

Structure with Course Title**B. Sc. In Chemistry****Semester – III**

SN	Courses	Type of Course	Credits	Marks	Int	Ext
Semester III						
30132111	Physical Chemistry-I (2 TH + 2 PR)	Major (Core)	4	100	50	50
30132112	Organic Chemistry – I (2 Th + 2 Pr)	Major (Core)	4	100	50	50
30132113	Inorganic Chemistry – I (2 Th + 2 Pr)	Major (Core)	4	100	50	50
30332111	Analytical Chemistry – I (2 Th + 2 Pr)	Minor Stream	2	50	0	50
30432111	Environmental Pollution	OEC	2	50	0	50
	Modern Indian Language Link- Click Here	AEC (Any One)	2	50	50	0
30810301	रचनात्मक लेखन (Hindi)					
30810401	मराठी भाषेचा पररचय - भाग १ (Marathi)					
30810501	Contemporary Sanskrit Nyaya (Sanskrit)					
30810201	શીખો ગુજરાતી – પ્રાથમિક ભાગ ૧: લિપિ િરચય, શ્રવણ અને વાચન કૌશલ્ય (Gujrati)					
31332101	Field Project	FP	2	50	50	0
	Co-Curricular Course Link- Click Here	CC (Any One)	2	50	50	0
31450121	Social issues Advocacy and Action					
31450221	National Cadets Corps. (NCC) Studies – III					
31450321	Traditional Sports and Fitness					
31450421	Unfolding The Beauty of Indian Music					
			22	550	300	250

Semester – IV

SN	Courses	Type of Course	Credits	Marks	Int	Ext
Semester IV						
40132111	Analytical Chemistry – II (2 Th + 2 Pr)	Major (Core)	4	100	50	50
40132112	Inorganic Chemistry – II (2 Th + 2 Pr)	Major (Core)	4	100	50	50
40132113	Organic Chemistry – II (2 Th + 2 Pr)	Major (Core)	4	100	50	50
40432111	Waste Management	OEC	2	50	0	50
40732111	Green Chemistry	SEC	2	50	0	50
	Modern Indian Language Link- Click Here	AEC (Any One)	2	50	0	50
40810411	मराठी भाषेचा पररचय - भाग २ (Marathi)					
40810411	सूचना प्रौद्योगिकी और गडिंदी भाषा (Hindi)					
40810511	वाल्मीकीकरामयणे अयोध्याकाण्डः (Sanskrit)					
40810211	शीषो गुजराती – भाष्मिड (Gujrati)					
41532101	Community Engagement and Service (CE)	CE	2	50	50	0
	Co-Curricular Course Link- Click Here	CC (Any One)	2	50	50	0
41450122	Personality and Leadership Development through National Service Scheme					
41450121	NSS Volunteers under National service scheme special camp					
41450221	National Cadets Corps. (NCC) Studies – IV					
41450421	Theatre & Dance					
			22	550	250	300

Course Syllabus

Semester – III

3.1 Major (Core)

Course Title	Physical Chemistry
Course Credits	4 (2+2) Theory + Practical's
Course Outcomes	After going through the course, learners will be able to
	<ul style="list-style-type: none">• The main objective of this paper is to give a basic and updated knowledge for students on Thermodynamics, Surface phenomena and phase equilibria, Electrochemistry, Chemical kinetics and Microwave Spectroscopy and Rotational Vibrational Spectroscopy.
Module 1(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none">• - Understand the basic principles of atomic structure, including the arrangement of electrons, protons, and neutrons within an atom.• - Explain how the periodic table is organized based on atomic structure.• - Predict the properties of elements based on their atomic structure.
Content Outline	<ul style="list-style-type: none">• Review of Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to atomic structure -Introduction to Quantum mechanics: Time independent Schrodinger equation and meaning of various terms in it (no derivation). Significance of ψ and ψ^2 Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law non-ideal solutions. Vapor pressure-composition and temperature-composition curves of ideal and non-ideal solutions. Distillation of solutions.• Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.• Liquids: Surface tension and its determination using a stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

Module 2(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none"> • Bonding: • Differentiate between different types of chemical bonds, such as covalent, ionic, and metallic bonds. • Describe the factors that influence bond formation and strength. • Predict the type of bonding in a given compound based on its chemical formula.
Content Outline	<ul style="list-style-type: none"> • Ionic bonding, lattice energy, Statement of Born-Landé equation for calculation of lattice energy, • Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, dipole moment and percentage ionic character. • Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of • VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO⁺. Comparison of VB and MO approaches
Module 3(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none"> • This course aims to build hands-on experience in the experimental aspects of physical chemistry. • It introduces students to the measurement and interpretation of physicochemical properties such as conductivity, viscosity, surface tension, and reaction kinetics. • It also develops skills in the use of analytical instruments, data plotting, and interpretation of results.
Content Outline	<ul style="list-style-type: none"> • Determination of enthalpy of neutralization of a strong acid with a strong base. • Determination of enthalpy of dissolution of salts like KNO₃ or CuSO₄. • Determination of rate constant of the reaction between potassium iodide and potassium persulphate (iodine clock reaction).

	<ul style="list-style-type: none"> Study of the effect of temperature on the rate constant and determination of activation energy.
Module 4(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<p>Students will perform experiments to determine heats of solution, neutralization, or hydration.</p> <p>Study of the kinetics of the acid-catalyzed hydrolysis of methyl acetate</p>
Content Outline	<ul style="list-style-type: none"> Determination of partition coefficient of iodine between water and carbon tetrachloride. Determination of surface tension of a liquid using a stalagmometer. Determination of viscosity of a liquid using Ostwald's viscometer. Determination of specific or equivalent conductance of electrolyte solutions and verification of Kohlrausch's law.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module I: Solutions and Liquid State

Activity Title: Real-World Applications of Non-Ideal Solutions

Assignment Type: Report + Optional PPT

Task:

Choose a real-life binary solution such as:

- Alcohol–water mixture
- Seawater
- Acetone–chloroform
- Blood plasma

Your report (4–5 pages) should include:

- Nature of deviation from Raoult's Law (positive or negative) and its molecular explanation.
- Application of Colligative Properties (freezing point depression, boiling point elevation, osmotic pressure).
- Concept of azeotropes and their separation using fractional distillation.
- Vapour pressure–composition and temperature–composition diagrams.
- Optional: Prepare a PowerPoint presentation (3–5 slides) for in-class discussion.

Module II: Surface Tension and Viscosity

Activity Title: Measurement of Surface Tension and Viscosity in Everyday Substances

Assignment Type: Experiment + Report

Select any 1–2 household substances:

- Cooking oil
- Shampoo
- Detergent
- Honey
- Glycerin

Method:

- Use stalagmometer to measure surface tension.
- Use Ostwald viscometer to measure viscosity.
- Record temperature and time/number of drops as applicable.

Your report should include:

- Title and Objective
- Methodology with labeled apparatus diagram
- Observations and calculations
- Graph: Surface tension or viscosity vs. temperature (optional)
- Conclusion about the effect of temperature
- Real-world applications in food, cosmetics, pharmaceuticals

Module III: Chemical Bonding

Activity Title: Molecular Geometry & Orbital Diagrams

Assignment Type: Diagrams + Short Report / Optional 3D Model

Choose 3–5 molecules such as:

- BeCl_2 , BF_3 , CH_4 , PCl_5 , SF_6 , H_2O , NH_3
- Homonuclear diatomics: O_2 , N_2 , F_2
- Heteronuclear diatomics: CO , NO , NO^+

Tasks:

- Draw VSEPR-based molecular geometries with bond angles.
- Draw Molecular Orbital (MO) diagrams for selected diatomic molecules.
- Indicate:
 - Type of Hybridization
 - Bond Order
 - Magnetic behavior (Paramagnetic/Diamagnetic)
- Optional: Create 3D molecular models using software (e.g., Avogadro) or physical materials.

Module IV: Ionic Equilibria

Activity Title: Buffer Systems in Daily Life

Assignment Type: Report + Optional Demonstration

Choose any one buffer system:

- Blood buffer ($\text{H}_2\text{CO}_3/\text{HCO}_3^-$)
- Phosphate buffer
- Soil buffer
- Buffer in shampoos or eye drops

Your report should include:

- Composition and function of the buffer system
- Working principle using the Henderson–Hasselbalch equation with example pH calculation
- Demonstration or graphical explanation of buffering capacity (conceptual or experimental)
- Optional: In-class demonstration using vinegar, baking soda, or citric acid system

Reference:

1. Gurdeep Raj, *Advanced Physical Chemistry*, 35th edition, Goel Publishing House, 2009.
2. Puri, Sharma Pathania, *Principles of Physical Chemistry*, 42nd edition, Vishal Publishing & Co, 2007.
3. R. Stephen Berry, Stuart A. Rice & John Ross, *Physical Chemistry*, 2nd edition, Oxford
4. University press, 2000..Levin, *Physical Chemistry*, 6th edition, Tata Mcgraw-Hill Education, 2011.

3.2 Major (Core)

Course Title	Organic Chemistry
Course Credits	4 (2+2) Theory + Practical's
Course Outcomes	After going through the course, learners will be able to
	1. To acquire skills in the preparation of organic compounds, their separation, purification and identification
	2. Students understand the process of preparation of organic through various reactions
	3. To develop an insight into the preparation of organic compounds in various reactions
Module 1(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none">• Students understand the process of preparation of organic through various reactions• Students understand reactive intermediate
Content Outline	<ul style="list-style-type: none">• Structure, shape and reactivity of organic molecules• Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule. Alkenes: Methods of preparation of alkenes by (i) dehydration of alcohols (ii) dehydrohalogenation. Saytzeff's elimination (Formation of highly substituted alkene, 2-butene), Hofmann orientation (Formation of least substituted alkene, 1-pentene). Chemical reactions of alkenes- Peroxide effect and its mechanism, hydroboration, oxidation, oxy-mercuration-reduction and mechanism, ozonolysis with respect to 2-butene and 2-methyl-2-butene, oxidation with KMnO₄.
Module 2(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none">• Students learn about Baeyer's strain theory• Students understand Geometrical isomerism:

Content Outline	<ul style="list-style-type: none"> • Baeyer's strain theory, calculation of angle strain, Sachse Mohr theory of strain-less rings. Chair and boat forms of cyclohexane. Axial and equatorial bonds. • Conformational isomerism: Basic concept of conformational analysis with reference to ethane and butane. • Geometrical isomerism: definition, E and Z notation for 2-butene and butenedioic acid, rules for assigning notations. Determination of configuration of butenedioic acid by anhydride formation, dipole moment measurement, melting point and stability. • Optical isomerism: Chirality, van't Hoff-Lebel hypothesis, optical activity, D and L configurations, R and S notations, sequence and priority rules, enantiomers, diastereoisomers, epimers, anomers, racemic and meso (with suitable examples like lactic and tartaric acids.). • racemisation, resolution of racemic mixture by chemical method, asymmetric synthesis, Walden inversion
Module 3(Credit 1)	
Learning Outcomes	<p>After learning the module, learners will be able to</p> <ul style="list-style-type: none"> • To develop skills in synthesizing and purifying organic compounds. • To train students in identification of organic compounds via functional group analysis. • To enhance understanding of organic reactions and compound characterization.
Content Outline	<ul style="list-style-type: none"> • Acylation: e.g., Preparation of acetanilide from aniline. • Electrophilic substitution: e.g., Bromination of acetanilide to form p-bromoacetanilide. • Esterification: e.g., Preparation of aspirin from salicylic acid. • Nucleophilic acyl substitution: e.g., Formation of benzanilide.
Module 4(Credit 1)	
Learning Outcomes	<p>After learning the module, learners will be able to</p> <ul style="list-style-type: none"> • To develop skills in synthesizing and purifying organic compounds.

	<ul style="list-style-type: none"> To train students in identification of organic compounds via functional group analysis. To enhance understanding of organic reactions and compound characterization.
Content Outline	<ul style="list-style-type: none"> Oxidation: e.g., Preparation of benzoic acid from benzyl chloride. Diazo coupling: e.g., Synthesis of methyl orange. Halogenation: e.g., Synthesis of 2,4,6-tribromophenol from phenol. Green synthesis: Any suitable environmentally friendly protocol like green preparation of aspirin or Schiff base.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

Module I: Structure, Reactivity & Alkenes

Activity Title: Exploring Reaction Mechanisms and Alkenes

Assignment Type: Reaction Mapping + Mechanistic Explanation

Tasks:

- Choose **any 3–5 reactions** from the following:
 - Dehydration of alcohols
 - Dehydrohalogenation
 - Saytzeff's elimination vs. Hofmann orientation
 - Hydroboration–oxidation
 - Peroxide effect
 - Ozonolysis
 - KMnO₄ oxidation
- For each reaction:
 - Draw the complete reaction mechanism with electron movement.
 - Explain regioselectivity and stereoselectivity.
 - Identify intermediates (carbocation, free radical, etc.).
 - Comment on the stability of the products.
- Compare the acidity/basicity of 2–3 organic acids/bases using **pK_a values**.

Module II: Isomerism and Stereochemistry

Activity Title: 3D Understanding of Isomers

Assignment Type: Drawing + Configurational Analysis

Choose the following systems to explore:

- Geometrical isomers:** 2-butene, butenedioic acid
- Conformational isomers:** Ethane, butane
- Optical isomers:** Lactic acid, tartaric acid

Tasks:

- Draw:
 - E/Z configurations** using CIP rules
 - Chair and boat forms** of cyclohexane

- **Newman projections** for conformers
 - **R/S configurations** for chiral compounds
2. Identify:
- Enantiomers and diastereomers
 - Racemic mixture and methods of resolution
 - Chirality centers and optical activity
3. Optional: Create **3D models** using software like ChemSketch or physical kits.

Module III: Organic Preparations (Lab Focus)

Activity Title: Synthesis and Mechanism of Common Organic Compounds

Assignment Type: Experimental Report + Reaction Mechanism

Choose any 2 experiments from:

- Preparation of acetanilide (acylation)
- Bromination of acetanilide (electrophilic substitution)
- Esterification (aspirin synthesis)
- Nucleophilic acyl substitution (benzanilide formation)

Your report should include:

- Aim and balanced reaction
- Reagents and procedure
- Reaction mechanism (stepwise with arrows)
- Observation and yield
- Safety precautions and green chemistry aspects

Module IV: Advanced Synthesis & Green Chemistry

Activity Title: Green Synthesis of Aromatic and Dye Compounds

Assignment Type: Reaction Design + Sustainability Reflection

Choose any 2 synthetic examples:

- Oxidation: Benzoic acid from benzyl chloride
- Diazotization: Methyl orange synthesis
- Halogenation: Tribromophenol synthesis
- Green synthesis: Aspirin or Schiff base

Your report should include:

- Reaction steps with structures
- Type of reaction (oxidation, substitution, etc.)
- Green chemistry principles involved (atom economy, eco-friendly solvents)
- Waste minimization strategies

Reference Books:

1. Organic Chemistry, T. W. Graham Solomons, Craig B. Fryhle, John Wiley & Sons; 10th edition (December, 2009)
2. Morrison and R. N. Boyd, „Organic Chemistry“, 6th Edition, Prentice Hall, 1992.

3. D. Nasipuri Stereochemistry of Organic Compounds", 2nd Edition, New Age International (P) Ltd., Publishers, 1994.
4. Peter Sykes, „A Guide book to Mechanism in Organic Chemistry“, 6th Edition, Pearson Education, 2009.
5. P. S. Kalsi“ „Organic Reactions and their Mechanisms““, New Age International Publishers,2009.
6. J. Clayden, N. Greeves, S. Warren and P. Wothers, „Organic Chemistry“, 2nd edition, OxfordUniversity Press, 2012.

3.3 Major (Core)

Course Title	Inorganic Chemistry
Course Credits	4 (2+2) Theory + Practical's
Course Outcomes	After going through the course, learners will be able to
	<ul style="list-style-type: none"> • Understanding of anomalous behavior of elements • Ability to understand, explain predict various rules involved in chemical bonding • In-depth knowledge about standard electrode potential and volumetric analysis • Understand the importance and application of chemical bonds, intermolecular and intramolecular weak chemical forces and their effect. • Understand the periodicity in atomic and ionic radii, electronegativity, ionization energy, electron affinity of elements of the periodic table
Module 1(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none"> • Students will understand general characteristics of f-block elements • Students will learn the different Extraction lanthanides series.
Content Outline	<ul style="list-style-type: none"> • General characteristics of d block elements- Electronic configuration, oxidation states, metallic property, color, reactivity, reducing property, magnetic, catalytic and complex formation properties. • f block elements: General characteristics of f block elements - Electronic configuration, cause and consequences of lanthanide contraction, oxidation states, color, magnetic properties, • General features of actinides- electronic configuration, oxidation state, extraction of uranium from pitchblende Separation of lanthanides (ion exchange method only).
Module 2(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none"> • Understand coordination number, ligand types, and geometry • Explain bonding models (Valence Bond Theory, Crystal Field Theory, and Ligand Field Theory).

	<ul style="list-style-type: none"> • Apply IUPAC rules for nomenclature of coordination complexes • Identify and differentiate ligands (monodentate, bidentate, polydentate).
Content Outline	<ul style="list-style-type: none"> • Definition of coordination compound, Coordinate bond, coordination number, and ligand & Distinction between double salts and coordination compounds. • Werner's theory and VBT Theory for coordination compounds Effective atomic number (EAN) rule • IUPAC nomenclature, Definition and types of isomerism in coordination compound • Types of Ligands
Module 3(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none"> • To train students in synthesis and purification of inorganic compounds. • To observe and record physical and chemical changes during reactions. • To understand concepts like hydration, oxidation state, and crystal structure.
Content Outline	<ul style="list-style-type: none"> • Preparation of Cuprous chloride (Cu_2Cl_2) from copper sulphate Reduction, precipitation, redox • Preparation of Manganese phosphate $[\text{MnPO}_4 \cdot x\text{H}_2\text{O}]$ from $\text{Mn}(\text{NO}_3)_2$ Precipitation, coordination • Preparation of Chrome Alum $[\text{K}_2\text{SO}_4 \cdot \text{Cr}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}]$ Redox reaction between $\text{K}_2\text{Cr}_2\text{O}_7$ and SO_2 • Preparation of Potash Alum $[\text{K}_2\text{SO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}]$ Double salt crystallization • Preparation of Ferric alum $[\text{K}_2\text{SO}_4 \cdot \text{Fe}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}]$ Salt hydrolysis and crystallization
Module 4(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none"> • To train students in synthesis and purification of inorganic compounds. • To observe and record physical and chemical changes during reactions. • To understand concepts like hydration, oxidation state, and crystal structure.
Content Outline	<ul style="list-style-type: none"> • Synthesis of Tetrammine Copper(II) Sulphate $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4 \cdot \text{H}_2\text{O}$ Ligand coordination, complex formation • Synthesis of Potassium Trioxalatoferate(III) $[\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3]]$ Coordination complex, redox, light sensitivity • Preparation of Nickel-DMG Complex $[\text{Ni}(\text{DMG})_2]$

	<ul style="list-style-type: none"> • Synthesis of Sodium Cobaltinitrite $[\text{Na}_3[\text{Co}(\text{NO}_2)_6]]$ Oxidation, complex ion formation • Preparation of Mohr's Salt $[(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}]$ Mixed salt crystallization
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Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module I: d-Block and f-Block Elements

Activity Title: Comparative Analysis of Transition and Inner-Transition Elements

Assignment Type: Tabular Report + Conceptual Questions

Tasks:

1. Prepare a **comparison chart** between:
 - 3d, 4d, and 5d transition elements
 - Lanthanides and actinides
 - Electronic configuration, oxidation states, magnetic properties, complex formation
2. Explain:
 - Lanthanide contraction and its consequences
 - Methods of uranium extraction from pitchblende
 - Ion-exchange method for separation of lanthanides
3. Include diagrams of **f-orbital shapes** and **lanthanide/actinide series in periodic table**.

Module II: Types of Coordination compounds.

Activity Title: Classification of Coordination compounds

Assignment Type: Report + Structure Drawing

Choose 3–4 topics from below:

- Tetrahedral Compounds
- Square Planar compounds
- Octahedral Compounds

Your report should include:

- Structures of coordination compounds
- Classification in tabular form

Module III: Inorganic Preparations and Salt Analysis

Activity Title: Synthesis and Characterization of Inorganic Compounds

Assignment Type: Lab Report

Choose any 2 practical preparations from:

- Cuprous chloride (Cu_2Cl_2)

- Manganese phosphate ($\text{MnPO}_4 \cdot x\text{H}_2\text{O}$)
- Chrome alum or Potash alum
- Ferric alum

For each:

- Write balanced chemical equations
- List reagents and procedure
- Identify type of reaction: redox, double salt formation, coordination
- Observe color change, texture, solubility, and crystal structure
- Comment on purity and crystallization process

Module IV: Coordination Chemistry and Complex Compounds

Activity Title: Synthesis and Study of Coordination Compounds

Assignment Type: Synthesis Report + Bonding Discussion

Choose any 2 coordination compounds from:

- Tetrammine Copper(II) Sulphate – $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4 \cdot \text{H}_2\text{O}$
- Potassium Trioxalatoferate(III) – $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3]$
- Nickel-DMG complex – $[\text{Ni}(\text{DMG})_2]$
- Sodium Cobaltinitrite – $\text{Na}_3[\text{Co}(\text{NO}_2)_6]$
- Mohr's salt – $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$

References:

1. Puri B R, Sharma L R, Kalia K K, *Principles of Inorganic Chemistry*, 23rd edition, Shoban Lal Nagin Chand & Co, New Delhi, 1993.
2. Lee J. D., *Concise Inorganic Chemistry*, Black Well Science, UK, 2006
3. Soni P. L., *Text Book of Inorganic Chemistry*, S, Chand & Co, New Delhi, 2006.

Reference Books:

1. Madan R. D., Tuli G. D and Malik S. M., *Selected Topics in Inorganic chemistry*, S. Chand & Co, New Delhi, 2006.
2. S. F. A. Kettle, *Physical Inorganic Chemistry*, Spectrum, 1996.
3. B. E. Douglas DH McDaniel's and Alexander, *Concepts and Models of Inorganic Chemistry*, Oxford IBH, 1983

3.4 Major (Core)

Course Title	Analytical Chemistry
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	<ul style="list-style-type: none"> • Imparting skills in the scientific method of planning, conducting, reviewing, reporting experiments and problem solving in chemical analysis. • Understanding of principle and working of the range of instrumental methods in analytical chemistry
Module 1(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none"> • Students understand solids phase extraction. • Students will learn solvent extraction, types of solvent extraction, batch continuous
Content Outline	<ul style="list-style-type: none"> • Partition coefficient and distribution ratio, extraction efficiency, separation factor, role of • complexing agents in solvent extraction, types of solvent extraction, batch continuous. • Solid Phase Extraction – Principle, Process, and Application with special reference to water and • industrial effluent analysis. <p>Comparison of Solid phase extraction and solvent extraction.</p>
Module 2(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none"> • Students learn about analysis of water. • Students will learn the resources for contaminated water.
Content Outline	<ul style="list-style-type: none"> • Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, determination of dissolved oxygen (DO) of a water sample, • Analysis of total hardness, analysis of total suspended solid, analysis of total dissolved solid, analysis of oil& grease in water

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module I: Solvent Extraction and Solid Phase Extraction

Activity Title: Separation Techniques in Analytical Chemistry

Assignment Type: Comparative Report + Case Study

Tasks:

1. Prepare a **comparative chart** between:
 - Solvent Extraction and Solid Phase Extraction (SPE)
 - Include: principle, apparatus, efficiency, selectivity, and advantages
2. Discuss:
 - Role of partition coefficient and distribution ratio
 - Use of complexing agents in improving extraction
 - Application of SPE in **water purification** or **industrial effluent analysis**
3. Optional: Provide a case study or industrial example using any of the two methods.

Module II: Water Quality Analysis

Activity Title: Analysis of Physicochemical Parameters of Water

Assignment Type: Experimental/Conceptual Report

Choose any 2–3 parameters to study:

- Dissolved oxygen (DO)
- Total hardness
- Total suspended solids (TSS)
- Total dissolved solids (TDS)
- Oil and grease content

Your report should include:

- Description of method used (titration, gravimetric, instrumental)
- Apparatus and reagents
- Sample collection guidelines
- Calculations and interpretation of results
- Comparison with standard limits (e.g., BIS/WHO guidelines)

Optional/Integrated Activity: Mini Investigation Project

Activity Title: Testing Local Water Sources

Assignment Type: Field Study + Lab Analysis Report

Tasks:

1. Collect water samples from two different sources (e.g., tap water, river water, borewell).
2. Test 2–3 quality parameters (as listed above).
3. Interpret the results and comment on water quality.
4. Suggest purification or treatment methods based on findings.
5. Include images of sampling and tabulated results (if applicable).

References:

1. Mendham J., Denney R.C., Barnes J.D., Thomas M., _Vogel's Text book of Quantitative Chemical analysis', 7th edition, Pearson education, 2008.
2. Sharma, B.K., Instrumental Methods of Chemical Analysis', Goel Publishing House, Merrut, 1997.

3.5 OEC

Course Title	Environmental Pollution
Course Credits	2
Course Outcomes	<p>After going through the course, learners will be able to</p> <ol style="list-style-type: none"> 1. This course introduces the Environmental pollution, its types and sources of Pollution. 2. Identify various types of environmental pollution and their impacts on health. 3. Apply relevant environmental policies and ethical considerations to real World scenarios. 4. Students should be able to gain the knowledge about the environmental pollution. 5. Apply the principles of key environmental treaties and legislation to case studies
Module 1 (Credit 1)	
Learning Outcomes	<p>After learning the module, learners will be able to</p> <ol style="list-style-type: none"> 1. Identify and explain the major sources and types of air pollutants, including both primary and secondary pollutants. 2. Analyze the environmental and human health consequences of exposure to air pollutants. Identify and explain the major sources and types of air pollutants, including both primary and secondary pollutants. 3. Describe the characteristics and health impacts of key criteria pollutants (CO, Pb, NO_x, O₃, PM, SO₂) as well as other significant pollutants such as VOCs, PAN, PAHs, and POPs.
Content Outline	<ul style="list-style-type: none"> • Sources of air pollution; Primary and secondary pollutants; • Criteria pollutants- carbon monoxide, lead, nitrogen oxides, ground-level ozone, particulate matter and sulphur dioxide; • Other important pollutants- Volatile organic compounds (VOCs), Peroxyacetyl nitrate (PAN), Polycyclic aromatic hydrocarbons and Persistent organic compounds (POPs); • Adverse health impacts air pollutants.
Module 2 (Credit 1)	
Learning Outcomes	<p>After learning the module, learners will be able to</p> <ol style="list-style-type: none"> 1. Understand and explain the microbially mediated aquatic reactions, including the nitrogen cycle and roles of iron and manganese bacteria.

	<p>2. Classify water pollutants and distinguish between organic and inorganic contaminants such as pesticides, detergents, and heavy metals.</p> <p>3. Analyze key water pollution issues including eutrophication, marine pollution, oil spills, and acid mine drainage, along with associated remedial and mitigation strategies.</p>
Content Outline	<ul style="list-style-type: none"> ● Water resources; Microbially mediated aquatic reactions, nitrogen cycle, iron and manganese bacteria; ● Classification of water pollutants; ● Organic and Inorganic pollutants: ● Pesticides, detergents, eutrophication, marine, oil, acid mine drainage, remedial measures.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module I: Air Pollution and Its Impact

Activity Title: Investigating Common Air Pollutants

Assignment Type: Report + Case-Based Analysis

Tasks:

1. Identify and describe **any 3 major air pollutants**, such as:
 - Carbon monoxide (CO)
 - Nitrogen oxides (NO_x)
 - Particulate matter (PM)
 - Volatile organic compounds (VOCs)
 - Sulphur dioxide (SO₂)
2. For each pollutant:
 - Mention source (natural/man-made)
 - Effects on human health and environment
 - Control measures and legal limits (BIS/WHO norms)
3. Optional: Discuss a case (e.g., Delhi smog, Bhopal gas tragedy) with pollutant-specific relevance.

Module II: Water Pollution and Microbial Reactions

Activity Title: Analysis of Water Pollution Sources and Effects

Assignment Type: Thematic Report + Flow Diagrams

Topics to Include:

- Classification of pollutants (organic/inorganic, industrial/agricultural)
- Microbial roles in aquatic ecosystems:
 - Nitrogen cycle
 - Iron & manganese bacteria
- Issues like:
 - Eutrophication
 - Marine oil spills
 - Acid mine drainage

Reference:

1. Shrader-Frechette, K. (1993). Burying Uncertainty: Risk and the Case Against Geological Disposal of Nuclear Waste.
2. Carson, R. (1962). Silent Spring.
3. Pimentel, D. (2001). Environmental and Economic Costs of the Application of Pesticides.
4. National Academy of Sciences (2009). On Being a Scientist: A Guide to Responsible Conduct in Research.
5. NCERT EVS Class XI – Chapters on Sustainable Technology & Science
6. Royal Society of Chemistry – Green Chemistry articles

.3.7 Field Project (FP)

Course Title	Field Project
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	<ul style="list-style-type: none"> Field reports are also an opportunity to obtain evidence through methods of observing professional practice that challenge or refine existing theories.
	<ul style="list-style-type: none"> Field reports facilitate the development of data collection techniques and observation skills and allow you to understand how theory applies to real world situations
Module 1(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none"> To develop the practice of field training challenges and theories. To understand the background and study of the organisation and company. To gather the data of the tables and graphs from the organisation.
Content Outline	<ul style="list-style-type: none"> INTRODUCTION – to the topic under study, e.g. if it is a study on Marketing Research practices, an Introduction as to what is Marketing Research and its practices, and other information should be given. BACKGROUND – A brief background about the company/organization under study, like Name, Location Etc. and also relevant details like organization structure, existing systems related to the particular subject Under study and a brief write up of the problem you want to study in that organization. METHODOLOGY – It forms the crux of the report. It should clearly identify the Problem, the main Objectives of the study, the scope which indicates the usefulness of the project, how applicable it is, and How it can be used by the organization for improved performance. Review of Literature can be done included, which indicates the research done so far with regard To the particular subject. The relevant data gathered should be presented in the form of tables, graphs, flow charts etc. Detailed discussion about the present practices related to the subject. If new

	<p>practices/augments Have been introduced, a discussion of the same may be done.</p> <ul style="list-style-type: none"> • Analysis of the data collected or the effect of the new practices on the existing one.
Module 2(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none"> • To study and understand the value of an organisation/ company. • To learn the techniques to improve the system and cost savings techniques.
Content Outline	<ul style="list-style-type: none"> • Based on the study done, what conclusions/inferences can be Drawn? Recommendations are based on the conclusions of the study. It is important lo indicate that a set of Recommendations should follow from the conclusions inferred. The recommendations should have value to the Organization. If possible <p>quantify the benefits that can be gained from following the recommendations.</p> <ul style="list-style-type: none"> • Indications as to what other techniques can be applied to improve the systems viz. Cost saving techniques, Precautions. • LIMITATIONS of the study if any should be highlighted.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module I: Field-Based Research Study

Activity Title: Investigating Real-World Chemical Applications

Assignment Type: Field Report + Data Analysis

Objective:

Gain hands-on experience by observing and analyzing real-world chemical/environmental/industrial applications in a relevant field setting.

Suggested Areas for Study:

- Water treatment plants
- Chemical industries (dye, fertilizer, pharma, etc.)
- Municipal waste management
- Local pollution hotspots
- Agriculture and soil chemistry practices
- Laboratory safety practices in research institutes

Your Field Report Should Include:

1. **Introduction:**
 - Topic under study

- Background on the field site or organization
- 2. **Methodology:**
 - Objectives of the study
 - Data collection methods: interviews, observation, sampling, photography, etc.
 - Scope and relevance of the project
- 3. **Review of Literature (if applicable):**
 - Brief overview of previous work/research related to your topic
- 4. **Observations and Data:**
 - Record data in the form of tables, graphs, charts
 - Photographs (if allowed)
- 5. **Discussion:**
 - Analyze the current practices observed
 - Compare with theoretical or textbook standards
 - Identify any issues or areas for improvement

Module II: Recommendations and Reflection

Activity Title: Problem Solving and Application

Assignment Type: Concluding Report Section + Action Points

Your Report Should Also Include:

1. **Conclusion:**
 - Summary of key findings
 - Learning outcomes and insights gained
2. **Recommendations:**
 - Suggest improvements or alternative techniques
 - Include cost-saving or environmentally safer options if possible
3. **Limitations of the Study:**
 - Mention any practical or access limitations
 - Suggestions for future improvements

Semester – IV

4.1 Major (Core)

Course Title	Analytical Chemistry
Course Credits	4 (2+2) Theory + Practical's
Course Outcomes	After going through the course, learners will be able to
	<ul style="list-style-type: none">• Imparting skills in the scientific method of planning, conducting, reviewing, reporting experiments and problem solving in chemical analysis.
	<ul style="list-style-type: none">• Developing skills in contemporary methods of separation and appropriate selection of instruments<ul style="list-style-type: none">a. for the successful analysis of chemical compounds
	<ul style="list-style-type: none">• Understanding of principle and working of the range of instrumental methods in analytical chemistry
Module 1(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none">• Students understand the concept of QA QC• Students understand samplings types
Content Outline	<ul style="list-style-type: none">• Concepts of Quality, Quality Assurance & Quality Control. Importance of quality in industries.• Error, Accuracy & Precision.• Chemical Calculations Percentage composition of elements in chemical compounds. Mean,• Median, Average deviation, relative average deviation, standard deviation.• Sampling Terms involved, importance of sampling, sampling techniques, Sampling of solids -• Sample size – Bulk ratio size to weight ratio. Size reduction Methods. Sampling of compact solids• Sampling of liquids – Homogeneous and heterogeneous, static and flowing liquid.• Sampling of Gases – Ambient and stack sampling. Apparatus and methods used for sampling.
Module 2(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none">• Students learn about analysis of water.• Students will learn the resources for contaminated water.

Content Outline	<ul style="list-style-type: none"> • Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, determination of dissolved oxygen (DO) of a water sample, • Analysis of total hardness, analysis of total suspended solid, analysis of total dissolved solid, analysis of oil & grease in water
Module 3(Credit 1)	
Learning Outcomes	<p>After learning the module, learners will be able to</p> <ul style="list-style-type: none"> • Apply chromatographic techniques (paper and TLC) for the separation and identification of cations, sugars, dyes, and amino acids. • Determine R_f values accurately and interpret them for qualitative analysis. • Perform solvent extraction techniques to isolate specific components from mixtures and quantify them using spectrophotometry. • Analyze the pH of commercial products (aerated drinks, fruit juices, shampoos, and soaps), applying pH measurement techniques. • Develop analytical skills in separation, quantification, and identification of chemical species. • Enhance laboratory proficiency in handling chromatographic and spectrophotometric instruments while maintaining safety protocols.
Content Outline	<ul style="list-style-type: none"> • Separate and identify cations (Fe²⁺, Mn²⁺, and Cd²⁺) by paper chromatography and calculate their R_f values, applying ion-exchange principles. • Separate monosaccharides (glucose and fructose) by paper chromatography, accurately determining their R_f values. • Separate a mixture of dyes by TLC and identify them based on their R_f values, mastering thin-layer chromatography techniques. • Separate and identify amino acids by TLC, applying principles of adsorption chromatography and calculating R_f values. <p>Separate cations (Pb²⁺ and Cd²⁺) by TLC, determining their R_f values and interpreting the separation efficiency</p>
Module 4(Credit 1)	

Learning Outcomes	<p>After learning the module, learners will be able to</p> <ul style="list-style-type: none"> • Extract iodine from an aqueous solution, demonstrating skills in liquid-liquid extraction techniques. • Separate Ni²⁺ and Fe²⁺ by complexation with DMG and extract the Ni²⁺-DMG complex into chloroform, applying the principles of metal-ligand complexation. • Determine the concentration of the Ni²⁺-DMG complex by spectrophotometry, mastering quantification techniques through absorbance measurements
Content Outline	<p>Solvent extractions:</p> <p>(a) Extraction of iodine from an aqueous solution</p> <p>(b) Separation of a mixture of Ni²⁺ & Fe²⁺ by complexation with DMG and extracting the Ni²⁺-DMG complex in chloroform, and determine its concentration by spectrophotometry.</p> <p>3. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.</p>

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

Module I: Quality Assurance and Sampling

Activity Title: Understanding QA/QC in Chemical Analysis

Assignment Type: Conceptual Report + Data Handling

Tasks:

1. Define and differentiate:
 - Quality, Quality Assurance (QA), and Quality Control (QC)
 - Accuracy vs. Precision
2. Include examples of QA/QC in chemical industries (e.g., food, pharma, water analysis).
3. Perform basic chemical calculations such as:
 - Percentage composition
 - Mean, Median, Standard Deviation
 - Relative average deviation
4. Optional: Create a small dataset (5–10 values) and calculate the above parameters.

Module II: Sampling Techniques

Activity Title: Importance of Sampling in Analytical Chemistry

Assignment Type: Comparative Table + Short Report

Include in your report:

1. **Sampling of:**
 - Solids (bulk materials, powders)
 - Liquids (homogeneous and heterogeneous)
 - Gases (ambient and stack sampling)
2. Sampling methods and instruments used
3. Sampling errors and how to minimize them
4. Draw diagrams of sampling apparatus (e.g., stack sampler, liquid samplers)

Module III: Chromatography and pH Analysis

Activity Title: Separation and Identification Techniques

Assignment Type: Practical Report + Diagram Work

Choose any 2–3 experiments or concepts:

- Paper chromatography: Cation or sugar separation
- TLC: Separation of dyes or amino acids
- Calculate and interpret R_f values
- pH analysis of products (aerated drinks, juices, soaps, shampoos)

Your report should include:

- Aim, chemicals used, and procedure
- Diagram of setup
- R_f value or pH calculation
- Conclusion on identification or product quality

Module IV: Solvent Extraction and Spectrophotometry

Activity Title: Analytical Separation and Quantification

Assignment Type: Lab-Based or Conceptual Report

Choose any 1–2 tasks:

- Extraction of iodine from water
- Separation of Ni²⁺ & Fe²⁺ by DMG complexation
- Estimation of Ni²⁺ concentration by spectrophotometry

Include in your report:

- Chemical equation
- Solvent system and method

- Spectral analysis (if available)
- Real-life applications (e.g., metallurgy, pharma analysis)

REFERENCES:

1. Mendham J., Denney R.C., Barnes J.D., Thomas M., _Vogel's Text book of Quantitative Chemical analysis', 7th edition, Pearson education, 2008. Sharma, B.K., Instrumental Methods of Chemical Analysis', Goel Publishing House, Merrut, 1997.

4.2 Major (Core)

Course Title	Inorganic Chemistry
Course Credits	4 (2+2) Theory + Practical's
Course Outcomes	After going through the course, learners will be able to
	<ul style="list-style-type: none"> • Understanding of anomalous behavior of elements
	<ul style="list-style-type: none"> • Ability to understand, explain predict various rules involved in chemical bonding
	<ul style="list-style-type: none"> • In-depth knowledge about standard electrode potential and volumetric analysis
	<ul style="list-style-type: none"> • Understand the importance and application of chemical bonds, intermolecular and intramolecular weak chemical forces and their effect.
	<ul style="list-style-type: none"> • Understand the periodicity in atomic and ionic radii, electronegativity, ionization energy, electron affinity of elements of the periodic table
Module 1(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none"> • Students will understand the properties of s-block elements.
	<ul style="list-style-type: none"> • Students will understand different types of bonding.
Content Outline	<ul style="list-style-type: none"> • S block elements General characteristics – atomic and ionic radii – ionization energies – • electropositive character – reducing properties – hydration of ions – flame coloration – lattice • energies – chemical properties – extraction of alkali and alkaline earth metals – uses of alkali • and alkaline earth metals – complexes of alkali and alkaline earth metals – compounds of alkali • and alkaline earth metals and their applications.
Module 2(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none"> • Understand the fundamental concepts of gravimetric estimation, including precipitation, filtration, drying, and weighing
	<ul style="list-style-type: none"> • Identify conditions for ideal precipitation
	<ul style="list-style-type: none"> • Understand factors affecting precipitation such as common ion effect, temperature, and pH.

Content Outline	<ul style="list-style-type: none"> • Definition and scope of gravimetric analysis Types of gravimetric methods: Precipitation methods & Volatilization methods Advantages and limitations of gravimetric methods. • Methods of precipitation: slow addition, stirring, digestion. Co precipitation and post-precipitation: causes and minimization. • Role of washing, drying, ignition of precipitates.
Module 3(Credit 1)	
Learning Outcomes	<p>After learning the module, learners will be able to</p> <ul style="list-style-type: none"> • Apply fundamental principles of acid-base and redox titrations to determine the concentration of unknown substances in various samples. • Perform quantitative estimations of calcium, iron, oxalate, carbonate, bicarbonate, and free alkali in different mixtures. • Demonstrate skills in inorganic synthesis by preparing compounds such as cuprous chloride, manganese phosphate, and alums. <p>Enhance analytical and laboratory skills by using internal and external indicators in redox titrations</p>
Content Outline	<p>Acid-Base Titrations</p> <p>(a) Determination of alkali content of antacid tablets using HCl.</p> <p>(b) Estimation of calcium content in chalk as calcium oxalate.</p> <p>(c) Estimation of carbonate and hydroxide present together in mixture.</p> <p>(d) Estimation of carbonate and bicarbonate present together in a mixture.</p> <p>(e) Estimation of free alkali present in different soaps/detergents</p> <p>2. Oxidation-Reduction Titrations</p> <p>(a) Estimation of Fe(II) and oxalic acid using standardized KMnO₄ solution.</p> <p>(b) Estimation of oxalic acid and sodium oxalate in a given mixture.</p>

	(c) Estimation of Fe(II) with K ₂ Cr ₂ O ₇ using internal (diphenylamine, anthranilic acid and external indicator
Module 4(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none"> • Demonstrate Understanding of Gravimetric Principles. • Use correct concentrations and understand stoichiometric relationships in gravimetric reactions. • Apply techniques like digestion, coagulation, and filtration using sintered glass crucibles, silica crucible or filter papers. • Calculate the amount or percentage of analyte from the mass of the final precipitate.
Content Outline	<p>Estimation of barium as BaSO₄</p> <p>Estimation of iron (III) as Fe₂O₃</p> <p>Estimation of nickel as Ni-DMG</p> <p>Estimation of chromium as Cr₂O₃</p> <p>Estimation of aluminium as Al₂O₃</p>

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module I: Bioinorganic Chemistry

Activity Title: Role of Metals in Biological Systems

Assignment Type: Report + Diagrammatic Presentation

Tasks:

1. Choose **any 2–3 topics** from the following:
 - Role of Iron in hemoglobin and myoglobin
 - Magnesium and chlorophyll
 - Cobalt in Vitamin B₁₂
 - Sodium and potassium in nerve function
 - Zinc and metalloenzymes
2. Your report should include:
 - Structure of the coordination complex
 - Function of the metal in the biological role
 - Deficiency disorders and toxicity (if applicable)
 - Diagrams/structures of biomolecules involved
3. Optional: Create a comparative chart for essential vs. toxic metals in the human body.

Module II: Crystal Field Theory (CFT)

Activity Title: Splitting Patterns and Electronic Configurations

Assignment Type: Conceptual Report + Orbital Diagrams

Tasks:

1. Draw **d-orbital splitting diagrams** for:
 - Octahedral field
 - Tetrahedral field
 - Square planar field
2. Choose 2–3 coordination compounds and determine:
 - Electronic configuration of central metal ion
 - High spin vs. low spin nature
 - Magnetic behavior (paramagnetic/diamagnetic)
 - Calculation of Crystal Field Stabilization Energy (CFSE)
3. Include sample CFT diagrams with electron filling and Δ_0 , pairing energy comparison.

Module III: Theories of Bonding in Coordination Compounds

Activity Title: Exploring VB and MO Theories

Assignment Type: Comparative Chart + Application Based Tasks

Tasks:

1. Prepare a **comparison table** for:
 - Valence Bond Theory (VBT) vs. Crystal Field Theory (CFT) vs. Molecular Orbital Theory (MOT)
 - Basis: Hybridization, bonding, magnetic properties, spectral behavior
2. Apply VB or MO theory to predict:
 - Structure and hybridization of $[\text{Ni}(\text{CN})_4]^{2-}$, $[\text{Fe}(\text{CN})_6]^{3-}$, $[\text{Co}(\text{NH}_3)_6]^{3+}$, $[\text{CuCl}_4]^{2-}$
 - Geometry, number of unpaired electrons, and nature of ligand
3. Draw orbital overlap diagrams or MO diagrams where applicable.

Module IV: Gravimetric Estimation

Activity Title: Understanding the principle of gravimetric estimation.

Assignment Type: Report Submission

Tasks:

Short answer questions (Digestion, Super saturation, Co precipitation & common error)

Difference between precipitation & co precipitation

Meaning & purpose of digestion, washing & ignition

Role of super saturation and how to avoid it.

Textbooks:

1. Puri B R, Sharma L R, Kalia K K, _Principles of Inorganic Chemistry', 23rd edition, Shoban Lal Nagin Chand & Co, New Delhi, 1993.
2. Lee J. D., _Concise Inorganic Chemistry', Black Well Science, UK. 2006
3. Soni P. L., _Text Book of Inorganic Chemistry', S, Chand & Co, New Delhi, 2006.

Reference Books:

1. Madan R. D., Tuli G. D and Malik S. M., _Selected Topics in Inorganic chemistry', S. Chand &Co,New Delhi, 2006.
2. S. F. A. Kettle, _Physical Inorganic Chemistry', Spectrum, 1996.
3. B. E. Dogulas DH McDaniel's and Alexander, _Concepts and Models of InorganiChemistry',Oxford IBH, 1983
4. Raj, G., Advanced Practical Inorganic Chemistry, Krishna Prakashan, Meerut (2013).
5. Mendham, J.; Denney, R. C., Barnes, J. D.; Thomas, M.; Sivasankar, B., Vogel's

4.3 Major (Core)

Course Title	Organic Chemistry
Course Credits	4 (2+2) Theory + Practical's
Course Outcomes	After going through the course, learners will be able to To expand on fundamental organic chemistry with a focus on application-driven understanding. To introduce students to green, medicinal, and spectroscopic organic chemistry.
Module 1(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ol style="list-style-type: none">1. Understand reactivity principles and design logic behind modern organic reactions.2. Correlate structure–function–application relationships in functional organic molecules.3. Interpret basic organic spectra for structural elucidation.4. Develop awareness of sustainability in organic synthesis.
Content Outline	Organic Reaction Mechanisms & Selectivity <ul style="list-style-type: none">• Reaction mechanism: SN1, SN2, E1, E2 (review + emphasis on factors affecting selectivity)• Orientation and reactivity: Substituent effects (EWG/EDG)• Named reactions: Aldol condensation, Cannizzaro, Perkin, Benzoin• Factors influencing regioselectivity and stereoselectivity• Mini project: Predicting product outcome in competing mechanisms
Module 2(Credit 1)	
	After learning the module, learners will be able to

Learning Outcomes	<p>To encourage critical thinking in organic reactivity, design, and sustainability.</p> <p>To bridge academic organic chemistry with real-world utility and industrial relevance</p>
Content Outline	<p>Functional Groups in Everyday Organic Molecules</p> <p>Alcohols, phenols, ethers, aldehydes, ketones, carboxylic acids, esters – structure, synthesis, uses</p> <p>Functional groups in drugs, fragrances, dyes, polymers</p> <p>Natural products: Introduction to alkaloids, terpenoids, flavonoids</p> <p>Case studies: Paracetamol, menthol, ethyl acetate, citral</p>
Module 3(Credit 1)	
Learning Outcomes	<p>After learning the module, learners will be able to</p>
	<p>To encourage critical thinking in organic reactivity, design, and sustainability.</p> <p>To bridge academic organic chemistry with real-world utility and industrial relevance</p>
Content Outline	<ol style="list-style-type: none"> 1. Preparation of Nitrobenzene from benzene using nitrating mixture – Electrophilic aromatic substitution 2. Synthesis of Benzil from Benzoin – Oxidation using nitric acid 3. Preparation of Phenylazo-β-naphthol (Orange dye) – Advanced diazotization and coupling 4. Preparation of Benzilic acid from benzil – Rearrangement reaction 5. Synthesis of Phthalimide from phthalic anhydride – Ammonolysis reaction
Module 4(Credit 1)	
Learning Outcomes	<p>After learning the module, learners will be able to</p>
	<p>To perform multi-step or mechanism-specific organic syntheses.</p> <p>To analyze organic reaction outcomes through observation and characterization.</p>

	<p>To develop skills in qualitative identification of unfamiliar organic compounds.</p> <p>To expose students to eco-friendly synthetic strategies and reagent handling.</p>
Content Outline	<ul style="list-style-type: none"> • Preparation of Phenolphthalein – Condensation of phthalic anhydride and phenol • Synthesis of Benzylideneaniline (Schiff base) – Condensation of benzaldehyde and aniline • Preparation of α,β-Unsaturated ketone (e.g., cinnamaldehyde analog) – Claisen–Schmidt condensation • Green synthesis of chalcones using solid-state grinding or ethanol reflux

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module I: Aromaticity and Electrophilic Substitution

Activity Title: Reactions and Mechanisms in Aromatic Compounds

Assignment Type: Mechanism Illustration + Conceptual Report

Tasks:

1. Define and explain **aromaticity** with respect to:
 - Benzene
 - Cyclopentadienyl anion
 - Cycloheptatrienyl cation
2. Describe mechanisms for any **three electrophilic substitution reactions:**
 - Nitration
 - Sulphonation
 - Halogenation
 - Friedel-Crafts alkylation/acylation
3. Include:
 - Curved-arrow mechanisms
 - Intermediates and stability
 - Directive influence of substituents (ortho/para/meta)
4. Optional: Create a table showing activating/deactivating groups and their effects.

Module II: Carbonyl Compounds and Nucleophilic Addition

Activity Title: Reactivity and Mechanism of Aldehydes and Ketones

Assignment Type: Reaction Mapping + Product Prediction

Tasks:

1. Choose and explain mechanisms of any **three nucleophilic addition reactions:**
 - Addition of HCN
 - Addition of bisulfite
 - Hydration
 - Formation of imines and oximes
2. Draw:

- Electron flow mechanisms
 - Intermediates
 - Final products
3. Compare the reactivity of aldehydes vs. ketones and explain with electronic and steric arguments.
 4. Optional: Solve short problems related to product prediction and functional group interconversion.

Module III: Carboxylic Acids and Their Derivatives

Activity Title: Acidity and Reactivity Comparison

Assignment Type: Tabular Comparison + Reaction Mechanisms

Tasks:

1. Compare **physical and chemical properties** of:
 - Monocarboxylic acids vs. dicarboxylic acids
 - Acid chlorides, anhydrides, esters, and amides
2. Reaction Mechanisms (choose any 2):
 - Esterification (Fischer)
 - Hydrolysis of esters in acidic/basic medium
 - Amide formation from acid chlorides
 - Conversion of acid chlorides to anhydrides
3. Draw mechanisms and explain the role of nucleophiles/electrophiles.
4. Include a pKa comparison chart to discuss acidity trends.

Module IV: Organic Synthesis and Multistep Reactions

Activity Title: Designing Synthesis Pathways

Assignment Type: Synthetic Route Design + Reaction Sequences

Tasks:

1. Choose **any 2 target molecules** (e.g., aspirin, paracetamol, benzoic acid derivatives).
2. Propose **multi-step synthesis** routes using reactions studied in class:
 - Mention all reagents, conditions, and intermediates
 - Use flowchart or stepwise format
 - Explain the choice of reagents and selectivity
3. Optional: Include green chemistry aspects where applicable (e.g., solvent choice, atom economy)

Reference:

1. Mahan L. K., Escott- Stump, S. and Raymond J. L. (2012): "Krause's Food and the Nutrition Care Process", 13th Edition, Elsevier.
2. Ross, A.C., Caballero B., Cousins R. J., Tucker K.L. and Ziegler T. (2014) Modern Nutrition in Health and Disease. Wolters Kluwer Health/ Lippincott Williams and Wilkins. Ed 11th

3. Garrow, J. S., James, W.P.T. and Ralph, A. (2000): Human Nutrition and Dietetics. 10th Edition, Churchill Livingstone.
4. Nix Staci (2013) William's Basic Nutrition and Diet Therapy. Elsevier Ed.

4.4 OEC

Course Title	Waste Management
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	<ul style="list-style-type: none"> To provide basic understanding of waste types, sources, and characteristics. To familiarize students with sustainable waste handling, treatment, and disposal techniques. To promote awareness of waste legislation and community involvement. To introduce concepts of zero-waste and circular economy approaches.
Module 1(Credit 1)	Fundamentals of Waste Management
Learning Outcomes	After learning the module, learners will be able to
	<ol style="list-style-type: none"> 1. Identify and classify different types of waste. 2. Understand methods for effective waste treatment and disposal. 3. Interpret key waste management regulations and policies in India. 4. Propose sustainable solutions for waste minimization and recovery.
Content Outline	<p>Definition and classification of waste:</p> <ul style="list-style-type: none"> Solid waste, municipal waste, industrial waste, agricultural waste, biomedical waste, hazardous waste, e-waste, plastic waste Sources and composition of various wastes Collection, segregation, storage, and transportation of waste Problems associated with unscientific waste disposal (health, environment, economy) Overview of waste management hierarchy: Reduce, Reuse, Recycle, Recover, Dispose
Module 2(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none"> Introduction to Circular Economy and Zero Waste Practices

	<ul style="list-style-type: none"> • Case studies: Indian municipalities with successful waste management systems
Content Outline	<p>Waste treatment methods:</p> <ul style="list-style-type: none"> • Composting, vermicomposting, anaerobic digestion • Incineration, pyrolysis, RDF (Refuse Derived Fuel) • Landfilling: types, leachate control, methane recovery • Resource recovery and recycling technologies • Informal sector and waste pickers in India • Extended Producer Responsibility (EPR) • Overview of Solid Waste Management Rules 2016, Plastic Waste Rules, and E-Waste Rules

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module I: Classification and Sources of Waste

Activity Title: Waste Audit of Local Environment

Assignment Type: Field Observation + Classification Report

Tasks:

1. Conduct a **waste audit** at your home, college, or a public place.
2. Classify the waste into the following categories:
 - Biodegradable
 - Non-biodegradable
 - Municipal
 - Industrial
 - Biomedical
 - E-waste
3. Create a tabular report with:
 - Type of waste
 - Quantity (approx.)
 - Source (household, lab, office, etc.)
 - Disposal method
4. Optional: Take photos or sketches and suggest improvements in disposal or segregation.

Module II: Waste Collection and Segregation

Activity Title: Design a Segregation Plan for a Small Community

Assignment Type: Flowchart + Awareness Report

Tasks:

1. Propose a **waste collection and segregation model** for:

- A school/college campus
 - Small housing society
 - Local street or ward
2. Include:
 - Color-coded bins and their types
 - Flowchart from collection to processing
 - Awareness strategies (posters, talks, campaigns)
 3. Optional: Draft a sample **waste management awareness poster** for display.

Module III: Waste Treatment Methods

Activity Title: Comparative Study of Waste Disposal Techniques

Assignment Type: Concept Map + Short Analytical Report

Include in your report:

1. Principles and comparison of:
 - Landfilling
 - Incineration
 - Composting
 - Vermicomposting
 - Anaerobic digestion
2. For each method:
 - Write pros and cons
 - Cost-effectiveness
 - Environmental impact
 - Suitability for different waste types
3. Optional: Visit or virtually explore a local composting or waste facility and include your observations.

Module IV: Waste Management Laws and Sustainability

Activity Title: Understanding Waste Policies and Circular Economy

Assignment Type: Legislative Report + Sustainable Solutions

Tasks:

1. Study key features of Indian Waste Management Rules:
 - Solid Waste Management Rules (2016)
 - E-Waste Management Rules (2022)
 - Plastic Waste Management Rules
2. Include in your report:
 - Summary of regulations
 - Roles of individuals, municipalities, and industries
 - Penalties and compliance framework
3. Suggest sustainable practices aligned with **circular economy**:
 - Reduce–Reuse–Recycle strategies
 - Extended producer responsibility
 - Zero waste lifestyle tips

Reference List:

1. Duckett, J. (2011). HTML and CSS: Design and Build Websites. Wiley.
2. Castro, E., & Hyslop, B. (2013). HTML5 and CSS3: Visual QuickStart Guide. Peachpit Press.
3. W3Schools Online Web Tutorials –
<https://www.w3schools.com>
4. Mozilla Developer Network (MDN) –
<https://developer.mozilla.org>

4.5 SEC

Course Title	Green Chemistry
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	<ul style="list-style-type: none"> To introduce students to the fundamental concepts and goals of green chemistry. To develop skills in identifying and implementing sustainable chemical practices. To promote critical thinking about the role of chemists in environmental responsibility and innovation. To encourage reflection on laboratory practices and their impact on human health and ecosystems.
Module 1(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ol style="list-style-type: none"> Understand the principles and scope of green chemistry. Evaluate environmental aspects of chemical synthesis and industrial processes. Design safer chemical processes using green chemistry tools. Reflect on how green chemistry contributes to environmental protection and sustainable development goals.
Content Outline	<ul style="list-style-type: none"> Foundations of Green Chemistry Definition, need, and importance of green chemistry Conventional vs. green chemistry Environmental problems caused by traditional chemical processes Scope in pharmaceuticals, agriculture, textiles, and polymers Case Study: Bhopal Gas Tragedy – Lessons and chemical responsibility
Module 2(Credit 1)	
Learning Outcomes	After learning the module, learners will be able to
	<ul style="list-style-type: none"> Assess environmental hazards of common laboratory and industrial processes. Suggest and design greener alternatives for traditional chemical reactions.

	<ul style="list-style-type: none"> • Reflect critically on the ethical responsibilities of chemists toward society.
Content Outline	<p>The 12 Principles of Green Chemistry</p> <p>Detailed explanation of each principle with examples:</p> <ol style="list-style-type: none"> 1. Prevention 2. Atom economy 3. Less hazardous synthesis 4. Designing safer chemicals 5. Safer solvents and auxiliaries 6. Energy efficiency 7. Renewable feedstocks 8. Reduce derivatives 9. Catalysis over stoichiometry 10. Design for degradation 11. Real-time analysis for pollution prevention 12. Inherently safer chemistry for accident prevention <p>Activities: Create posters/infographics on assigned principles.</p>

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module I: Principles of Green Chemistry

Activity Title: Exploring the 12 Principles in Practice

Assignment Type: Conceptual Report + Real-World Applications

Tasks:

1. Write a brief explanation of each of the **12 Principles of Green Chemistry**.
2. Choose any **2–3 industrial or laboratory practices** that violate or follow these principles.
3. Describe how modifications could make them more eco-friendly.
4. Optional: Create a **poster or infographic** summarizing all 12 principles with examples.

Module II: Green Synthesis

Activity Title: Eco-friendly Laboratory Preparations

Assignment Type: Practical Report / Research Summary

Choose any 1–2 green synthesis experiments or processes:

- Synthesis of aspirin using water as a solvent
- Solvent-free aldol condensation
- Preparation of benzoic acid using microwave heating
- Synthesis of biodiesel from vegetable oil

Include in your report:

- Reaction equation and conditions
- Green alternatives used (e.g., solvent, catalyst, energy)
- Yield and product purity
- Comparison with conventional methods
- Environmental benefits (less waste, less energy, safer reagents)

Module III: Green Metrics and Evaluation

Activity Title: Measuring Sustainability in Chemistry

Assignment Type: Analytical Report + Calculations

Tasks:

1. Define and explain key **green metrics**:
 - Atom economy
 - E-factor
 - Reaction mass efficiency
 - Carbon efficiency
2. For any 1–2 reactions (real or hypothetical), calculate:
 - Atom economy using molecular weights
 - E-factor using mass of products and waste
3. Interpret which synthesis is more sustainable and why.

Module IV: Green Chemistry and Society

Activity Title: Greener Alternatives in Everyday Life

Assignment Type: Awareness Essay / Case Study

Tasks:

1. Identify **3–5 conventional products** or chemicals (e.g., plastic bags, cleaners, pesticides) and suggest greener alternatives.
2. Discuss the impact of green chemistry in:
 - Pharmaceuticals
 - Agriculture
 - Consumer products
 - Cosmetics or textiles
3. Optional: Design an awareness brochure or campaign promoting eco-friendly choices for consumers.

Reference Books:

1. Anastas, P. & Warner, J. (1998). Green Chemistry: Theory and Practice. Oxford University Press.
2. Clark, J. & Macquarrie, D. (2002). Handbook of Green Chemistry and Technology. Blackwell.
3. Lancaster, M. (2010). Green Chemistry: An Introductory Text, 2nd Ed., Royal Society of Chemistry.
4. Sharma, R. K., & Sanghi, R. (2012). Green Chemistry for Environmental Remediation.
5. Khan, F.A., & Gupta, B. (2015). Environmental Chemistry and Green Chemistry.
6. W3 Schools Green Tech Section

.4.7 Community Engagement and Service (CE)

Course Title	Community Engage Project [CEP] Health and Hygiene of Community
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	The students shall take the responsibility of motivating, facilitating, and guiding the students.
	They have to interact with local leadership and people and appraise the objectives and benefits of this kind of projects. The project reports shall be placed in the library for reference. Systematic, factual, methodical and honest reporting shall be ensured.
Module 1 (Credit 1): Module 1: Introduction to Health and Hygiene	
Learning Outcomes	After learning the module, learners will be able to
	Students will gain knowledge and practical skills to promote personal and community health through effective hygiene practices. After learning this module students should interact with General public, students, community workers, or health educators
Content Outline	<ul style="list-style-type: none"> • Definition and importance of health and hygiene • Relationship between hygiene, disease prevention, and well-being. Overview of global and local health challenges (e.g., waterborne diseases, sanitation issues). • Importance of handwashing, oral hygiene, and skin care. Proper grooming and its impact on physical and mental health. Menstrual hygiene management • Stress management and self-care routines. Social hygiene: Respecting personal space and community norms.
Module 2 (Credit 1) : Environmental and Food Hygiene	
Learning Outcomes	After learning the module, learners will be able to

	<p>After learning this module students will able to Training community volunteers to promote hygiene.</p> <p>Students also Collaborating with local health workers and organizations.Monitoring and sustaining hygiene initiatives.</p>
Content Outline	<ul style="list-style-type: none"> • Safe water management and purification techniques. Waste disposal and recycling practices. Sanitation in households and public spaces. • Safe food handling, storage, and preparation.Preventing foodborne illnesses.Nutritional hygiene: Balanced diet and its role in health. • Organizing workshops, street plays, or school programs. • Engaging stakeholders (local leaders, schools, health workers

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1:

Group discussion: Common hygiene practices in daily life, Case study: Impact of poor hygiene on community health.Demonstration: Correct handwashing techniques.Quiz: Myths and facts about personal hygiene. Practical: Designing a simple community health survey.

Module 2:

Practical: Building a low-cost water filter.Group project: Designing a community sanitation plan, Case study: Successful community hygiene programs.Plan an awareness campaign for a local hygiene issue, Mindfulness exercise: Stress-relief techniques. Discussion: Stigma around mental health and hygiene. Written project proposal (8-10 pages). Presentation or report on project outcomes.

Reference Books:

1. "Community Health Education Methods: A Practical Guide" by Robert J. Bensley and Jodi Brookins-Fisher.
2. "Introduction to Community and Public Health" by Manoj Sharma, Paul W. Branscum, and Ashutosh Atri.
3. "Water, Sanitation, and Hygiene (WASH) in Developing Countries" by Albert M. Wright and James A. Listorti.
4. "Health Behavior and Health Education: Theory, Research, and Practice" by Karen Glanz, Barbara K. Rimer, and K. Viswanath.
5. "Essentials of Public Health" by Bernard J. Turnock.
6. "Environmental Health: From Global to Local" by Howard Frumkin.