



SNDT Women's University, Mumbai

**Undergraduate Degree / UG
Programme (Syllabus as Per NEP) -
Faculty of Science & Technology**

**Bachelor of Science
(Chemistry)**

B.Sc. In Chemistry

As Per NEP – 2020

Semester – V & VI

**Syllabus
(W.E.F. Academic Year 2026-27)**

Terminologies

Vertical	Full-Form/Definition	Remarks	Related To Major And Minor Courses
Major (Core)	Subject Comprising Mandatory and Elective Courses, Major Specific IKS, Vocational Skill Courses, Internship/ Apprenticeship, Field Projects, Research Projects Connected to Major	Minimum 50% Of Total Credits Corresponding to Three/Four - Year UG Degree- Mandatory Courses	Related To The Major
Minor Course	Course From Same Or Different Faculty	Minimum 18-20 Credits to Be Completed in The First Three Years of UG Programme	Related To the Minor
OEC	Open Elective Courses/ Generic Courses	10-12 Credits to Be Offered in I And/Or II Year. Faculty-Wise Baskets of OEC To Be Prepared	OEC Is to Be Chosen Compulsorily from Faculty Other Than That of the Major
VSC	Vocational Skill Courses, Including Hands On Training Corresponding To The Major And/Or Minor Subject	8-10 Credits, To Be Offered in First Three Years, Wherever Applicable Vocational Courses Will Include Skills Based on Advanced Laboratory Practical's of Major	Related To the Major or Minor
SEC	Skill Enhancement Courses	06 Credits, To Be Offered in I And II Year, To Be Selected from The Basket of Skill Courses Approved by University	Related To the Major or Minor Any Relevant Skill
AEC	Ability Enhancement Courses	08 Credits, To Be Offered in I And II Year, English: 04 Credits to Be Earned in Sem - I, Modern Indian Language Of 04 Credits to Be Offered in II Year	NA
VEC	Value Education Courses	Understanding India, Environmental Science/Education, Digital and Technological Solutions, Health &	NA

		Wellness, Yoga Education, Sports, And Fitness	
IKS	Indian Knowledge System	Generic IKS Course: Basic Knowledge Of The IKS To Be Offered At First Year Level	Major-Specific IKS Courses: Advanced Information About the Major, Part of the Major Credit to Be Offered at Second- Or Third-Year Level
OJT	On-Job Training (Internship / Apprenticeship)	Corresponding To the Major Subject	Related To The Major
FP	Field Projects	Corresponding To the Major Subject	Related To the Major
CC	Co-Curricular Courses	Health And Wellness, Yoga Education Sports, And Fitness, Cultural Activities, NSS/NCC And Fine/ Applied/Visual/ Performing Arts	NA
CE	Community Engagement and Service		Related To Major
RP	Research Project	Corresponding To the Major Subject	Related To Major

Programme Template

Degree		B.Sc and honor / Research
Programme		Chemistry
Preamble		<p>BSc Honours is an undergraduate degree programme of three to four academic years, designed to provide a comprehensive understanding of specific Science subjects.</p> <p>BSc Honours degree programme focuses on research, critical thinking, and course curriculum of the particular science subject</p>
Programme Specific Outcomes(PSOs)		After completing this programme, Learners will be able to
	1	<p>Research-related skills and Scientific temper:</p> <p>Develop the working knowledge and applications of instrumentation and laboratory techniques.</p> <p>Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.</p>
	2	<p>Disciplinary Knowledge:</p> <p>Demonstrate comprehensive knowledge of the disciplines that form a part of an graduate programme.</p> <p>Execute strong theoretical and practical understanding generated from the specific graduate programme in the area of work.</p>
	3	<p>Environment and Sustainability:</p> <p>Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.</p>
	4	<p>Self-directed and Life-long learning:</p> <p>Acquire the ability to engage in independent and life-long learning in the broadest context of socio technological changes.</p>
	5	<p>Trans-disciplinary knowledge:</p> <p>Integrate different disciplines to uplift the domains of cognitive abilities and transcend beyond discipline-specific approaches to address a common problem.</p>
	6	<p>Competence:</p> <p>Display the understanding, behavioural skills needed for successful social adaptation, work in groups, exhibits thoughts and ideas effectively in writing and orally.</p>
Eligibility Criteria for		Candidates should clear Class 12 in the Science stream

Programme		with a minimum of 50% - to 60% aggregate from a recognized board.
Intake		

Structure with Course Titles**B.Sc. In Chemistry****Semester – V**

Sr. No.	Course	Type of Course	Credits	Marks	Int Marks	Ext Marks
	Semester – V					
50132111	Physical Chemistry-II (Th)	Major (Core)	4	100	50	50
50132112	Organic Chemistry-II (Th)	Major (Core)	4	100	50	50
51032121	Physical and Organic Chemistry-Experimental Work (Pr)	IKS (Major Specific)	2	50	0	50
50232111	Biochemistry (Th)	Major (Elective) (Any One)	4	100	50	50
50232112	Making Measurements in Chemistry (Th)					
50332111	Data Analysis in Chemistry (Th)	Minor Stream	4	100	50	50
50632101	Applied Chemistry leadership & Professional Skills (Th)	VSC-4	2	50	50	0
51332101	Workshop Visit Report (Pr)	FP	2	50	50	0
			22	550	300	250

Semester – VI

Sr. No.	Course	Type of Course	Credits	Marks	Int Marks	Ext Marks
	Semester - VI					
60132111	Analytical Chemistry II (Th)	Major (Core)	4	100	50	50
60132112	Inorganic Chemistry II (Th)	Major (Core)	4	100	50	50
60232111	Molecular Modelling (Th)	Major (Elective) (Any One)	4	100	50	50
60232112	Drug Design and Discovery (Th)					
60332121	Analytical & Inorganic Chemistry-Experimental Work (Pr)	Minor Stream	2	50	0	50
60332112	Integrated Chemistry of Health & Society (Th)	Minor Stream	4	100	50	50
61232121	Internship (Pr)	OJT	4	100	50	50
			22	550	250	300

Exit with Degree (3-year)

Course Syllabus

Semester – V

.5.1 Major (Core)

Course Titles	Physical Chemistry - II (Th)
Course Credits	4 Credit's
Course Outcomes	After going through the course, learners will be able to
	1. The course will equip you with a deep understanding of the fundamental principles that govern the behavior of matter at the molecular level.
	2. Here are some key learning outcomes you can expect to achieve in areas like solid-state, solutions, surface chemistry, chemical bonding, and thermodynamics
Module 1 (Credit 1) Chemical Kinetics	
Learning Outcomes	After learning the module, learners will be able to
	1. Identify and differentiate between different crystal structures (e.g., ionic, covalent, metallic) and relate them to the properties of solids.
	2. Explain how band theory accounts for electrical conductivity and semi-conductivity in solids.
	3. Understand the principles behind X-ray diffraction and neutron diffraction for characterizing solid-state materials.
Content Outline	<ul style="list-style-type: none">• Symmetry in crystals. Law of constancy of interfacial angles.• The law of rationality of indices. The law of symmetry. Definition of lattice point, space lattice, unit cell.• Bravis lattices and crystal systems. X-ray diffraction and crystal structure. Bragg's law.• Defects in crystals. Stoichiometric and nonstoichiometric defects.
Module 2 (Credit 1) Theories of Reaction Rates	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none">• Explain the colligative properties of solutions (e.g., boiling point elevation, freezing point depression, osmotic pressure) and perform calculations related to them.
Content Outline	<ul style="list-style-type: none">• Liquid-liquid – ideal solutions, Raoult's law. Ideally dilute solutions, Henry's law.• Nonideal solutions. Vapour pressure – composition and vapour pressure- temperature curves. Azeotropes-HCl-H₂O, ethanol-water systems and fractional distillation.• Partially miscible liquids-phenol-water, trimethyl amine water, nicotine-water systems. Effect of impurity on consulate temperature. Immiscible liquids and steam distillation.• Nernst distribution law. Calculation of the partition coefficient.

	Applications of distribution law.
Module 3 (Credit 1) Thermodynamics	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none"> Students are able to understand the concepts of surface tension, adsorption, and desorption at the Interface between phases (e.g., gas-liquid, solid-liquid).
	<ul style="list-style-type: none"> Students are able to understand the properties and behavior of colloids, including factors affecting their stability and applications.
Content Outline	<ul style="list-style-type: none"> Definition of colloids. Solids in liquids(sols), preparation, purification, properties -kinetic, optical, electrical. Stability of colloids, Hardy-Schulze law, protective colloid. Liquids in liquids (emulsions) preparation, properties, uses. Liquids in solids (gels) preparation, uses. Adsorption: Physical adsorption, chemisorption. Freundlich, Langmuir adsorption isotherms. Applications of adsorption Chemical Bonding Valence bond theory, hybridization, VB theory as applied to ClF_3, $\text{Ni}(\text{CO})_4$, Molecular orbital theory – LCAO method, construction of M.O. diagrams for homonuclear and hetero-nuclear diatomic molecules (N_2, O_2, CO and NO).
Module 4 (Credit 1) Phase Equilibria & Statistical Thermodynamics	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none"> Students are able to understand the fundamental laws of thermodynamics and their implications for chemical processes.
	<ul style="list-style-type: none"> Students are able to understand Define and utilize state functions (e.g., enthalpy, entropy, Gibbs free energy) to understand energy changes and spontaneity of reactions.
Content Outline	<ul style="list-style-type: none"> The first law of thermodynamics-statement, definition of internal energy and enthalpy. Heat capacities and their relationship. Joule-Thomson effect-coefficient. Calculation of w, for the expansion of perfect gas under isothermal and adiabatic conditions for reversible processes. State function. Temperature dependence of enthalpy of formation Kirchoff's equation. Second law of thermodynamics. Different Distinguish between ideal and non-ideal solutions and apply models to account for deviations from ideality.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module I: Chemical Kinetics

Activity Title: Kinetics in Real Chemical and Industrial Systems

Assignment Type: Report + Numerical Work + Optional PPT

Task:

Choose any real-life or industrial reaction such as:

- Decomposition of hydrogen peroxide
- Acid–base neutralization
- Enzyme-catalyzed reactions (e.g., digestion)
- Corrosion of iron (rusting process)
- Your report (4–5 pages) should include:
 - Definition and explanation of rate of reaction, order, and molecularity
 - Determination of order using assumed or experimental data
 - Integrated rate equations (zero, first, or second order)
 - Calculation of half-life and its significance
 - Graphs: concentration vs time / log concentration vs time
 - Explanation of reaction mechanism and identification of rate-determining step
 - Real-life or industrial significance of the selected reaction
- Optional: Prepare a PowerPoint presentation (3–5 slides) showing graphical analysis

Module II: Theories of Reaction Rates

Activity Title: Temperature Dependence and Energy Profile of Reactions

Assignment Type: Report + Graph + Diagram

Task:

Select any reaction influenced by temperature such as:

- Ester hydrolysis
- Decomposition of calcium carbonate
- Catalytic industrial reactions
- Combustion reactions
- Your report (4–5 pages) should include:
 - Explanation of Arrhenius equation and activation energy
 - Plot of $\ln k$ vs $1/T$ using assumed or sample data
 - Calculation of activation energy (numerical example)
 - Comparison between Collision Theory and Transition State Theory
 - Energy profile diagram showing activation energy and intermediates

- Effect of temperature, catalyst, and solvent on reaction rate
- Real-life application (industrial or biological systems)
- Optional: Prepare a short PPT (3–5 slides) explaining energy diagram

Module III: Thermodynamics

Activity Title: Energy Changes and Spontaneity in Chemical Processes

Assignment Type: Report + Numerical Problems

Task:

Choose any real-life system such as:

- Combustion of fuels
- Refrigeration or air conditioning system
- Electrochemical cells (battery)
- Metabolic reactions in the human body
- Your report (4–5 pages) should include:
 - Explanation of first and second laws of thermodynamics
 - Definition and calculation of enthalpy (ΔH), entropy (ΔS), and Gibbs free energy (ΔG)
 - Interpretation of spontaneity using ΔG values
 - Relationship between free energy and equilibrium constant
 - Numerical problems (2–3 examples) related to thermodynamics
 - Graphical representation (energy vs reaction coordinate)
 - Real-life applications in industry or daily life

Module IV: Phase Equilibria & Statistical Thermodynamics

Activity Title: Phase Behavior and Molecular Distribution in Systems

Assignment Type: Report + Diagram Work + Optional Case Study

Task:

Choose any system such as:

- Water system (ice–water–vapour equilibrium)
- Sulfur system
- Binary liquid mixtures
- Gas distribution in atmosphere
- Your report (4–5 pages) should include:
 - Explanation of phase rule and its application
 - Description of one-component or two-component system
 - Phase diagrams with proper labeling

- Explanation of colligative properties and their applications
- Introduction to Boltzmann distribution law
- Basic concept of partition function (conceptual understanding)
- Graphs: phase diagrams or distribution curves
- Real-life or industrial applications of phase equilibria
- Optional: Include a short case study (e.g., distillation or material processing)

References:

1. Advanced physical chemistry by Gurudeep Raj
2. Advanced Physical Chemistry by Atkins
3. Text book of physical chemistry by S Glasstone
4. Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi (2006).
5. Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
6. Rogers, D. W. Concise Physical Chemistry Wiley (2010).
7. Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. Physical Chemistry 4th Ed., John Wiley & Sons, Inc. (2005).

Semester – V**.5.2 Major (Core)**

Course Titles	Organic Chemistry - II (Th)
Course Credits	4 Credit's
Course Outcomes	1. Learn about mechanisms and reactivity of these functional groups.
	2. Explore the preparation, properties, and reactions of carboxylic acids, amides, esters, and nitriles (all containing a COOH carboxylic acid group).
	3. Learn about base-catalyzed reactions specific to these functional groups.
	4. Students will Apply this knowledge in organic synthesis
Module 1 (Credit 1) Heterocyclic Compounds	
Learning Outcomes	After learning the module, learners will be able to
	1. Students are able to understand the preparation, properties, and reactions of organic compounds containing halogens (Cl, Br, I, F) as functional groups.
	2. Students are able to Apply knowledge of these reactions to predict products and design synthetic routes.
	3. Students are able to understand Grasp the preparation, properties, and reactions of alcohols and phenols (compounds with an OH group).
4. Students are able to Learn about mechanisms and reactivity of these functional groups.	
Content Outline	<ul style="list-style-type: none">• Halogen compounds :- Nomenclature and classification of alkyl (into primary, secondary, tertiary), aryl, aryl alkyl, allyl, vinyl, benzyl halides. Nucleophilic aliphatic substitution reaction- classification into SN1 and SN2 – reaction mechanism with examples – Ethyl chloride, t-butyl chloride and optically active alkyl halide 2-bromobutane.• Hydroxyl compounds Nomenclature and classification of hydroxy compounds. Alcohols: Preparation with hydroboration reaction, Grignard synthesis of alcohols. Phenols: Preparation i) from diazonium salt, ii) from aryl sulphonates, iii) from cumene. Physical properties- Hydrogen bonding (intermolecular and intramolecular). Effect of hydrogen bonding on boiling point and solubility in water.• Identification of alcohols by oxidation with KMnO₄, Ceric ammonium nitrate, Luca's reagent and phenols by reaction with FeCl₃. Chemical properties:

	<ul style="list-style-type: none"> ○ Dehydration of alcohols. ○ Oxidation of alcohols by CrO₃, KMnO₄. ○ Special reaction of phenols. • Bromination, Kolbe-Schmidt reaction, Riemer-Tiemann reaction, Fries rearrangement, azocoupling, Pinacol-Pinacolone rearrangement.
Module 2 (Credit 1) Organic Reaction Mechanisms	
Learning Outcomes	After learning the module, learners will be able to
	1. Students are able to understand the knowledge on the preparation, properties, and reactions of aldehydes and ketones (compounds containing a C=O carbonyl group).
	2. Students are able to understand the influence of substituent groups on their reactivity.
	3. Students are able to understand Explore the preparation, properties, and reactions of carboxylic acids, amides, esters, and nitriles (all containing a COOH carboxylic acid group).
	4. Students are able to Learn about base-catalyzed reactions specific to these functional groups.
Content Outline	<ul style="list-style-type: none"> • Carbonyl compounds : Nomenclature of aliphatic and aromatic carbonyl compounds, structure of the carbonyl group. Synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones using 1,3dithianes, synthesis of ketones from nitriles and from carboxylic acids. Physical properties: Reactivity of carbonyl group in aldehydes and ketones. • Nucleophilic addition reaction with a) NaHSO₃, b) HCN, c) RMgX, d) NH₂OH, e) PhNHNH₂, f) 2,4 DNPH, g) Alcohols- formation of hemiacetal and acetal. • Base catalysed reactions: a) Aldol, b) Cannizzaro's reaction, c) Perkin reaction, d) Benzoin condensation, e) Haloform reaction, f) Knoevenagel reaction. Oxidation of aldehydes- Baeyer-Villiger oxidation of ketones. Reduction: Clemmensen reduction, Wolf-Kishner reduction, MPV reduction, reduction with LiAlH₄ and NaBH₄. Analysis of aldehydes and ketones with a) 2,4-DNPH test, b) Tollen's test, c) Fehling test, d) Schiff's test e) Haloform test (with equation)
Module 3 (Credit 1) Spectroscopy (UV, IR, NMR Basics)	
Learning Outcomes	After learning the module, learners will be able to
	1. Students are able to Explore the preparation, properties, and reactions of carboxylic acids, amides, esters, and nitriles (all containing a COOH carboxylic acid group).
	2. Students are able to Learn about base-catalyzed reactions specific to these functional groups.

Content Outline	<ul style="list-style-type: none"> • Nomenclature, classification and structure of carboxylic acids. Methods of preparation by a) Hydrolysis of nitriles, amides b) Hydrolysis of esters by acids and bases with mechanism c) Carbonation of Grignard reagents. • Special methods of preparation of aromatic acids by <ul style="list-style-type: none"> ○ Oxidation of side chain. ○ Hydrolysis by benzotrichlorides. ○ Kolbe reaction. Physical properties: Hydrogen bonding, dimeric association, acidity- strength of acids with examples of trimethyl acetic acid and trichloroacetic acid. • Relative differences in the acidities of aromatic and aliphatic acids. Chemical properties: Reactions involving H, OH and COOH groups- salt formation, anhydride formation, acid chloride formation, amide formation and esterification (mechanism). Degradation of carboxylic acids by Huns-Diecker reaction, decarboxylation by Schimdt reaction, ArndtEistert synthesis, halogenation by Hell- Volhard-Zelinsky reaction.
Module 4 (Credit 1). Biomolecules / Applied Organic Chemistry	
Learning Outcomes	<p>After learning the module, learners will be able to</p> <ol style="list-style-type: none"> 1. Students are able to understand the concept of active methylene compounds (compounds with a CH₂ group adjacent to a carbonyl group) and their unique reactivity. 2. Students will apply this knowledge in organic synthesis
Content Outline	<ul style="list-style-type: none"> • Active methylene compounds • Acetoacetic ester: keto-enol tautomerism, preparation by Claisen condensation, Acid hydrolysis and ketonic hydrolysis. Preparation of <ul style="list-style-type: none"> ○ monocarboxylic acids. ○ Dicarboxylic acids. ○ Reaction with urea • Malonic ester: preparation from acetic acid. Synthetic applications: • Preparation of <ul style="list-style-type: none"> ○ monocarboxylic acids (propionic acid and n-butyric acid). ○ Dicarboxylic acids (succinic acid and adipic acid) ○ α,β-unsaturated carboxylic acids (crotonic acid). ○ Reaction with urea.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

Module I: Heterocyclic Compounds

Activity Title: Structure, Reactivity, and Importance of Heterocyclic Compounds

Assignment Type: Report + Diagram Work + Optional PPT

Task:

Choose any heterocyclic compounds such as:

- Pyrrole
- Furan
- Thiophene
- Pyridine

Your report (4–5 pages) should include:

- Structure and classification of heterocyclic compounds
- Aromaticity and resonance stabilization with structures
- Physical and chemical properties
- Electrophilic substitution reactions (mechanism with diagrams)
- Comparison of reactivity among selected heterocycles
- Applications in pharmaceuticals, dyes, and biological systems
- Optional: Prepare a PowerPoint presentation (3–5 slides)

Module II: Organic Reaction Mechanisms

Activity Title: Mechanistic Pathways in Organic Reactions

Assignment Type: Mechanism-Based Report + Flow Diagrams

Task:

Select reactions such as:

- Nucleophilic substitution (SN1, SN2)
- Elimination reactions (E1, E2)
- Addition reactions
- Rearrangement reactions

Your report (4–5 pages) should include:

- Detailed step-by-step reaction mechanisms
- Energy profile diagrams for reactions
- Comparison between different mechanisms (SN1 vs SN2, E1 vs E2)
- Factors affecting reaction pathways (substrate, solvent, nucleophile)
- Stereochemical aspects of reactions
- Real-life examples (drug synthesis, industrial reactions)

Module III: Spectroscopy (UV, IR, NMR Basics)

Activity Title: Identification of Organic Compounds using Spectroscopy

Assignment Type: Data Interpretation + Report

Task:

Choose any organic compound (simple molecule or functional group):

- Alcohols
- Aldehydes
- Ketones
- Carboxylic acids

Your report (4–5 pages) should include:

- Basic principles of UV, IR, and NMR spectroscopy
- Interpretation of IR peaks (functional groups)
- Basic NMR signals (chemical shift, splitting)
- UV absorption (conceptual understanding)
- Identification of compound using given or assumed spectral data
- Real-life applications in pharmaceuticals and chemical industries

Module IV: Biomolecules / Applied Organic Chemistry

Activity Title: Role of Organic Compounds in Biological Systems

Assignment Type: Report + Case Study

Task:

Choose any biomolecule or applied organic topic such as:

- Carbohydrates (glucose, starch)
- Proteins and amino acids
- Lipids and fats
- Drugs and pharmaceuticals

Your report (4–5 pages) should include:

- Structure and classification of the selected biomolecule
- Chemical properties and reactions
- Biological importance and functions
- Mechanism of action (for drugs, if selected)
- Real-life applications in medicine, food, or industry
- Optional: Include a case study (e.g., role of a drug in disease treatment)

References:

1. A Text Book of Organic Chemistry by Bahl and Arun bahl
2. A Text Book of Organic chemistry by I L Finar Vol I Organic chemistry by Bruice
3. Organic chemistry by Clayden
4. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt.Ltd. (Pearson Education).
5. Finar, I. L. Organic Chemistry (Volume 1),
6. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons.

Semester – V

.5.3 Indian Knowledge System (IKS) (Major Specific)

Course Titles	Physical and Organic Chemistry - Experimental Work (Pr)
Course Credits	2 Credit's
Course Outcomes	After going through the course, learners will be able to
	1. A course focused on practical knowledge in organic chemistry and physical chemistry will provide students with the opportunity to develop essential laboratory skills alongside theoretical knowledge.
Module 1 (Credit 1) Experimental Techniques in physical chemistry	
Learning Outcomes	After learning the module, learners will be able to
	1. Student will Apply techniques like potentiometry
	2. Students will the following potentiometric titrations
Content Outline	<ul style="list-style-type: none">• Physical Chemistry<ul style="list-style-type: none">○ Potentiometry○ Perform the following potentiometric titrations:<ul style="list-style-type: none">✓ Strong acid vs. strong base✓ Weak acid vs. strong base✓ Dibasic acid vs. strong base✓ Potassium dichromate vs. Mohr's salt
Module 2 (Credit 1) Organic Analysis & Estimation	
Learning Outcomes	After learning the module, learners will be able to
	1. Student will Apply techniques like recrystallization, distillation, and chromatography to purify organic compounds.
	2. Students will Perform laboratory procedures for the synthesis of various organic compounds.
Content Outline	<ul style="list-style-type: none">• Functional group test for nitro, amine and amide groups.• Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols and carbonyl compounds)

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module I: Experimental Techniques in Physical Chemistry

Activity Title: Determination of Physicochemical Properties of Liquids

Assignment Type: Experiment + Report

Task:

Perform any one experiment:

- Viscosity measurement using Ostwald viscometer
- Surface tension using stalagmometer
- Refractive index using Abbe refractometer

Your report should include:

- Aim and Principle of the experiment
- Detailed experimental setup with labeled diagram
- Stepwise procedure (in paragraph form)
- Observations and tabulated data
- Calculations with formulae
- Result and interpretation
- Sources of error and precautions
- Application in industry (pharmaceuticals, food, petrochemicals)

Module II: Organic Analysis & Estimation

Activity Title: Quantitative Estimation of Organic Compounds

Assignment Type: Experiment + Report

Task:

- Perform estimation of any one compound:
- Estimation of aspirin in tablet formulation
- Estimation of phenol by bromination method
- Estimation of glucose by titration

Your report should include:

- Aim, Theory, and Reaction involved
- Sample preparation (in detail)
- Procedure (paragraph format)
- Observations and endpoint detection
- Calculations (normality, strength, % purity)
- Result and discussion
- Pharmaceutical or industrial relevance

References:

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R.
3. Practical Organic Chemistry, 5th Ed., Pearson (2012)
4. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
5. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011)

Semester – V**.5.4 A. Major (Elective)**

Course Titles	Biochemistry (Th)
Course Credits	4 Credit's
Course Outcomes	After going through the course, learners will be able to
	1. Bioinorganic and bioorganic chemistry explores the fascinating interplay between inorganic elements and biological systems
	2. Carbohydrate Chemistry primarily concerned to distinguish between different type of sugars, their synthesis, structures, and functions.
	3. To understand the structure, function of important biological mo
Module 1 (Credit 1) Biomolecules – Structure and Function	
Learning Outcomes	After learning the module, learners will be able to
	1. Students are able to understand the roles of various metals (e.g., Fe, Cu, Zn, Mg) as essential elements for life and their distribution in biological systems.
	2. Students will Explain how metal ions interact with biomolecules (proteins, nucleic acids) through coordination bonds and other forces.
Content Outline	<ul style="list-style-type: none"> The elements of living system: The biological roles of metal ions, Calcium biochemistry, Iron biochemistry, Nonmetals biochemistry Enzymes exploiting acid catalysis: Carbonic anhydrase, Carboxy peptidases.
Module 2 (Credit 1) Enzyme Activity and Kinetics	
Learning Outcomes	After learning the module, learners will be able to
	1. Students will Analyze the structure and function of key metalloproteins like hemoglobin, myoglobin, and cytochromes.
	2. Students will understand the Comprehend the role of metal complexes in facilitating electron transfer reactions in biological processes (e.g., respiration, photosynthesis)
Content Outline	<ul style="list-style-type: none"> Redox catalysis: Iron sulphur proteins and non-heme iron, Cytochromes of the Electron transport chain, Cytochrome P-450 enzymes, Coenzyme B12, Blue Copper proteins Metals in medicine: Antibiotic and related compounds, Chelate therapy, Inhibition and poisoning, Metal complexes as probes of nucleic acids.
Module 3 (Credit 1) Clinical and Biochemical Analysis	
Learning Outcomes	After learning the module, learners will be able to
	1. Students will learn configuration and ring size of sugars and

	<p>conformational analysis of monosaccharide.</p> <p>2. Student will understand the structure, synthesis, ring size determination and conformational structure of different types of carbohydrates.</p> <p>3. Student will understand the primary, secondary and tertiary structure of DNA and RNA and their different types.</p>
Content Outline	<ul style="list-style-type: none"> • Introduction to the importance of Carbohydrates. Types of naturally occurring sugars. Deoxy sugars, aminosugars, branched chain sugars methyl ethers and acid derivatives of sugars. Determination of configuration and determination of ring size of Dglucose and D- Fructose. • Conformational analysis of monosaccharides. 4C1 and 1C4 conformations of D- glucose. • Reactions of six carbon sugars: Ferrier, Hanesian reaction and Ferrier rearrangement. Synthesis of amino, halo and thiosugars. Structure, ring size determination of sucrose and maltose. • Conformational structures of sucrose, lactose, maltose, cellobiose and gentobiose. Structure and biological functions of starch, cellulose, glycogen and chitin. Role of sugars in cell to cell recognition, blood groups.
Module 4 (Credit 1) Measurement and Instrumentation in Biochemistry	
Learning Outcomes	<p>After learning the module, learners will be able to</p> <p>1. Students will understand the classification and properties of lipids, Chemical synthesis and of biosynthesis phospholipids and glyco lipids.</p> <p>2. Students will understand the Classification, nomenclature and bonding of peptides and biological importance and classification of different structure of proteins.</p>
Content Outline	<ul style="list-style-type: none"> • Nucleic acids: Retro synthetic analysis of nucleic acids - Nucleotides, Nucleosides, Nucleotide bases and Sugars. Structure and synthesis of nucleosides and nucleotides. • Primary, secondary and tertiary structure of DNA. Types of mRNA, tRNA and rRNA. Replication, transcription and translation. Genetic code. Protein biosynthesis. DNA finger printing. • Lipids: Introduction and classification of lipids. Stereochemical notation in lipids. Chemical synthesis and biosynthesis of phospholipids and glycolipids. Properties of lipid aggregates, micelles, bilayers, liposomes and biological membranes.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module I: Biomolecules – Structure and Function

Activity Title: Study of Biomolecules in Daily Life

Assignment Type: Report + Chart

Task:

Select any one biomolecule:

- Carbohydrates
- Proteins
- Lipids
- Enzymes

Your report should include:

- Classification and structure (with diagrams)
- Functions in the human body
- Sources in daily diet
- Deficiency disorders (if applicable)
- Chemical properties and reactions
- Real-life applications (nutrition, medicine, industry)
- Optional: Prepare a chart/model showing structure

Module II: Enzyme Activity and Kinetics

Activity Title: Factors Affecting Enzyme Activity

Assignment Type: Experiment / Demonstration + Report

Task:

Perform or study enzyme activity using simple systems:

- Amylase on starch
- Catalase on hydrogen peroxide

Your report should include:

- Aim and theory (enzyme mechanism)
- Effect of:
 - Temperature
 - pH
 - Substrate concentration
- Procedure (paragraph format)
- Observations and graphical representation
- Conclusion on optimum conditions
- Applications in food and pharmaceutical industries

Module III: Clinical and Biochemical Analysis

Activity Title: Biochemical Tests and Their Significance

Assignment Type: Practical Study + Report

Task:

Study any 2–3 biochemical tests:

- Benedict's test (glucose)
- Biuret test (proteins)
- Iodine test (starch)
- Lipid test

Your report should include:

- Principle and chemical reaction
- Procedure
- Observation (color change)
- Interpretation of results
- Clinical significance (diagnosis of diseases)
- Safety precautions

Module IV: Measurement and Instrumentation in Biochemistry

Activity Title: Analytical Techniques in Biochemical Estimation

Assignment Type: Report + Optional PPT

Task:

Select any one technique:

- Colorimetry
- Spectrophotometry
- pH measurement in biological samples

Your report should include:

- Principle and working
- Instrument diagram
- Sample preparation
- Applications in clinical laboratories
- Advantages and limitations
- Case example (blood sugar estimation, protein assay)

References:

1. Elements of Bioinorganic Chemistry, G.N. Mukerjee and Arabinda Das
2. Bioinorganic Chemistry, G. R. Chatwal and A. K. Bhagi Principles of Bioinorganic Chemistry, S.J. Lippard and J. M. Bersa
3. Bioinorganic Chemistry, Bertini, H. B. Gray and S. J. Lippard Inorganic Chemistry, Shriver and Atkins
4. Inorganic Chemistry, James E. huheey, Ellen A. Keiter and Richard L. Keiter
5. Bio-inorganic Chemistry, R.W. Hay – R.W. Hay, Ellis Horwood Limited Publishers chichester 1984.

Semester – V

.5.4 B. Major (Elective)

Course Titles	Making Measurements in Chemistry (Th)
Course Credits	4 Credit's
Course Outcomes	After going through the course, learners will be able to
	1. Analyze accuracy, precision, and different types of errors in chemical measurements.
	2. Identify and use laboratory apparatus and analytical instruments effectively.
	3. Apply statistical methods, calibration techniques, and validation parameters in chemical analysis.
Module 1 (Credit 1) Basics of Measurement (Fundamental Measurement)	
Learning Outcomes	After going through the course, learners will be able to
	1. Classify fundamental and derived quantities.
	2. Apply SI units and perform unit conversions
	3. Use significant figures correctly in calculations.
	4. Differentiate between accuracy and precision.
	5. Define measurement and explain its importance
Content Outline	<ul style="list-style-type: none">• Measurement & Types of Quantities<ul style="list-style-type: none">○ Definition and importance of measurement in chemistry. Fundamental quantities and derived quantities.• Units and Systems, Significant Figures SI units and unit conversion methods.<ul style="list-style-type: none">○ Rules for determining significant figures and their application in calculations.• Accuracy and Precision<ul style="list-style-type: none">○ Concept of accuracy and precision and their distinction.
Module 2 (Credit 1) Errors and Data Handling	
Learning Outcomes	After going through the course, learners will be able to
	1. Classify and explain different types of errors.
	2. Calculate various error terms.
	3. Apply statistical tools to analyze experimental data.
	4. Evaluate reliability and confidence in measurements
Content Outline	<ul style="list-style-type: none">• Types of Errors<ul style="list-style-type: none">○ Systematic errors and random errors.

	<ul style="list-style-type: none"> ○ Absolute error, relative error, and percentage error. ● Statistical Treatment of Data <ul style="list-style-type: none"> ○ Mean, median, variance, and standard deviation. ● Accuracy and Precision <ul style="list-style-type: none"> ○ Detailed interpretation of accuracy and precision in data analysis. ○ Confidence interval, reproducibility, and reliability of experimental results.
Module 3 (Credit 1) Laboratory Apparatus and Instruments	
Learning Outcomes	After going through the course, learners will be able to
	1. Identify laboratory glassware and describe their uses
	2. Understand principles of basic and advanced analytical instruments.
	3. Explain calibration procedures and their importance.
	4. Apply good laboratory practices in experiments.
Content Outline	<ul style="list-style-type: none"> ● Common Laboratory Glassware <ul style="list-style-type: none"> ○ Beaker, conical flask, measuring cylinder, pipette, and burette. ● Analytical Instruments <ul style="list-style-type: none"> ○ Mass measurement instruments, temperature measuring devices, volume measuring apparatus, and advanced analytical instruments. ● Calibration of Instruments, Good Laboratory Practices (GLP) Principles and importance of calibration. <ul style="list-style-type: none"> ○ Proper handling, maintenance, labelling, contamination prevention, and data recording.
Module 4 (Credit 1) Advanced Measurement and Analytical Validation	
Learning Outcomes	After going through the course, learners will be able to
	1. Explain validation parameters in analytical chemistry.
	2. Interpret detection and quantification limits.
	3. Construct and analyze calibration curves.
	4. Evaluate error propagation in measurements.
Content Outline	<ul style="list-style-type: none"> ● Method Validation Parameters & Limit Terms <ul style="list-style-type: none"> ○ Accuracy, precision, sensitivity, selectivity, and robustness. Limit of detection and limit of quantification. ● Calibration Curve & Statistical Tests Concept, construction, and applications. t-test, F-test, and Q-test.

	<ul style="list-style-type: none"> • Error Propagation & Quality Control Combination and effect of multiple errors. <ul style="list-style-type: none"> ○ Control charts, standard solutions, and standard operating procedure ○ Use of software tools, graph plotting, and regression analysis.
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Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module I: Basics of Measurement

Activity Title: Fundamentals of Measurement and Significant Figures

Assignment Type: Report + Numerical Work

Task:

Prepare a report based on core concepts of measurement in chemistry.

Your report (4–5 pages) should include:

- Definition and importance of measurement
- Fundamental and derived quantities
- SI units and unit conversion methods
- Rules and application of significant figures
- Concept of accuracy and precision

Module II: Errors and Data Handling

Activity Title: Error Analysis and Statistical Treatment

Assignment Type: Numerical Problems + Report

Task:

Analyze experimental data and evaluate different types of errors.

Your report (4–5 pages) should include:

- Classification of errors in measurement
- Calculation of absolute, relative, and percentage errors
- Statistical treatment including mean, median, variance, and standard deviation
- Interpretation of accuracy and precision
- Confidence, reproducibility, and reliability of results

Module III: Laboratory Apparatus and Instruments

Activity Title: Study of Laboratory Apparatus and Analytical Instruments

Assignment Type: Diagram Work + Report + Optional PPT

Task:

Prepare a detailed study of laboratory tools and instruments used in chemical analysis.

Your report (4–5 pages) should include:

- Description of common laboratory glassware
- Principles of analytical instruments for mass, temperature, and volume measurement
- Overview of advanced analytical instruments
- Calibration methods for instruments
- Good Laboratory Practices and safety measures
- Optional: Prepare a PowerPoint presentation (3–5 slides)

Module IV: Advanced Measurement and Validation

Activity Title: Analytical Validation and Data Interpretation

Assignment Type: Report + Data Analysis

Task:

Study advanced measurement techniques and validation methods in chemical analysis.

Your report (4–5 pages) should include:

- Method validation parameters
- Limit of detection and limit of quantification
- Construction and interpretation of calibration curves
- Application of statistical tests
- Error propagation in measurements
- Quality control procedures and standard operating practices
- Use of modern tools for data handling and analysis

References:

1. Bahl, A. and Bahl, B. S., A Textbook of Organic Chemistry
2. Finar, I. L., Organic Chemistry (Volume 1)
3. Bruice, P. Y., Organic Chemistry
4. Clayden, J., Greeves, N., and Warren, S., Organic Chemistry
5. Morrison, R. T. and Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd.
6. Solomons, T. W. G., Organic Chemistry, John Wiley & Sons

Semester – V

.5.5 Minor Stream

Course Titles	Data Analysis in Chemistry (Th)
Course Credits	4 Credit's
Course Outcomes	After going through the course, learners will be able to
	1. Develop proficiency in performing basic analytical calculations using statistical methods and spreadsheets.
	2. Demonstrate the ability to analyze and interpret data in analytical chemistry using statistical tools.
	3. Understand the importance of validation parameters such as accuracy, precision, specificity, and robustness in analytical method validation.
	4. Apply statistical tools to evaluate method performance and validate analytical procedures.
Module 1 (Credit 1) Data Handling and Statistical Analysis	
Learning Outcomes	After going through the course, learners will be able to
	1. Students are able to understand and Develop proficiency in performing basic analytical calculations using statistical methods and spreadsheets.
	2. Demonstrate the ability to analyze and interpret data in analytical chemistry using statistical tools.
Content Outline	<ul style="list-style-type: none"> • Fundamental and derived units, universal constants, preparation of solutions, evaluation of concentrations, chemical stoichiometry, keeping records and making calculations, use of spreadsheets for calculations and practice. Quality • Management System: The laboratory product, Laboratory process, Customer Satisfaction, Improvement, Documentation Requirements, Management Responsibility Quality Policy, Responsibility, Authority and Communication, Resource Management, Product Realization, Measurement, Analysis and Improvement, Tools and Mechanism, Laboratory Environment.
Module 2 (Credit 1) Calibration and Validation Techniques	
Learning Outcomes	After going through the course, learners will be able to
	1. Demonstrate proficiency in documenting and reporting validation results according to industry standards and regulatory requirements.
	2. Apply quality control principles to ensure the reliability and accuracy of analytical results in laboratory settings.
Content Outline	<ul style="list-style-type: none"> • Errors, Types of errors—Sources of determinate errors and their elimination, random errors, Precision and accuracy, standard deviation, coefficient of variation, confidence interval, and their

	distribution, propagation of determinate errors and random errors, Control charts, Statistical tools – 't' test, 'F' test and 'Q' test; Method of least squares; Correlation coefficient and coefficient of determination; Limit of detection (LOQ); Limit of determination (LOD), Sensitivity and selectivity of an analytical method.
Module 3 (Credit 1) Computer Applications in Chemistry	
Learning Outcomes	After going through the course, learners will be able to
	1. Students are able to understand the principles of Total Quality Management (TQM) in the context of analytical chemistry.
	2. Students are able to Apply TQM principles to ensure quality control and improvement in analytical processes.
	3. Students are able to understand and Develop skills in analytical method development and validation, including method optimization and validation protocols.
Content Outline	<ul style="list-style-type: none"> Systems Definitions of Quality, Quality control and quality assessment. Internal methods of quality assessment, external methods of quality assessment, evaluating quality assurance data, Standards and reference materials, Comparison of standards. Standard operation procedures (SOPs), Data collection, control charts, data records, evaluation of data, data archiving, documentation, Good laboratory practices, Laboratory safety and good house keeping practices, Automation and mechanization and data retrieval, audits and accreditation. Quality Management System: The laboratory product, Laboratory process, Customer Satisfaction, Improvement, Documentation Requirements, Management Responsibility Quality Policy, Responsibility, Authority and Communication, Introduction to ISO 17025.
Module 4 Credit 1 Case Study in Chemical Data Interpretation	
Learning Outcomes	After learning the module, learners will be able to
	1. Students are able to Demonstrate knowledge of regulatory requirements and guidelines for method validation in analytical chemistry.
	2. Students are able to understand the importance of validation parameters such as accuracy, precision, specificity, and robustness in analytical method validation.
	3. Students are able to Apply statistical tools to evaluate method performance and validate analytical procedures.
Content Outline	<ul style="list-style-type: none"> Back ground, Introduction; defining the Objectives/ Requirements of the method, Specifications for Method Development, International Guidelines, The Method Development, its Life Cycle-Over view. Policy on Method

	<p>Development/Validation, Illustration of method</p> <ul style="list-style-type: none"> • Requirements, Information Gathering, Recourses/ Instrumentation/ Materials and Standards, Development Plan. Method development General considerations; Initial Method Development, method Optimization, method Pre-validation evaluation, robustness system suitability, Method Development- Experimental Considerations.
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Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module I: Data Handling and Statistical Analysis

Activity Title: Statistical Treatment of Experimental Data

Assignment Type: Data Analysis + Report

Task:

Collect experimental data from any chemistry experiment (e.g., titration, viscosity, and spectrophotometer) and perform statistical analysis.

Your report should include:

- Collection of raw data (minimum 10 readings)
- Calculation of:
 - Mean, Median, Standard Deviation
 - Variance and Relative Error
- Graphical representation (e.g., calibration curve)
- Interpretation of accuracy and precision
- Discussion on errors (systematic & random)
- Conclusion on reliability of data

Module II: Calibration and Validation Techniques

Activity Title: Preparation and Validation of Calibration Curve

Assignment Type: Experiment + Graph + Report

Task:

Prepare a calibration curve using any method:

- Colorimetric analysis (e.g., KMnO_4 , CuSO_4)
- pH vs concentration
- Conductivity vs concentration
- Your report should include:
 - Principle of calibration
 - Preparation of standard solutions
 - Experimental procedure
 - Graph plotting (concentration vs response)
 - Determination of unknown concentration
 - Discussion on linearity and deviations
 - Applications in analytical chemistry

Module III: Computer Applications in Chemistry

Activity Title: Use of Software Tools in Data Analysis

Assignment Type: Practical + Report / PPT

Task:

Use any software/tool:

- MS Excel
- Origin / ChemDraw / Graphing tools
- Perform:
 - Data entry and tabulation
 - Graph plotting
 - Trendline and regression analysis
- Your report should include:
 - Steps used in software
 - Screenshots (optional)
 - Graphs and equations obtained
 - Interpretation of results
 - Advantages of digital analysis over manual methods

Module IV: Case Study in Chemical Data Interpretation

Activity Title: Real-Life Chemical Data Analysis

Assignment Type: Case Study + Report

Task:

Select any one case:

- Water quality analysis data
- Pharmaceutical drug assay data
- Environmental pollution data
- Food quality testing
- Your report should include:
 - Description of dataset
 - Parameters analyzed
 - Graphs and trends
 - Comparison with standard values
 - Interpretation of results
 - Suggestions and conclusion

References

1. Handbook of Instrumental Techniques for Analytical Chemistry, F. Serlie, Prentice Hall.
2. Vogels Text book of Quantitative Chemical Analysis, Basett, Denny Jebbary, 5th Ed. ELBs 1990.
3. Instrumental Methods of Chemical Analysis, Willard Merrit, Dean, Stella Jr 6th Edition.
4. Instrumental Methods of Analysis, Seventh Edition, Willard, Merrit, Dean, Settle

5. Vogel's Qualitative Inorganic Analysis, Seventh Edition, G. Svehla
6. Vogels Text book of Quantitative Chemical Analysis, Basett, Denny, Barnes Jebbary

Semester – V

.5.6 Vocational Skill Courses (VSC-4)

Course Titles	Applied Chemistry leadership & Professional Skills (Th)
Course Credits	2 Credit's
Course Outcomes	After going through the course, learners will be able to
	1. This module has been designed to enable learners to embark on paths of personal and professional leadership development.
	2. The objective of this module is to make the learners understand why and how leadership skills are so critical for personal and organizational success.
	3. This module intends to develop critical appreciation and impart effective leadership skills.
Module 1 (Credit 1) Internship Training Record	
Learning Outcomes	After learning the module, learners will be able to
	1. Students will assess potential leadership philosophy, traits, skills, behaviors, and develop a leadership portfolio.
	2. Students will assess potential leadership philosophy, traits, skills, behaviors, and develop a leadership portfolio.
Content Outline	<ul style="list-style-type: none"> • Awareness of personal values, beliefs and vision that motivates behaviour; Personal SWOT; Trust: Openness, confidentiality, blind spot and unknown part of personality; Self disclosure, seeking feedback, self reflection, introspection and self management
Module 2 (Credit 1) Organization and Work Profile Study	
Learning Outcomes	After learning the module, learners will be able to
	1. Students will evaluate fundamental leadership practices relevant to contemporary organizations.
	2. Students will enhance their writing skills by comparing and contrasting different leadership approaches.
Content Outline	<ul style="list-style-type: none"> • Foundations of Group behaviour; Group development; Group properties: Roles, norms, status, size, design and cohesiveness, Group decision making; Group culture and dynamics; Managing group conflict, power, politics, change and management of diversity. • Games / Activities / Exercises on Leadership

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module I: Internship Training Record

Activity Title: Maintenance of Training Diary

Assignment Type: Daily Logbook + Submission

Assessment Criteria:

- Regularity of entries (daily record)
- Clarity of work description
- Mention of instruments/techniques
- Recording of learning outcomes
- Supervisor authentication

Module II: Organization and Work Profile Study

Activity Title: Study of Host Organization

Assignment Type: Report

Assessment Criteria:

- Introduction and background of organization
- Understanding of workflow and processes
- Explanation of products/services
- Role of chemistry in operations
- Presentation and organization of report

References

1. Ashokan, M. S. (2015). Karmayogi: A Biography of E. Sreedharan. Penguin, UK.
2. Elkington, J., & Hartigan, P. (2008). The Power of Unreasonable People: How Social Entrepreneurs Create Markets that Change the World. Harvard Business Press.
3. Goleman D. (1995). Emotional Intelligence. Bloomsbury Publishing India Private Limited
4. Kalam A. A. (2003). Ignited Minds: Unleashing the Power within India. Penguin Books India

Semester – V

.5.7 Field Projects (FP)

Course Titles	Workshop Visit Report (Pr)
Course Credits	2 Credit's
Course Outcomes	After going through the course, learners will be able to
	1. Students will Reinforce core chemistry concepts
	2. Students will Gain exposure to new advancements
	3. Student Develop practical laboratory skills
Module 1 (Credit 1)	
Learning Outcomes	After going through the course, learners will be able to
	1. Students understand workplace.
	2. Students learn about hands-on activities.
Content Outline	<ul style="list-style-type: none">• Briefly introduce the workshop topic and its significance within the field of chemistry.• Mention the organizers of the workshop and the date/location of the Workshop Overview Provide a summary of the workshop program, including:• Key presentations or lectures delivered by speakers (names and affiliations can be included if relevant)• Interactive sessions, demonstrations, or hands-on activities offered Topics covered in detail during the workshop
Module 2 (Credit 1) Mini Research / Project Work	
Learning Outcomes	After going through the course, learners will be able to
	1. Students Enhance data analysis and interpretation skills
	2. Students Learn about applications of chemistry in various
Content Outline	<ul style="list-style-type: none">• Outline the key concepts or techniques you learned during the workshop.• For example, if the workshop focused on organic synthesis, mention specific reactions or methodologies discussed. If new equipment or analytical techniques were demonstrated, provide a brief description of their applications.• Workshop Impact & Benefits• Discuss the potential impact of the workshop on your understanding of the field and your future endeavors (research, professional development, etc.) Mention any networking opportunities or connections you made with other participants or presenters. Briefly highlight any broader societal benefits of the workshop topic (e.g., development of new drugs, environmental applications).

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module I: Industrial / Workshop Study

Activity Title: Industrial Visit Report

Assignment Type: Field Visit + Report

Task:

Visit any one industry / laboratory:

- Pharmaceutical industry
- Food processing unit
- Water treatment plant
- Chemical manufacturing unit

Your report should include:

- Introduction of the industry
- Raw materials and products
- Flow diagram of process
- Description of instruments and techniques used
- Safety measures and waste management
- Quality control methods
- Learning outcomes from the visit

Module II: Process Understanding and Documentation

Activity Title: Study of Industrial Chemical Process

Assignment Type: Report + Flowchart

Task:

Select any one industrial process:

- Manufacture of ammonia (Haber process)
- Manufacture of sulphuric acid (Contact process)
- Cement manufacturing
- Soap or detergent manufacturing

Your report should include:

- Chemical reactions involved
- Stepwise process explanation
- Flowchart/diagram
- Conditions (temperature, pressure, catalyst)
- Industrial importance
- Environmental impact and control measures

Module III: Quality Control and Safety

Activity Title: Laboratory Safety and SOP Preparation

Assignment Type: Report + Chart

Task:

Prepare Standard Operating Procedures (SOP) for a chemistry lab

Your report should include:

- Laboratory safety rules
- Handling of chemicals (acids, bases, solvents)
- Waste disposal methods
- Emergency procedures (fire, chemical spill)
- Use of PPE (gloves, goggles, lab coat)
- Safety symbols and their meanings
- Optional: Prepare safety chart/poster

Module IV: Mini Research / Project Work

Activity Title: Small Research-Based Project

Assignment Type: Project + Report

Task:

Choose any small research topic:

- Analysis of packaged drinking water
- Comparison of detergent efficiency
- Study of pH in different soil samples
- Food adulteration detection
- Your report should include:
 - Title and objective
 - Literature background (short)
 - Methodology
 - Observations and data
 - Results and discussion
 - Conclusion and future scope

Reference Books

1. Chemistry by Raymond Chang and Kenneth A. Goldsby
2. Organic Chemistry by David Klein
3. Inorganic Chemistry by Catherine Housecroft and Alan Sharpe
4. Physical Chemistry by P.W. Atkins and Julio de Paula
5. Additional tips for finding reference books for your workshop visit report:
6. Search the library catalog at your school or university.

Course Syllabus

Semester – VI

.6.1 Major (Core)

Course Titles	Analytical Chemistry - II (Th)
Course Credits	4 Credit's
Course Outcomes	After going through the course, learners will be able to
	1. Understand the principles and theories behind analytical chromatography.
	2. Demonstrate proficiency in operating chromatographic instruments and equipment.
	3. Develop the ability to select and optimize chromatographic conditions for different analytes
Module 1 (Credit 1) Advanced Analytical Techniques	
Learning Outcomes	After learning the module, learners will be able to
	1. Students will understand and Interpret chromatographic data accurately and effectively.
	2. Students will Apply chromatographic techniques to solve real-world analytical problems.
	3. Students will understand and Demonstrate knowledge of different types of chromatographic techniques, such as gas chromatography, liquid chromatography, and ion chromatography
Content Outline	<ul style="list-style-type: none">• Chromatography: classification of different chromatographic methods, methods of development Elution development, Gradient elution development, displacement development, and frontal analysis.• Principles of chromatography, different migration, adsorption phenomena, partition, adsorption coefficient, retardation factor, retention time and volume, column capacity, temperature effects, partition isotherm.
Module 2 (Credit 1) Spectroscopic Methods	
Learning Outcomes	After learning the module, learners will be able to
	1. Students will understand the importance of sample preparation and handling in chromatographic analysis.
	2. Students will understand and Demonstrate proficiency in troubleshooting common issues in chromatographic analysis.
Content Outline	<ul style="list-style-type: none">• Dynamics of chromatography-efficiency of chromatographic column, zone spreading, High Equivalent Theoretical Plate (HETP), Van Demeter equation, resolution, choice of column, length and flow velocity, qualitative and quantitative analysis.

	<ul style="list-style-type: none"> Paper chromatography: Principle, papers as a chromatographic medium, modified papers, solvent systems, mechanism of paper chromatography, experimental technique, different development methods ascending, descending, horizontal, circular spreading, multiple development, two dimensional development, reverse phase paper chromatographic technique-visualization and evaluation of chromatograms,
Module 3 (Credit 1) Electroanalytical Methods	
Learning Outcomes	After learning the module, learners will be able to
	1. Students will understand the factors affecting resolution and efficiency in gel exclusion chromatography.
	2. Students will Apply gel exclusion chromatography techniques to separate and analyze macromolecules, such as proteins, polymers, and nucleic acids.
Content Outline	<ul style="list-style-type: none"> Thin layer chromatography: principle, chromatographic media coating materials, applications, activation of adsorbent, sample development, solvent systems, development of chromate plate, types of development, visualization methods, documentation, and applications in the separation. High Performance Thin layer chromatography (HPTLC): principle, technique, and applications. Column chromatography (adsorption chromatography): principles, general aspects, adsorption isotherms, chromatographic media, nature of forces between adsorbent and solutes, eluents (mobile phase), column chromatography without detectors and liquid chromatography with detectors and applications.
Module 4 (Credit 1) Environmental and Industrial Analysis	
Learning Outcomes	After learning the module, learners will be able to
	1. Develop skills in optimizing experimental conditions for gel exclusion chromatography.
	2. Apply gel exclusion chromatography to characterize and purify complex mixtures of analytes.
	3. Demonstrate proficiency in troubleshooting common issues that may arise during gel exclusion chromatography
Content Outline	<ul style="list-style-type: none"> Gel Exclusion chromatography or Gel filtration chromatography: principles, properties of xero gels, apparatus and detectors, resolution of gel type, applications to organic compounds. Capillary Electrophoresis: Principle, Details of the Instrument, Applications to Inorganic and Organic compounds. Inorganic molecular sieves: structure of zeolites, crystals, types of sieves, application in the separation of gases including

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module I: Advanced Analytical Techniques

Activity Title: Chromatographic Techniques in Analysis

Assignment Type: Report + Diagram / Optional Demo

Task: Study any one chromatographic technique:

- Paper Chromatography
- Thin Layer Chromatography (TLC)
- Column Chromatography

Your report should include:

- Principle of separation
- Types and working mechanism
- Labeled diagram
- Procedure (stepwise)
- Calculation of R_f value (if applicable)
- Applications in pharmaceuticals, food, forensics
- Advantages and limitations

Module II: Spectroscopic Methods

Activity Title: Interpretation of Spectral Data

Assignment Type: Data Analysis + Report

Task: Study any one technique:

- UV-Visible Spectroscopy
- IR Spectroscopy

Your report should include:

- Principle and theory
- Instrumentation
- Types of transitions (UV) / functional group identification (IR)
- Given or collected sample spectrum interpretation
- Applications in structure determination
- Case example (drug or organic compound analysis)

Module III: Electroanalytical Methods

Activity Title: Electrochemical Analysis

Assignment Type: Experiment / Report

Task: Perform or study any one method:

- pH measurement
- Conductometric titration
- Potentiometric titration

Your report should include:

- Principle and working

- Instrumentation
- Procedure (paragraph format)
- Observations and graphs
- Calculations
- Applications in analytical chemistry

Module IV: Environmental and Industrial Analysis

Activity Title: Monitoring Chemical Parameters in Environment

Assignment Type: Case Study + Report

Task: Analyze any one parameter:

- Air pollution (SO₂, NO_x)
- Water pollution (BOD, COD, pH)
- Soil analysis

Your report should include:

- Importance of parameter
- Methods of estimation
- Standard permissible limits
- Data interpretation (real or collected)
- Environmental impact
- Control and prevention methods

Reference books:

1. R.P.W Scott, Techniques and practice of Chromatography, Marel Dekker Inc., New York
2. M.N. Sastri ,Separation methods, Himalaya Publishing Company, Mumbai
3. E. Lederer and M. Lederer, Chromatography, Elsevier, Amsterdam.
4. Chemical separation methods, John A Dean, Von Nostrand Reinhold, New York R.P.W Scott, Techniques and practice of Chromatography, Marel Dekker Inc., New York
5. H.M Mc Nair and J. M. Miller, Basic Gas Chromatography, John Wiley, New York

Semester – VI**.6.2 Major (Core)**

Course Titles	Inorganic Chemistry - II (Th)
Course Credits	4 Credit's
Course Outcomes	After going through the course, learners will be able to
	1. Develop proficiency in synthesizing and characterizing organometallic compounds of transition elements.
	2. Explain the principles and applications of photochemistry in metal complexes, including photophysical processes and photochemical reactions.
	3. Understand the chemistry of metal-metal multiple bonds and their role in catalysis and reactivity.
	4. Explore the properties and applications of nanomaterials based on transition metal elements.
Module 1 (Credit 1) Coordination Chemistry & Bonding	
Learning Outcomes	After learning the module, learners will be able to
	1. Students will understand the electronic structure and bonding of transition metal complexes.
	2. Students will understand and Demonstrate knowledge of the coordination chemistry of transition elements, including ligand exchange reactions and isomerism.
Content Outline	<ul style="list-style-type: none">• Chemistry of transition elements: General characteristic properties of transition elements;• Coordination chemistry of transition metal ions; stereochemistry of coordination compounds;• Interpretation of electronic spectra including charge transfer spectra; Metal clusters. Metal-Ligand bonding: Crystal field theory;• CFT for octahedral, tetrahedral and square planer complexes; John-Teller effect, spectro chemical series, limitation of crystal field theory;• Molecular orbital theory for octahedral, tetrahedral complexes, Ligand field theory.
Module 2 Credit 1 Crystal Field Theory & Spectra	
Learning Outcomes	After learning the module, learners will be able to
	1. Students will understand and Develop proficiency in synthesizing and characterizing organometallic compounds of transition elements.
	2. Students will understand and Explain the principles and applications of photochemistry in metal complexes, including

	photo physical processes and photochemical reactions.
Content Outline	<ul style="list-style-type: none"> • Organo metallic Chemistry of transition elements: Ligand captivity; • Electron count for different types of organ metallic compounds; • 18 and 16 electron rule exceptions; • Synthesis, structure and bonding, organ metallic reagents in organic synthesis and in homogeneous catalytic reactions (Hydrogenation and hydroformylation, isomerisation).
Module 3 (Credit 1) Metal Complexes in Biology	
Learning Outcomes	After learning the module, learners will be able to
	1. Students will understand the chemistry of metal-metal multiple bonds and their role in catalysis and reactivity.
	2. Students will understand and Explore the properties and applications of nanomaterials based on transition metal elements.
Content Outline	<ul style="list-style-type: none"> • Photochemistry of Metal Complexes and Metal–Metal Multiple Bonds: Excited states, ligand field states, charge-transfer states and Thexi states; • Phosphoresence and fluorescence; Photochemical reactions: substitution and redox reactions of Cr(III) and Ru(II) complexes; • Applications: synthesis and catalysis, chemical actinometrical and photo-chromism.
Module 4 (Credit 1) Organometallic Compounds	
Learning Outcomes	After learning the module, learners will be able to
	1. Students will understand the concept of hard and soft acids and bases and their relevance to coordination chemistry.
	2. Students will Apply the HSAB theory to predict stability and reactivity in transition metal complexes.
	3. Students will understand and Demonstrate knowledge of the differences between hard and soft acids and bases in complex formation.
	4. Students will understand the role of transition metal complexes in catalysis and industrial applications.
Content Outline	<ul style="list-style-type: none"> • Nanomaterials: General introduction to nonmaterial's and emergence of nanotechnology; synthesis of nanoparticles of gold, palladium, platinum, and silver; Synthesis of nanowires and Nano rods • Hard & Soft Acid Base: Hard and soft acid base, Principle, theoretical basis of hardness and softness; Lewis-acid Base reactivity approximately; Donor acceptor number, applications of

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):**Module I: Coordination Chemistry & Bonding****Activity Title: Structure and Properties of Coordination Compounds****Assignment Type: Diagrams + Short Report****Task:**

Study any 3–4 coordination compounds:

- $[\text{Co}(\text{NH}_3)_6]^{3+}$
- $[\text{Fe}(\text{CN})_6]^{4-}$ / $[\text{Fe}(\text{CN})_6]^{3-}$
- $[\text{Ni}(\text{CO})_4]$
- $[\text{Cu}(\text{NH}_3)_4]^{2+}$
- Your report should include:
- Structure and geometry (with diagrams)
- Hybridization and bonding (VBT/CFT approach)
- Magnetic properties (paramagnetic/diamagnetic)
- Color and electronic transitions
- Stability and applications

Module II: Crystal Field Theory & Spectra**Activity Title: Crystal Field Splitting and Spectrochemical Series****Assignment Type: Diagram + Analysis****Task:**

Analyze crystal field splitting for:

- Octahedral complexes
- Tetrahedral complexes

Your report should include:

- Crystal Field Theory explanation
- Splitting diagrams (Δ_o and Δ_t)
- High spin vs low spin complexes
- Spectrochemical series
- Calculation of CFSE (simple cases)
- Relation with color and magnetism

Module III: Metal Complexes in Biology**Activity Title: Role of Metal Ions in Biological Systems****Assignment Type: Report + Chart****Task:**

Study any one system:

- Hemoglobin (Fe)
- Chlorophyll (Mg)
- Vitamin B₁₂ (Co)
- Metalloenzymes

Your report should include:

- Structure of the complex
- Role of metal ion
- Mechanism of action
- Importance in biological systems
- Deficiency or toxicity effects
- Applications in medicine

Module IV: Organometallic Compounds

Activity Title: Study of Metal Carbonyls and Organometallics

Assignment Type: Report + Optional PPT

Task:

Study any one compound:

- Fe(CO)₅
- Ni(CO)₄
- Ferrocene

Your report should include:

- Structure and bonding
- Preparation methods
- Physical and chemical properties
- Applications in catalysis / industry
- Safety and toxicity aspects

Reference Books:

1. R. C. Mehrotra & A. Singh. Organometallic Chemistry: A Unified Approach (2nd edn.), New Age International (2000).
2. F. A. Cotton & G. Wilkinson. Advanced Inorganic Chemistry (5th edn.), John Wiley (1988).
3. D. M. Roundhill. Photochemistry and Photophysics of Metal Complexes, Plenum Press.
4. F. Wells, Structural Inorganic Chemistry – 5th edition (1984)
5. J H Huheey, Inorganic Chemistry – Principles, structure and reactivity, Harper and Row Publisher, Inc. New York (1972).
6. J. D. Lee, Concise Inorganic Chemistry, Elbs with Chapman and Hall, London

Semester – VI**.6.3 A. Major (Elective)**

Course Titles	Molecular Modeling (Th)
Course Credits	4 Credit's
Course Outcomes	After going through this course, learners will be able to:
	1. Explain the fundamental concepts of molecular modelling, coordinate systems, and molecular visualization.
	2. Apply principles of molecular mechanics and force fields to describe molecular interactions.
	3. Analyze molecular systems using energy minimization and computational techniques.
	4. Evaluate molecular behavior through simulation methods and interpret computational results.
Module 1 (Credit 1) Fundamentals of Molecular Modeling	
Learning Outcomes	After going through this course, learners will be able to:
	1. Define molecular modelling and explain its scope and applications.
	2. Describe different coordinate systems used in molecular representation.
	3. Explain the concept of potential energy surfaces.
	4. Interpret molecular structures using visualization tools.
Content Outline	<ul style="list-style-type: none">• Introduction to molecular modelling• Scope and applications of molecular modelling• Coordinate systems (Cartesian and internal coordinates)• Potential energy surfaces• Molecular graphics and visualization techniques• Computer hardware and software used in modelling
Module 2 (Credit 1) Molecular Mechanics and Force Fields	
Learning Outcomes	After going through this course, learners will be able to:
	1. Explain the principles of molecular mechanics. 2. Analyze bonded interactions including bond stretching, angle bending, and torsional effects.
Content Outline	<ul style="list-style-type: none">• Molecular mechanics fundamentals• Force fields and their components• Bond stretching and angle bending• Torsional interactions

	<ul style="list-style-type: none"> • Non-bonded interactions • Electrostatic interactions • van der Waals interactions • Hydrogen bonding
Module 3 (Credit 1) Computational Methods and Energy Minimization	
Learning Outcomes	After going through this course, learners will be able to:
	1. Explain the concept of energy minimization in molecular systems.
	2. Describe optimization algorithms used in molecular modelling.
	3. Analyze potential energy surfaces for molecular stability.
	4. Interpret results obtained from energy minimization techniques.
Content Outline	<ul style="list-style-type: none"> • Energy minimization concepts • Optimization methods (first and second order methods) • Non-derivative methods • Exploration of potential energy surfaces • Convergence criteria • Applications of energy minimization
Module 4 (Credit 1) Molecular Dynamics and Simulation Techniques	
Learning Outcomes	After going through this course, learners will be able to:
	1. Explain the principles of molecular dynamics simulations.
	2. Describe Monte Carlo simulation methods.
	3. Analyze thermodynamic properties obtained from simulations.
	4. Interpret simulation data and molecular trajectories.
Content Outline	<ul style="list-style-type: none"> • Molecular dynamics simulation methods • Equations of motion • Simulation at constant temperature and pressure • Monte Carlo simulation • Phase space and boundary conditions • Analysis of simulation results

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

Module I: Fundamentals of Molecular Modelling

Activity Title: Visualization of Molecular Structures

Assignment Type: Practical (Software) + Report

Task: Use molecular modelling software such as Avogadro or ChemDraw. Your report should include:

- Introduction to molecular modelling
- Steps used in software
- Visualization of molecular structures
- Basic structural parameters
- Applications of molecular modelling

Module II: Molecular Mechanics and Force Fields

Activity Title: Study of Force Fields and Molecular Interactions

Assignment Type: Report + Diagram Work

Task:

Prepare a report on molecular interactions and force field concepts.

Your report should include:

- Types of force fields
- Bonded and non-bonded interactions
- Energy components in molecular systems
- Applications of molecular mechanics

Module III: Energy Minimization Techniques

Activity Title: Optimization of Molecular Structures

Assignment Type: Report + Flow Diagram

Task:

Study energy minimization methods used in molecular modelling.

Your report should include:

- Energy minimization methods
- Optimization algorithms
- Potential energy surface analysis
- Interpretation of minimized structures

Module IV: Molecular Simulation Methods

Activity Title: Simulation of Molecular Systems

Assignment Type: Report + Data Analysis

Task:

Prepare a report on simulation techniques.

Your report should include:

- Molecular dynamics simulation
- Monte Carlo methods
- Thermodynamic properties
- Analysis and interpretation of simulation data

References:

1. Leach, A. R., Molecular Modelling: Principles and Applications
2. Jensen, F., Introduction to Computational Chemistry
3. Cramer, C. J., Essentials of Computational Chemistry
4. Hinchliffe, A., Modelling Molecular Structures
5. Szabo, A. and Ostlund, N. S., Modern Quantum Chemistry

Semester – VI**.6.3 B. Major (Elective)**

Course Titles	Drug Design and Discovery (Th)
Course Credits	4 Credit's
Course Outcomes	After learning this module, learners will be able to:
	1. Explain the principles and stages involved in drug discovery and development.
	2. Apply concepts of target identification and structure-based drug design.
	3. Analyze drug–receptor interactions and pharmacological activity.
	4. Evaluate pharmacokinetic properties and optimize drug candidates.
Module 1 (Credit 1) Introduction to Drug Design and Discovery	
Learning Outcomes	After learning this module, learners will be able to:
	1. Define drug discovery and explain its stages
	2. Describe sources of drugs and lead compounds.
	3. Explain target identification and validation.
Content Outline	<ul style="list-style-type: none">• Introduction to drug discovery and development• Sources of drugs: natural, synthetic, and semi-synthetic• Concept of lead compounds and lead optimization• Target identification and validation• Drug development process and challenges• Introduction to medicinal chemistry
Module 2 (Credit 1) Drug–Target Interactions	
Learning Outcomes	After learning this module, learners will be able to:
	1. Explain drug–receptor interactions.
	2. Describe types of bonding in drug binding.
	3. Analyze structure–activity relationships
	4. Explain factors affecting drug activity and selectivity.
Content Outline	<ul style="list-style-type: none">• Drug–receptor interactions• Types of intermolecular forces in drug binding• Structure–activity relationship (SAR)• Factors influencing drug action• Agonists, antagonists, and partial agonists• Dose-response relationships

Module 3 (Credit 1) Drug Design Strategies	
Learning Outcomes	After learning this module, learners will be able to:
	1. Explain structure-based drug design.
	2. Describe ligand-based drug design.
	3. Understand molecular docking principles
	4. Evaluate computational approaches in drug design.
Content Outline	<ul style="list-style-type: none"> • Structure-based drug design • Ligand-based drug design • Molecular docking principles • Quantitative structure–activity relationships (QSAR) • Pharmacophore modelling • Introduction to computational tools in drug design
Module 4 (Credit 1) Pharmacokinetics and Drug Optimization	
Learning Outcomes	After learning this module, learners will be able to
	1. Explain pharmacokinetic processes.
	2. Describe ADME properties.
	3. Analyze drug metabolism pathways.
	4. Evaluate factors affecting drug distribution and excretion.
Content Outline	<ul style="list-style-type: none"> • Introduction to pharmacokinetics • ADME: absorption, distribution, metabolism, excretion • Drug metabolism and biotransformation • Bioavailability and half-life • Drug toxicity and safety evaluation • Strategies for drug optimization

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module I: Introduction to Drug Design and Discovery

Activity Title: Drug Discovery Process and Lead Identification

Assignment Type: Report

Task:

Prepare a report on the drug discovery and development process.

Your report (4–5 pages) should include:

- Stages involved in drug discovery and development
- Sources of drugs and lead compounds
- Concept of lead identification and optimization

- Target identification and validation
- Challenges in drug development

Module II: Drug–Target Interactions

Activity Title: Analysis of Drug–Receptor Interactions

Assignment Type: Report + Diagram Work

Task:

Prepare a detailed report on drug–target interactions.

Your report (4–5 pages) should include:

- Types of drug–receptor interactions
- Intermolecular forces involved in drug binding
- Structure–activity relationship
- Factors affecting drug activity and selectivity
- Concepts of agonists and antagonists

Module III: Drug Design Strategies

Activity Title: Computational Approaches in Drug Design

Assignment Type: Report + Flow Diagram + Optional PPT

Task:

Prepare a report on different drug design approaches.

Your report (4–5 pages) should include:

- Structure-based drug design
- Ligand-based drug design
- Molecular docking concepts
- QSAR studies
- Pharmacophore modelling
- Role of computational tools in drug design
Optional: Prepare a PowerPoint presentation (3–5 slides)

Module IV: Pharmacokinetics and Drug Optimization

Activity Title: ADME and Drug Optimization Studies

Assignment Type: Report + Case Study

Task:

Prepare a report on pharmacokinetics and drug optimization.

Your report (4–5 pages) should include:

- Pharmacokinetic processes
- ADME properties of drugs
- Drug metabolism and excretion
- Factors affecting bioavailability

- Drug toxicity and safety
- Strategies for drug optimization
- Optional: Include a case study related to drug action or metabolism

References:

1. Patrick, G. L., An Introduction to Medicinal Chemistry
2. Silverman, R. B., The Organic Chemistry of Drug Design and Drug Action
3. Wilson, C. O. and Gisvold, O., Textbook of Organic Medicinal and Pharmaceutical Chemistry
4. Lemke, T. L., Williams, D. A., Foye's Principles of Medicinal Chemistry
5. Rang, H. P., Dale, M. M., Ritter, J. M., Pharmacology
6. Krogsgaard-Larsen, P., Liljefors, T., Textbook of Drug Design and Discovery

Semester – VI**.6.4 Minor Stream**

Course Titles	Analytical & Inorganic Chemistry-Experimental Work (Pr)
Course Credits	2 Credit's
Course Outcomes	After going through the course, learners will be able to
	1. Students will understand and Develop skills in systematic identification of cations and anions in unknown mixtures using classical wet chemical methods.
	2. Master the calculations involved in determining the concentration of an analyte in a sample
Module 1 (Credit 1) Quantitative Analysis Techniques	
Learning Outcomes	After learning the module, learners will be able to
	1. Learn to interpret observations like color changes, precipitate formation, and gas
Content Outline	<ul style="list-style-type: none"> • To perform quantitative separation and determination of the following pairs of metal ions using gravimetric and volumetric methods: <ul style="list-style-type: none"> ○ Ag⁺ (gravimetrically) and Cu²⁺(Volumetrically) ○ Cu²⁺ (gravimetrically) and Zn²⁺(Volumetrically) ○ Fe³⁺ (gravimetrically) and Ca²⁺(Volumetrically) ○ Mg²⁺ (gravimetrically) and Ca²⁺(Volumetrically)
Module 2 (Credit 1) Gravimetric and Separation Methods	
Learning Outcomes	After learning the module, learners will be able to
	2. Students will Learn and follow proper safety protocols for working in a chemistry lab, including handling hazardous materials, using personal protective equipment (PPE), and waste disposal procedures
Content Outline	<ul style="list-style-type: none"> • To determine separation of a mixture of cations/anions by paper chromatographic technique using aqueous/nonaqueous media. <ul style="list-style-type: none"> ○ Pb²⁺ and Ag⁺ (aqueous and non-aqueous media) Co²⁺ and Cu²⁺ (non-aqueous medium) ○ Cl⁻ and I⁻ (aqueous-acetone medium) ○ Br⁻ and I⁻ (aqueous-acetone medium)

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):**Module I: Quantitative Analysis Techniques****Activity Title: Volumetric Analysis of Chemical Compounds****Assignment Type: Experiment + Report**

Task:

- Perform any one titration:
- Acid–base titration
- Redox titration (KMnO_4 / $\text{K}_2\text{Cr}_2\text{O}_7$)
- Complexometric titration (EDTA)

Your report should include:

- Aim, Principle, and Reaction
- Preparation of standard solutions
- Procedure (paragraph format)
- Observations and tabulation
- Calculations (normality, molarity)
- Result and accuracy
- Sources of error and precautions

Module II: Gravimetric and Separation Methods

Activity Title: Gravimetric Estimation and Precipitation Techniques

Assignment Type: Experiment + Report

Task:

- Perform estimation of:
- Nickel using DMG method
- Sulphate as BaSO_4
- Chloride as AgCl

Your report should include:

- Principle of gravimetric analysis
- Chemical reactions involved
- Procedure (stepwise)
- Filtration, drying, and weighing process
- Calculations
- Result and discussion
- Importance in analytical chemistry

References:

1. Vogel ,A text book of Quantitative Inorganic Analysis
2. W. G. Palmer Experimental Inorganic Chemistry

Semester – VI

.6.5 Minor Stream

Course Titles	Integrated Chemistry of Health and Society (Th)
Course Credits	4 Credit's
Course Outcomes	1. Describe and discuss the biological and social bases for sexuality, including problems of methodology and meaning.
	2. Articulate the relation of the presentation of the self in relations to sex roles and social roles.
	3. Explain the relation of incest taboos to the social boundaries of sexuality, in relation to classical theory and 'pop' anthropology.
	4. Describe the basic forms of human sexuality and the cross-cultural attitudes toward them.
	5. Discuss the process of sexual development according to sex research.
Module 1 (Credit 1) Human Biology and Chemistry Interface	
Learning Outcomes	After learning the module, learners will be able to
	1. Students able to Describe and discuss the biological and social bases for sexuality, including problems of methodology and meaning.
Content Outline	<ul style="list-style-type: none"> • Theories of gender and sexuality in the social sciences • Biology vs. Culture Biological Orientations • The biological basis for sexuality and gender • Primate studies
Module 2 (Credit 1) Nutrition and Health Chemistry	
Learning Outcomes	After learning the module, learners will be able to
	1. Students understand the basic forms of human sexuality and the cross-cultural attitudes toward them
Content Outline	<ul style="list-style-type: none"> • Cultural Orientations • Culture and personality • Love, Marriage, Incest , Taboo
Module 3 (Credit 1) Social and Environmental Aspects	
Learning Outcomes	After learning the module, learners will be able to
	1. Students understand the process of sexual development according to sex research.
	2. Students learn about the politics of sexuality in various cultures.
Content Outline	<ul style="list-style-type: none"> • The Impact of Material Conditions on the Expression of Sexuality and Gender

	<ul style="list-style-type: none"> • Foragers: sexual and gender equality? • Horticulturalists and pastoralists: the origins of sexual inequality? • Agriculturalists and Industrialists: ideologies of sexual inequality • Ideological Constraints on the Expression of Gender and Sexuality
Module 4 (Credit 1) Gender, Society and Science	
Learning Outcomes	After learning the module, learners will be able to
	1. Students learn about the Birth and social difference
	2. Students learn about Religion and Language and its influence.
Content Outline	<ul style="list-style-type: none"> • Birth and social difference • Religion • Language and its influence

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module I: Human Biology and Chemistry Interface

Activity Title: Chemical Basis of Human Physiology

Assignment Type: Report + Diagram

Task:

Study any one system:

- Nervous system (neurotransmitters)
- Endocrine system (hormones)
- Digestive system (enzymes)

Your report should include:

- Structure and function of biomolecules involved
- Chemical nature of hormones/enzymes
- Mechanism of action
- Role in maintaining body functions
- Disorders related to imbalance
- Diagrammatic representation

Module II: Nutrition and Health Chemistry

Activity Title: Role of Nutrients in Human Health

Assignment Type: Report + Chart

Task:

Study major nutrients:

- Carbohydrates
- Proteins

- Vitamins
- Minerals

Your report should include:

- Classification and sources
- Daily requirement (RDA)
- Biochemical role in body
- Deficiency diseases
- Balanced diet concept
- Real-life dietary chart (optional)

Module III: Social and Environmental Aspects

Activity Title: Chemical Impact on Society and Environment

Assignment Type: Case Study + Report

Task:

Choose any one topic:

- Pollution due to chemicals
- Waste management
- Use of chemicals in agriculture
- Public health issues

Your report should include:

- Description of issue
- Chemical basis
- Effects on environment and health
- Preventive measures
- Government regulations / standards
- Suggestions and conclusion

Module IV: Gender, Society and Science (Interdisciplinary)

Activity Title: Role of Science in Social Development

Assignment Type: Essay / Report

Task:

Analyze any one topic:

- Women in science
- Gender equality in STEM
- Role of science in social empowerment

Your report should include:

- Introduction to topic
- Current scenario
- Challenges and opportunities
- Role of education and science
- Case examples

- Conclusion with future scope

Reference:

1. Brettell, C. and Sargent, C. (2005). Gender in Cross-Cultural Perspective. Upper Saddle River, NJ: Prentice-Hall.
2. Abu-Lughod, L. (2008). Writing Women's World's: Bedouin Stories. Berkeley: University of California Press. Klein, L. (2004). Women and Men in World Cultures. Toronto: McGraw-Hill.
3. Herdt, G. (2006). The Sambia: Ritual, Sexuality, and Change in Papua New Guinea. Toronto: Nelson Education

Semester – VI

.6.6 On-Job Training (OJT)

Course Titles	Internship (Pr)
Course Credits	4 Credit's
Course Outcomes	After going through the course, learners will be able to
	1. It will provide opportunity to find out their interest in a particular carrier.
	2. Experiential learning will have broader perspective for employment
Module (Credit 4) Internship Training Record	
Learning Outcomes	After learning the module, learners will be able to
	1. The intern will develop skills in the analytical techniques in practical work situation.
	2. Intern will develop and strengthen their professional skills and interpersonal relationship in work environment of the industry.
Content Outline	<ul style="list-style-type: none">• Internship placement will be in research institutes, industries like pharma, food and cosmetic or Government organization (BARC or Haffkine Institute), subject to approval of the internship coordinator. Student will prepare a detailed plan with the approval of external mentor which will be submitted to the internship coordinator within 7 days of the joining.• At the end of internship, student will prepare a write up (2000 to 3000 words) based on their daily work activities in the organization. Evaluation of the internship assignment will be done internally and externally.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Internship Training Record

Activity Title: Maintenance of Training Diary

Assignment Type: Daily Logbook + Submission

Task:

- Maintain a daily record of work during internship in:
- Laboratory
- Industry
- Research institute

Your report should include:

- Day-to-day activities performed
- Instruments/techniques used
- Observations and learning outcomes
- Attendance record
- Supervisor remarks/signature