complex problems in the field of coordination chemistry.

Unit CO4: Organometallic Compounds

CO4a-Define organometallic compounds and articulate their significance in chemistry.

Classify organometallic compounds based on the nature of the metal-carbon bond and hapticity.

CO4b-Apply systematic naming conventions to organometallic compounds.

CO4c-Explain the 18-electron rule and assess the stability of organometallic compounds.

CO4d-Demonstrate the preparation, properties, and bonding of ferrocene using Valence Bond Theory (VBT).

CO4e-Analyze metal-alkene complexes, focusing on the example of Zeise's salt.

CO4f-Evaluate the catalytic properties of organometallic compounds, specifically Zeigler Natta catalyst in alkene polymerization and Wilkinson catalyst in alkene hydrogenation (mechanism not expected).

CO4g-Describe the preparation and properties of mononuclear carbonyls, highlighting structures such as Mo(CO)6, Fe(CO)5, and Ni(CO)CO4.

CO4h-Examine polynuclear carbonyls, bridged carbonyls, and bonding in carbonyls using examples like Mn2(CO)10 and Fe2(CO)9.

CO4i-Calculate the effective atomic number (EAN) of metals in metal carbonyls and interpret its indication of metal-metal bonding.

CO4j-Analyze the structure of the quadruple bond in $Re_2Cl_8^{2-}$.

Unit 5: Bioinorganic Chemistry

CO-5a: Demonstrate a foundational understanding of the fundamental principles of bioinorganic chemistry, including the role of metal ions in biological systems.

CO-5b: Analyze the structure and function of metalloproteins and metalloenzymes, including the coordination geometry of metal centers and their catalytic roles.

CO-5c: Study metallocofactors in enzymes, including the identification and characterization of metal-containing active sites and their involvement in catalysis.

CO-5d: Explore the mechanisms of metal ion transport in biological systems, including membrane transporters and metallochaperones.

CO-5e: Analyze the processes involved in metal homeostasis within biological organisms, including metal ion sensing and regulatory mechanisms.

CO-5f: Study the role of metalloantibiotics and metallopharmaceuticals, including their mechanisms of action and potential applications in medicine.

Unit 6: Boron Compounds

CO 6a Explain the synthesis pathways for diborane.

CO 6b Evaluate the efficiency and safety considerations of various diborane production techniques.

CO 6c Identify physical and chemical properties of diborane.

CO 6d Analyze the reactivity of diborane in various chemical reactions.

CO 6e Understand the molecular structure of diborane.

CO 6f Explain the concept of bridging hydrogen atoms in diborane molecules.

CO 6g Describe the synthesis routes for borazine.

CO 6h Compare and contrast the preparation of borazine with other boron-nitrogen compounds.

CO 6i Identify the physical and chemical properties of borazine.

CO 6j Discuss the unique characteristics of borazine compared to other boron-containing compounds.

CO 6k Understand the molecular structure of borazine.

CO 6l Analyze the bonding patterns and geometry in borazine molecules.

CO 6m Describe the methods for obtaining boric acid from boron-containing minerals.
CO 6n Discuss industrial processes for boric acid production.
CO 6o Identify the physical and chemical properties of boric acid.
CO 6p Analyze the role of boric acid in various applications, such as in the pharmaceutical and glass industries.
CO 6q Understand the molecular structure and bonding in boric acid.
CO 6r Discuss the significance of boric acid's structure in its properties and applications.
CO 6s Describe the synthesis pathways for boron nitride.
CO 6t Compare the methods for producing different forms of boron nitride, such as hexagonal and cubic.
CO 6u Identify the physical and chemical properties of boron nitride.
CO 6v Discuss the unique characteristics of boron nitride in comparison to other boron and nitrogen compounds.
CO 6w Understand the crystal structure and bonding in different forms of boron nitride.
CO 6x Analyze the relationship between boron nitride's structure and its properties.
CO 6y Interpret experimental data related to the preparation and properties of diborane, borazine, boric acid, and boron nitride.
CO 6z Draw conclusions and make predictions based on experimental observations.
CO 6aa Present information on the preparation, properties, and structure of diborane, borazine, boric acid, and boron nitride clearly and coherently.
CO 6bb Engage in discussions on the applications and significance of these compounds in various industries.

Unit 7: Inter-halogen and Noble Gas Compounds

a. Understanding Interhalogens
CO 7b Exploring Interhalogen Structures
CO 7c Investigating Reactivity of Interhalogens
CO 7d Comparing Pseudohalogens with Halogens
CO 7e Understanding Electropositive Character of Iodine
CO 7f Exploring Noble Gases and Their Separation
CO 7g Studying Compounds of Noble Gases
CO 7h Synthesizing Knowledge in Reactivity
CO 7i Critical Evaluation of Properties

CH6CRT10 - ORGANIC CHEMISTRY – IV

Unit 1: Natural Products

CO 1a Classify terpenoids based on the Isoprene rule.
CO 1b Explain the significance of the Isoprene rule in terpenoid classification.
CO 1c Elucidate the structures of citral and geraniol.
CO 1d Discuss the uses of citral and geraniol in various applications.
CO 1e Understand the structure of natural rubber.
CO 1f Explain latex processing methods, vulcanization, rubber compounding, mastication, and the diverse uses of natural rubber.
CO 1g Describe general methods for the isolation of alkaloids.
CO 1h Classify alkaloids based on their structures and sources.
CO 1i Explain the physiological actions of alkaloids.
CO 1j Discuss the medicinal importance of alkaloids in various therapeutic applications.
CO 1k Elucidate the structures of coniine, nicotine, and piperine.

CO 1l Understand the synthesis methods for coniine, nicotine, and piperine.

Unit 2: Lipids

CO 2a Introduce the concept of lipids and their classification.
CO 2b Discuss the biological functions of different classes of lipids.
CO 2c Explain the biological functions of oils and fats.
CO 2d Discuss extraction, refining, and the common fatty acids present in oils and fats.
CO 2e Analyze the impact of trans fats on health.
CO 2f Explain the process of hydrogenation and its relevance.
CO 2g Discuss the biological functions of waxes, phospholipids, and glycolipids.
CO 2h Elaborate on the structural characteristics and roles of these lipid classes.
CO 2i Explain the types of soaps and their cleansing action.
CO 2j Classify synthetic detergents and compare them with soaps.
CO 2k Discuss the environmental aspects of detergent use.

Unit 3: Vitamins, Steroids, and Hormones

CO 3a Classify vitamins into different categories.
CO 3b Understand the structures of vitamins A, B1, B2, B3, B5, B6, C, and D.
CO 3c Discuss the biological functions of each vitamin.
CO 3d Explain the deficiency diseases associated with vitamins A, B1, B2, B3, B5, B6, C, and D.
CO 3e Introduce the concept of steroids.
CO 3f Describe the structure of cholesterol and its functions.
CO 3g Explain the elementary idea of HDL and LDL.
CO 3h Introduce the concept of hormones.
CO 3i Classify hormones into steroid hormones, peptide hormones, and amine hormones.
CO 3j Discuss examples of each hormone type.
CO 3k Explain the biological functions of steroid hormones, peptide hormones, and amine hormones.
CO 3l Provide an understanding of artificial hormones.

Unit CO4: Amino Acids, Peptides and Proteins

CO 4a To identify the structures and names of the 20 standard amino acids and to categorize them
CO 4b To explain the synthesis and reactions of amino acids
CO 4c To analyze Ionic Properties of Amino Acids
CO 4d To perform peptide synthesis using protecting groups and solid phase peptide synthesis
CO 4e To define and categorize proteins based on their functions and structures.
CO 4f To understand the hierarchical organization of protein structure and its significance in function.
CO 4g To understand the principles and procedures involved in determining the N-terminal and C-terminal amino acids.
CO 4h To understand the concept of protein denaturation

Unit 5: Nucleic Acids

CO 5a To understand nucleic acid components and structures
CO 5b To comprehend polynucleotide structures and DNA and RNA Models
CO 5c To understand how transcription and translation processes are involved in the expression of genetic information.

Unit 6: Enzymes

CO 6a To understand enzyme fundamentals

CO 6b To explore the mechanisms of enzyme action and the factors that influence enzyme activity.
CO 6c To analyze enzyme specificity, inhibitors, and applications

Unit 7: Supramolecular Chemistry

CO 7a To develop an understanding of supramolecular chemistry
CO 7b To identify and describe different types of non-covalent interactions
CO 7c To understand host-guest interactions and their role in molecular recognition
CO 7d To recognize the importance of molecular recognition in the sturcuture and stability of biopolymers (DNA).

Unit 8: Organic Photochemistry

CO 8a: To understand the fundamental distinctions between reactions initiated by light (photochemical) and those initiated by heat (thermal).
CO 8b: To analyze the subsequent pathways of excited molecules, including emission, energy transfer, or participation in chemical reactions.
CO 8c: To gain insight into the detailed mechanisms governing specific organic photochemical reactions.

Unit 9: Organic Spectroscopy

CO 9a Understand the different types of electronic transitions in UV spectroscopy.
CO 9b Define terms such as max, chromophores, auxochromes, bathochromic, and hypsochromic shifts.
CO 9c Apply Woodward Rules for calculating max in various systems including ,- unsaturated aldehydes, ketones, carboxylic acids, and esters.
CO 9d Differentiate between cis and trans isomers in conjugated dienes, alicyclic, homoannular, and heteroannular systems.
CO 9e Define fundamental and non-fundamental molecular vibrations in IR spectroscopy.
CO 9f Explain the positions of O and N-containing functional groups in IR spectra.
CO 9g Discuss the effects of H-bonding, conjugation, resonance, and ring size on IR absorptions.
CO 9h Explore the significance of the fingerprint region in IR spectra.
CO 9i Explain the basic principles of proton magnetic resonance (NMR).
CO 9j Define chemical shift and discuss factors influencing it.
CO 9k Understand spin-spin coupling and coupling constant in NMR spectra.
CO 9l Analyze anisotropic effects in alkene, alkyne, aldehydes, and aromatics.
CO 9mInterpret NMR spectra of simple organic compounds.
CO 9n Apply IR, UV, and NMR spectroscopy for the identification of simple organic molecules.
CO 9o Understand the basics of mass spectrometry.
CO 9p Discuss EI ionization and the determination of molecular mass.

CH6CRT11 – PHYSICAL CHEMISTRY – III
Credits – 3 (5CO4 Hrs)

Unit 1 & 2: Thermodynamics-I & Thermodynamics-II

CO-1: Demonstrate a foundational understanding of the basic concepts of thermodynamics, including the laws of thermodynamics and the principles of energy, work, and heat.
CO-2: Analyze and solve problems related to thermodynamic systems, including closed and open systems, using appropriate mathematical models and equations.

CO-3: Apply the first law of thermodynamics to analyze energy conservation in various processes, including heat transfer and work done.
CO-4: Study different thermodynamic processes, including isothermal, adiabatic, and isobaric processes, and understand their implications in practical applications.
CO-5: Evaluate the performance of heat engines and refrigerators, including the Carnot cycle, and understand the principles of efficiency and coefficient of performance.
CO-6: Analyze phase transitions, including the study of phase diagrams, phase equilibria, and the behavior of substances under different temperature and pressure conditions.
CO-7: Understand thermodynamic potentials, such as internal energy, enthalpy, Helmholtz free energy, and Gibbs free energy, and their significance in thermodynamic analysis.

Unit 3: Chemical Equilibria

CO-3a: Demonstrate a foundational understanding of fundamental concepts related to chemical equilibria, including equilibrium constant, reaction quotient, and Le Chatelier's principle.
CO-3b: Analyze and solve problems related to homogeneous chemical equilibria in gaseous and solution phases, applying principles of mass action and the equilibrium constant.
CO-3c: Study and analyze heterogeneous chemical equilibria involving multiple phases, including gas-solid and liquid-solid equilibria.
CO-3d: Apply Le Chatelier's principle to predict the effects of changes in temperature, pressure, and concentration on chemical equilibria.
CO-3e: Understand the principles of acid-base equilibria, including the ionization of weak acids and bases, and calculate pH for various solutions.
CO-3f: Analyze the properties and behavior of buffer solutions, including the Henderson-Hasselbalch equation, and their applications in maintaining pH.

Unit 4.Ionic Equilibria

CO 4.1. To define Acids and Bases:
CO 4.2. To define acids and bases according to both the Arrhenius and Brønsted-Lowry theories.
CO 4.3. To identify common examples of acids and bases.
CO 4. 4.To calculate pH and pOH:
CO 4.5 To calculate the pH and pOH of solutions using the appropriate formula
CO 4.6 To understand the properties and significance of buffer solutions.
CO 4.7. To design and prepare buffer solutions.
CO 4.8 . To understand Salt Hydrolysis

Unit 5.Phase Equilibria

CO5.1 To define Phases and Understand Phase Transitions:
CO 5.2 To define and differentiate between the different phases (solid, liquid, gas) in a one-component system.
CO 5.3 To understand the concept of phase transitions, such as melting and vaporization.
CO 5. 4. To analyze Phase Diagrams:
CO5.5.To Interpret and analyze the phase diagram of a one-component and Two component system
CO 5.6. To identify and explain the critical point on the phase diagram.

CO 5.7. To apply Thermodynamics to Phase Equilibria:
CO 5.8. To apply thermodynamic principles, such as the Gibbs phase rule, to predict the conditions of phase equilibrium.
CO 5.9.To calculate the critical temperature, pressure, and volume for a given substance.
CO 5.10.To understand the Clapeyron Equation:
CO 5.11.To derive and apply the Clapeyron equation to relate changes in pressure and temperature during phase transitions.

Unit 6: Chemical Kinetics

CO 6a Define and explain the rate of reaction in chemical kinetics.
CO 6b Derive rate equations for different types of reactions.
CO 6c Determine the order and molecularity of reactions through experimental data.
CO 6d Apply integrated rate laws to analyze reaction progress over time.
CO 6e Understand the characteristics of zero-order reactions.
CO 6f Analyze and calculate half-life in various kinetic scenarios.
CO 6g Effect of Temperature on Rate:
CO 6h Explore the Arrhenius equation and its significance.
CO 6i Understand the concept of activation energy and its role in reaction rates.
CO 6j Explain collision theory as a model for chemical reactions.
CO 6k Discuss the relationship between transition states and reaction rates.
CO 6l Derive and understand the Eyring equation.
CO 6m Discuss enthalpy and entropy of activation in the context of reaction kinetics.
CO 6n Understand the Lindemann theory for unimolecular reactions.
CO 6o Discuss the role of molecular collisions in unimolecular reactions.
CO 6p Analyze kinetics of complex reactions involving opposing, consecutive, and parallel steps.
CO 6q Apply steady-state treatment to understand reaction progress.
CO 6r Explain chain reactions and their mechanisms.
CO 6s Derive the rate expression for the hydrogen–bromine reaction.
CO 6t Explore examples and applications of homogeneous catalytic reactions.
CO 6u Introduce enzyme catalysis and the Michaelis–Menten equation.
CO 6v Discuss surface catalysis in heterogeneous catalytic reactions.
CO 6w Explore elementary ideas about autocatalysis in catalytic processes.

CH6CRT12– PHYSICAL CHEMISTRY – IV
Credits – 3 (5CO4 Hrs)

UNIT – 1 SOLUTIONS

CO 1a: To differentiate and describe binary solutions.
CO 1b: To apply Raoult's law to calculate vapor pressure in ideal solutions.
CO 1c: To illustrate the deviations from ideal behavior.
CO 1d: To understand the thermodynamic properties of ideal solutions.
CO 1e: To understand the concept of CST and its significance.
CO 1f: To explore the factors that affect the solubility of gases, such as temperature and pressure.
CO 1g: To understand the partial molar quantities.
CO 1h: To explore the principles of reverse osmosis and its applications.

UNIT – 2 ELECTRICAL CONDUCTANCE

CO 2a: To describe the fundamental principles behind Faraday’s laws.
CO 2b: To determine the amount of substance deposited or liberated during electrolysis.
CO 2c: To analyze the electrolytic conductance as a measure of a solution's ability to conduct electricity.

CO 2d: To analyze the changes in molar conductivity with varying concentrations of electrolytes.
CO 2e: To understand Kohlrausch's law and its role in determining molar conductivity.
CO 2f: To gain knowledge of how conductance measurements can be applied to study various chemical processes in solutions.
CO 2g: To understand the principles of conductance measurements in analytical chemistry.

Unit 3: Electromotive Force

CO 3a Understand the fundamental principles of electrochemical cells.
CO 3b Explore the characteristics and components of galvanic cells.
CO 3c Discuss the characteristics of reversible cells.
CO 3d Define and explain reference electrodes.
CO 3e Understand the concept of electrode potential.
CO 3f Explore the Electrochemical series.
CO 3g Apply the Nernst equation to calculate electrode potential and cell potential.
CO 3h Calculate ΔG, ΔH, and ΔS from EMF data.
CO 3i Calculate equilibrium constants using EMF data.
CO 3j Differentiate between electrolyte concentration cells with and without transference.
CO 3k Discuss applications and advantages of fuel cells
CO 3l Apply EMF measurements to determine solubility products.
CO 3m Determine pH using different electrodes: hydrogen electrode, quinhydrone electrode, and glass electrode.
CO 3n Conduct potentiometric titrations for acid-base and redox reactions.
CO 3o Understand the use of oxidation-reduction indicators.
CO 3p Understand the concept of overvoltage in irreversible electrode processes.
CO 3q Explore methods for monitoring and preventing corrosion.

CO 3r UNIT – CO4 PHOTOCHEMISTRY

CO 4a: To establish the importance of light absorption in the initiation of photochemical processes.
CO 4b: To understand the relationship between the number of molecules excited and the number of photons absorbed.
CO 4c: To interpret various photo-physical processes on the basis of its electronic structure.

UNIT – 5 GROUP THEORY

CO 5a: To demonstrate various symmetry elements and operations in molecules.
CO 5c: To apply the principles of group theory in symmetry operations in molecules.

Choice Based Course

CH6CBT02 - NANOCHEMISTRY AND NANOTECHNOLOGY

Credits - 3 (5CO4 hours)

Unit 1: History of Nanotechnology

CO 1a Identify significant events and discoveries that contributed to the evolution of nanotechnology.
CO 1b Explain the role of various scientists and researchers in shaping the field.
CO 1c Explain terms such as nanotechnology, nanoscience, nanomaterials, etc.
CO 1d Demonstrate understanding of specialized vocabulary used in the field.
CO 1e Differentiate between macroscopic, microscopic, and nanoscopic scales.
CO 1f Discuss the challenges and opportunities associated with working at the nanoscale.
CO 1g Explain the concepts of top-down and bottom-up fabrication methods.
CO 1h Evaluate the advantages and limitations of each approach in nanoscale engineering.

CO 1i Summarize Richard Feynman's famous lecture on "There's Plenty of Room at the Bottom."

CO 1j Analyze the impact of Feynman’s ideas on the development of nanotechnology.

CO 1k Define Moore’s law and its implications for the miniaturization of electronic components.

CO 1l Evaluate the challenges and predictions associated with the continued application of Moore’s law.

CO 1m Describe the discovery and production of fullerene.

CO 1n Assess the contribution of fullerene to nanotechnology.

CO 1o Analyze the unusual properties of fullerene and their applications.

CO 1p Explain the synthesis methods of carbon nanotubes.

CO 1q Explore the properties of carbon nanotubes and their significance.

CO 1r Discuss various applications of carbon nanotubes in different fields.

CO 1s Apply knowledge gained in the unit to analyze and solve problems related to nanotechnology.

CO 1t Critically evaluate the ethical implications and societal impact of nanotechnology.

CO 1u Present information on historical landmarks, terminology, scales, and nanomaterials clearly and concisely.

Unit 2:

CO 2.1 .To Understand the basic building blocks of matter and the nature of electromagnetic radiation.

CO 2.2.To define fundamental particles and their classification.

CO 2.3.To explain the properties and behavior of quarks, leptons, and bosons.

CO 2.4. To discuss the electromagnetic spectrum and the properties of electromagnetic waves.

CO 2.5 To Understand the relationship between energy, frequency, and wavelength in electromagnetic radiation.

CO 2.6. To explore the concept of wave-particle duality.

CO 2.7.To derive and understand the De Broglie wavelength equation.

CO 2.8. To Relate the De Broglie wavelength to the behavior of particles.

Co 2.9. To understand colour and constitution

CO 2.10. To define auxochromes and chromophores

CO 2.10. To Introduce various spectroscopic techniques and their applications in nanosystem studies.

CO 2.11.To define UV-Visible spectroscopy and explain its principles.

CO 2.12.To discuss the concept of auxochromes and their role in molecular color.

CO 2.13.To explore X-ray photoelectron spectroscopy (XPS) and its applications.

CO 2.14. To understand the principles of Secondary Ion Mass Spectrometry (SIMS).

Unit 3

Electrical and Optical properties of nanomaterials

CO 3a-Analyze the electrical and optical properties of nanomaterials with a focus on metal nanoparticles.

CO 3b-Evaluate the electrical and optical characteristics of carbon nanotubes.

CO 3c-Examine the unique electrical and optical features exhibited by nanocrystals.

CO 3d-Apply principles of nanolithography in the fabrication of nanostructures.

CO 3e-Assess the operation and applications of optoelectronic devices utilizing nanomaterials.

CO 3f-Design and construct photodetectors based on nanotechnology principles.

CO 3g-Integrate knowledge of electrical and optical properties to optimize the performance of nanomaterials in various applications.

Unit CO4: Applications of Nanomaterials

CO 4a-Explain the principles and mechanisms of Nanocatalysis.
CO 4b-Comprehend the design and synthesis of Nanomedicines.
CO 4c-Understand the principles behind immunogold labeling techniques.
CO 4d-Apply nanocatalysts in catalytic reactions for specific applications.
CO 4e-Utilize nanomedicines in targeted drug delivery systems.
CO 4f-Apply immunogold labeling for visualizing specific biomolecules.
CO 4g-Evaluate the applications of nanomaterials in medical diagnosis.
CO 4h-Critically analyze the effectiveness of nanobased drug delivery in therapeutic contexts.
CO 4i-Assess the impact of immunogold labeling in advancing diagnostic techniques.
CO 4j-Integrate nanomaterials into biotechnological processes.
CO 4k-Explore the use of nanosensors in biotechnological applications.
CO 4l-Investigate nanosensors based on quantum size effects.
CO 4m-Examine the destructive applications of nanomaterials.
CO 4n-Understand the interdisciplinary nature of nanoscience and its applications.

PRACTICALS
SEMESTER V & VI
CH6CRP03 - QUALITATIVE INORGANIC ANALYSIS
Credit – 3 (108 Hrs)

CO 1- to study the reactions of some acidic and basic radicals with a view to their identification and confirmation
CO 2- To understand the elimination of interfering radicals.
CO 3- To understand the systematic qualitative analysis of mixtures containing two acid and two basic radicals with one interfering radical

CH6CRP0CO4 - ORGANIC PREPARATIONS AND LABORATORY TECHNIQUES
Credits-2 (72 Hrs)

CO 1- To understand the techniques of solvent extraction, crystallization, distillation, TLC and Column Chromatography
CO 2- To understand the methods of organic preparations involving like oxidations, hydrolysis, nitration, halogenation, diazocoupling, acylation, Esterification, Side chain oxidation, Claisen – Schmidt reaction etc.

CH6CRP05 - PHYSICAL CHEMISTRY PRACTICALS
Credits 3 (108 hrs)

CO 1- to determine percentage composition of a mixture
CO 2- to determine Heat of solution and neutralization
CO 3- to determine equivalent conductance of an electrolyte
CO 4- to determine partition coefficient

CO 5- to determine Transition temperature of salt hydrates
CO 6-To understand the techniques of conductometric titration and potentiometric titration
CO 7- to determine molecular weight by Rast's Method
CO 8- To determine the kinetics of simple reactions
CO 9- To determine the rate constant of reaction (using spread sheet program)

CH6CRP06 GRAVIMETRIC ANALYSIS

2 Credits (36 Hrs) – Semester VI only

CO 1-To estimate Barium, sulphate, magnesium, iron, Nickel, copper gravimetrically