SNDT Women's University, Mumbai

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

Bachelor of Science (Chemistry) (AEDP)

B.Sc. (Chemistry) (AEDP)

As Per NEP – 2020

Semester – I to IV

Syllabus
(W.E.F. Academic Year 2025-26)

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	NA

		Solutions, Health & 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

Faculty		**Science and Technology**
Programme Degree		**B.Sc.**
Specialization		**Chemistry**
Preamble		BSc Honours is an undergraduate degree programme of three to four academic years, designed to provide a comprehensive understanding of specific Science subjects. BSc Honours degree programme focuses on research, critical thinking, and course curriculum of the particular science subject
Programme Specific Outcomes (PSOs)		After completing this programme, Learners will be able to
	1	Research-related skills and Scientific temper: Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.
	2	Disciplinary Knowledge: Demonstrate comprehensive knowledge of the disciplines that form a part of an graduate programme. Execute strong theoretical and practical understanding generated from the specific graduate programme in the area of work.
	3	Environment and Sustainability: Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
	4	Self-directed and Life-long learning: Acquire the ability to engage in independent and lifelong learning in the broadest context of socio technological changes.
	5	Trans-disciplinary knowledge: Integrate different disciplines to uplift the domains of cognitive abilities and transcend beyond

		disciplinespecific approaches to address a common problem.
	6	Competence: Display the understanding, behavioural skills needed for successful social adaptation, work in groups, exhibits thoughts and ideas effectively in writing and orally.
	7	Candidates should clear Class 12 in the Science stream
Eligibility Criteria for Programme		with a minimum of 50% - to 60% aggregate from a recognized board.
Intake		

Structure with Course Titles

B. Sc. (Chemistry) (AEDP)

Semester - I

SN	Courses	Type of Course	Credits	Marks	Int Marks	Ext Marks
	Semester - I					
10032101	Surface Chemistry	Major (Core)	2	50	50	0
	Subject 2	Major (Core)	2	50	50	0
	Subject 3	Major (Core)	2	50	50	0
10432111	Dyes and Pigment	OEC	4	100	50	50
10632101	Practical of Chemistry	VSC S1	2	50	50	0
10732111	Leadership development Program	SEC	2	50	0	50
	Ability Enhancement Course (AEC) Link: **https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/aec-syllabus/ug-degree/ability-enhancement-course.pdf** (Available on Website)	AEC (English) **(Any One)**	2	50	0	50
10810111	English For Academic Writing - Paper I (For Students of English Medium)					
10810112	English Language and Literature - I (For Students of Non-English medium)					

11051111	Inception of India Knowledge System **IKS Link:** **https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/iks-syllabus/ug-degree/inception-of-indian-knowledge-system.pdf** (Available on Website)	IKS (Generic)	2	50	0	50
10952111	Introduction to Indian Constitution **Link:** **https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/vec-syllabus/ug-degree/introduction-to-indian-constitution.pdf** (Available on Website)	VEC	2	50	0	50
11450121	Basics of National Service Scheme	CC **(Any One)**	2	50	50	0
11450221	National Cadets Corps. (NCC) Studies – I					
11450322	Health and Wellness					
11450421	Performing Arts Exploration					
			22	**550**	**300**	**250**

Semester – II

SN	Courses	Type of Course	Credits	Marks	Int Marks	Ext Marks
	Semester – II					
20032111	Aromatic Chemistry	Major (Core)	2	50	0	50
	Subject 2	Major (Core)	2	50	0	50
	Subject 3	Major (Core)	2	50	0	50
		VSC-S2	2	50	50	0
		VSC-S3	2	50	50	0
20432111	Science Café	OEC	4	100	50	50
20732101	Personality And Communication	SEC	2	50	50	0
	Ability Enhancement Course (AEC) Link: **https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/aec-syllabus/ug-degree/ability-enhancement-course.pdf** (Available on Website)	AEC (English) **(Any One)**	2	50	0	50
20810111	English For Academic Writing - Paper II (For Students of English Medium)					
20810112	English Language and Literature – II (For Students of Non-English medium)					
20952111	Environment Awareness **Link:** **https://www.sndt.ac**	VEC	2	50	0	50

	.in/pdf/academics/syllabus-as-per-nep/vec-syllabus/ug-degree/environment-awareness.pdf (Available on Website)					
	Co-Curricular Course (CC) Link: https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/cc-syllabus/ug-degree/co-curricular-course-as-per-nep-2020-semester-ii-syllabus.pdf (Available on Website)	CC **(Any One)**	2	50	50	0
21450121	Volunteerism and National Service Scheme					
21450221	National Cadets Corps. (NCC) Studies - II					
21450323	Yoga Education					
21450421	Fine Art					
			22	**550**	**250**	**300**

Exit with UG Certificate with 4 extra credits (44 + 4 credits)

Semester – III

SN	Courses	Type of Course	Credits	Marks	Int Marks	Ext Marks
	Semester – III					
30132111	Physical Chemistry-I (Th+Pr)	Major (Core)	4	100	50	50
30132112	Organic Chemistry-I (Th+Pr)	Major (Core)	4	100	50	50
30132113	Inorganic Chemistry-I (Th+Pr)	Major (Core)	4	100	50	50
30332111	Analytical Chemistry-I (Th)	Minor Stream	2	50	0	50
30432111	Environmental Pollution (Th)	OEC	2	50	0	50
	Modern Indian Language **Ability Enhancement Course (AEC) Link:** **https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/aec-syllabus/ug-degree/aec-semester-iii.pdf** (Available on Website)	AEC **(Any One)**	2	50	50	0
30810201	**શીખો ગુજરાતી – પ્રાથમિક ભાગ ૧: પરિચય, લેખન અને વાચન કૌશલ્ય (ગુજરાતી)** Shikho Gujarati – Prathmik Bhag 1: Parichay, Lekhan ane Vachan Kaushalya (Gujarati)					
30810301	रचनात्मक लेखन (हिन्दी) Rachnatmak Lekhan (Hindi)					
30810401	मराठी भाषेचा परिचय भाग १ - (मराठी) Marathi Bhashecha Parichay- Bhaag 1					

	(Marathi)					
30810501	लौकिक संस्कृत न्यायः (संस्कृत) Contemporary Sanskrit Nyaya (Sanskrit)					
30132104	Inorganic Chemistry-II-Part I (Th)	Major (Core)	2	50	50	0
	Co-Curricular Course (CC) Link: **https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/cc-syllabus/ug-degree/co-curricular-course-as-per-nep-2020-semester-iii-syllabus.pdf** (Available on Website)	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 Marks	Ext Marks
	Semester – IV					
40132111	Analytical Chemistry-II (Th+Pr)	Major (Core)	4	100	50	50
40132112	Inorganic Chemistry-II (Th+Pr)	Major (Core)	4	100	50	50
40332111	Organic Chemistry-II (Th+Pr)	Minor Stream	4	100	50	50
40432111	Waste Management (Th)	OEC	2	50	0	50
40732111	Green Chemistry (Th)	SEC	2	50	0	50
	Modern Indian Language **Ability Enhancement Course (AEC) Link:** **https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/aec-syllabus/ug-degree/aec-semester-iv.pdf** (Available on Website)	AEC **(Any One)**	2	50	0	50
40810211	શીખો ગુજરાતી – પ્રાથમિક (ગુજરાતી) Shikho Gujarati – Prathmik (Gujarati)					
40810311	सूचना प्रौद्योगिकी और हिन्दी भाषा (हिन्दी) Suchana Praudyogiki aur Hindi Bhasha (Hindi)					
40810411	मराठी भाषेचा परिचय भाग -२ (मराठी) Marathi Bhashecha Parichay- Bhaag 2 (Marathi)					

40810511	वाल्मीकीयकृत रामायणम् – अयोध्याकाण्डः (संस्कृत) Valmikiyakrut Ramayanam – Ayodhyakanda (Sanskrit)					
40332102	Industrial Chemistry (Th)	Minor Stream	2	50	50	0
	Co-Curricular Course (CC) Link: **https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/cc-syllabus/ug-degree/co-curricular-course-as-per-nep-2020-semester-iv-syllabus.pdf** (Available on Website)	CC **(Any One)**	2	50	50	0
41450121	NSS Volunteers under National service scheme special camp					
41450122	Personality and Leadership Development through National Service Scheme					
41450221	National Cadets Corps. (NCC) Studies – IV					
41450321	Basics of Self Defence and Fitness Training					
41450421	Theatre & Dance					
			22	**550**	**250**	**300**

Exit with UG Diploma with 4 extra credits (44 + 4 credits)

Course Syllabus

Semester - I

.1.1 Major (Core)

Course Title	**Surface Chemistry**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	1. Apply adsorption principles using Freundlich and Langmuir isotherms inindustrial processes
	2. Analyze physisorption and chemisorption characteristics and factors affectinggas adsorption on solids.
	3. Evaluate the effectiveness and selectivity of homogeneous, heterogeneous, andenzymatic catalysts
	4. Design experiments to investigate colloid properties and phenomena like Tyndalleffect and Brownian movement
Module 1 (Credit 1) - Adsorption & Catalysis	
Learning Outcomes	After learning the module, learners will be able to,
	1. Utilize the Freundlich and Langmuir isotherms to address adsorption issuesinvolving gases on solids.
	2. Assess the effectiveness and selectivity of homogeneous and heterogeneouscatalysts, including enzymatic mechanisms.
Content Outline	• Adsorption- Physisorption and chemisorption and their characteristics, factors affecting adsorption of gasses on solids - Freundlich and Langmuir adsorption isotherms, adsorption from solutions. • Catalysis - Homogeneous and heterogeneous, activity and selectivity of solid catalysts, enzymecatalysis and its mechanism. • Colloidal state- distinction among true solutions, colloids and suspensions, classification of colloids -lyophilic. Lyophobic; multimolecular, macromolecular andassociated colloids (micelles). preparation and properties of colloids - • Tyndall effect. Brownian movement, electrophoresis, dialysis, coagulation andflocculation: Emulsions and their

	characteristics.
Module 2 (Credit 1) - Reaction Dynamics	
Learning Outcomes	After learning the module, learners will be able to,
	1. Implement the concepts of inductive, electromeric, resonance, and mesomericeffects in analyzing organic reactions. 2. Examine the types, shapes, and relative stability of electrophiles, nucleophiles,and reaction intermediates like carbocations and free radicals.
Content Outline	● Electronic Displacements: Inductive, electromeric, resonance and mnesomeric effects,hyperconjugation and their applications; Dipole moment; Organic acids andbases; their relativestrength. Homolytic and heterolytic fission with suitable examples. Curly arrow rules; ● Electrophiles and Nucleophiles; Nucleophilicity and basicity; Types, shape andrelative stability of carbocations, carbanions, free radicals and carbenes. Introduction to types of organicreactions and their mechanism: Addition, Elimination and Substitution reactions. ● Carbon-carbonsigma bonds Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relativereactivity and selectivity.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 - Adsorption & Catalysis

<u>Project 1: Household Adsorbent Investigation</u>

Description: Students will explore adsorption principles using household materials like activated charcoal, tea bags, and various colored solutions such as food coloring or ink. By placing the household adsorbents in containers with colored solutions, they will observe and document the changes in color over time. Through simple filtration techniques, students will separate the adsorbents from the solutions and analyze the remaining color concentration. This project not only demonstrates adsorption concepts but also connects classroom learning to real-world scenarios, such as water purification or air filtration systems, that are applicable in both urban and rural environments.

Safety Measures: Ensure students handle materials safely, avoid ingestion of any chemicals, and conduct experiments in well-ventilated areas to prevent exposure to harmful fumes.

<u>Project 2: Kitchen Catalyst Investigation</u>

Description: Students will explore catalysis principles using common kitchen ingredients

like potatoes, yeast, and hydrogen peroxide. By mixing hydrogen peroxide with grated potatoes and yeast solutions in separate containers, students will observe the production of foam over time. They will measure and compare the quantity of foam produced by each catalyst to evaluate their effectiveness in catalyzing the decomposition of hydrogen peroxide. This project provides a hands- on experience that bridges classroom learning with real-world applications, such as understanding the role of catalysts in food processing or environmental remediation, and can be easily conducted in home kitchens or school labs.

Safety Measures: Students should handle hydrogen peroxide with care, wear protective gloves and goggles, and conduct experiments in a controlled environment to prevent spills and accidents.

Module 2 (Credit 1) - Reaction Dynamics

Project 1: Kitchen Chemistry: Organic Reactions

Description: Students will explore organic reaction mechanisms using readily available kitchen ingredients such as vinegar, baking soda, and lemon juice. By conducting simple experiments like

vinegar-baking soda reaction or lemon juice with milk, students will observe the formation of reaction products and propose mechanisms based on their understanding of inductive and resonance effects. This project fosters a connection between classroom learning and real-world scenarios, such as understanding the chemistry behind food preservation or cooking processes, and can be easily conducted in home kitchens or school labs.

Safety Measures: Students should handle chemicals with care, avoid ingestion, and conduct experiments in a well-ventilated area to prevent exposure to fumes.

Project 2: Home Chemistry: Alkane Reactivity

Description: Students will investigate alkane reactivity using common household solvents like rubbing alcohol and various cleaning agents containing chlorine. By mixing alkanes with these solvents in separate containers, students will observe the formation of reaction products and assess the relative reactivity and selectivity of different halogens. This project allows students to connect classroom learning with real-world applications, such as understanding the chemistry behind cleaning products or disinfectants used in everyday life, and can be easily conducted in home environments or school labs.

Safety Measures: Students should handle chemicals with care, avoid ingestion, and conduct experiments in a well-ventilated area to prevent exposure to fumes.

Reference Books:

1. Cotton, F. A., Wilkinson, G., & Gaus, P. L. (1987). Basic Inorganic Chemistry (5th ed.). JohnWiley.

2. Rao, C. N. R. (2000). University General Chemistry. Macmillan, India.

3. Chanda, M. (2000). Atomic Structure and Chemical Bond (4th ed.). Tata McGraw-Hill.

Semester - I

.1.4 Open Elective Courses/ Generic (OEC)

Course Title	**Dyes and Pigment**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	1. Apply fundamental dye concepts practically in textiles.
	2. Analyze diverse dye, pigment, and auxiliaries' applications.
	3. Evaluate production methods and properties of dyes.
	4. Design innovative solutions for textile industry challenges.
Module 1 (Credit 1) - Dye Fundamentals	
Learning Outcomes	After learning the module, learners will be able to,
	1. Investigate fundamentals of dyes, including chemical chromophores.
	2. Assess dye classes and their principal applications, including synthesis ofcommercial dyes.
Content Outline	● Fundamental of dyes: General, Important chemical chromophore of dyes ● Dyes Class for principle applications, Description of individuals of class andsynthesis of some commercial dyes.
Module 2 (Credit 1) - Textile Dyeing Techniques	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explore dying processes of textiles, including pre-treatment of fibers and dyeing methods for various textiles, as well as textile finishes and auxiliaries.
	2. Examine non-textile dyes, such as those used in leather, fur, hair, food, ink,photography, and as indicator dyes.
Content Outline	● Dying processes of textiles: Pre-treatment of textile fibers, dyeing methods forvarious textiles,Textile finishes and Textile auxiliaries. ● Non textile dyes: Leather, Fur, Hair, Food, Ink, Photographic, indicator dyes.
Module 3 (Credit 1) - Zinc Oxide Pigments	
Learning Outcomes	After learning the module, learners will be able to,
	1. Develop a study on fundamentals, properties, and production of Iron Oxidepigments, specifically focusing on the precipitation process.

	2. Examine fundamentals, properties, and production methods of Zinc Oxide pigments, including raw materials and processes such as the Direct (American)and Precipitation processes.
Content Outline	• Zinc Oxide pigments (Fundamentals and properties, Raw materials, Directprocess (American process), Precipitation process) • Iron oxide pigments (Fundamentals and properties, Production of iron oxidepigment by precipitation process)
Module 4 (Credit 1) - Advanced Dye Applications	
Learning Outcomes	After learning the module, learners will be able to,
	1. Design experiments for synthesis, characterization, and application of dyes.
	2. Explore additional aspects of dyes, such as non-mutagenic variants andcolorants for high-tech fluorescent brightening agents.
Content Outline	• Synthesis, Characterization and application. • Some other aspects related to dyes: Non mutagenic dyes, colorants for hightechnology Fluorescent Brightening agents.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 - Dye Fundamentals

Project 1: Chromophore Exploration

Description: Students will investigate the fundamentals of dyes by analyzing the chemical chromophores responsible for coloration. They will select common household items such as food coloring, ink cartridges, or fabric dyes and perform simple separation techniques like paper chromatography to isolate and identify the chromophores present. Through observation and analysis, students will deepen their understanding of dye chemistry and its practical applications, particularly in textile dyeing processes.

Safety Measures: Ensure students handle chemicals safely and conduct experiments in a well - ventilated area.

Module 2 - Textile Dyeing Techniques

Project 1: Fabric Dyeing Experiment

Description: Students will explore textile dyeing techniques by designing and conducting experiments to dye fabric samples using natural or synthetic dyes. They will pre-treat fabric fibers to enhance dye uptake and select appropriate dyeing methods such as immersion, padding, or printing techniques. Through hands-on experimentation, students will observe and analyze the effects of different dyeing parameters on color intensity, fastness properties, and overall textile appearance. This project provides practical experience in textile dyeing processes and allows students to apply their knowledge to address challenges in the textile industry.

Safety Measures: Ensure students handle dyes and chemicals safely, follow proper dyeing protocols, and dispose of waste materials appropriately.

Module 3 - Zinc Oxide Pigments

Project 1: Zinc Oxide Pigment Production Simulation

Description: Students will simulate the production process of zinc oxide pigments, focusing on the precipitation method. They will research the raw materials and equipment used in the Direct (American) and Precipitation processes and develop a step-by-step simulation. Using available resources, students will set up experimental setups mimicking the precipitation reaction, observing the formation and properties of zinc oxide pigments. Through this hands-on simulation, students will gain a deeper understanding of the fundamentals and production methods of zinc oxide pigments, preparing them for real-world applications in the pigment industry.

Safety Measures: Ensure students handle chemicals safely and conduct experiments in a well - ventilated area.

Module 4 - Advanced Dye Applications

Project 1: Dye Synthesis and Application Design

Description: Students will design and execute a series of experiments to synthesize novel dyes and evaluate their application potential. They will explore various synthetic routes to prepare new dye compounds and characterize their chemical structures using spectroscopic techniques. Students will then test the synthesized dyes on different substrates such as fabrics, plastics, or paper to assess their coloration efficiency and fastness properties. Through this project, students will gain hands-on experience in dye synthesis, characterization, and application, fostering innovation and problem - solving skills in dye chemistry.

Safety Measures: Ensure students handle chemicals safely and wear appropriate personal protective equipment.

Reference Books:

1. Sharma, B. K. (2014). Industrial Chemistry (18th ed.). Goel Publishing House.
2. Kent, J. A. (Ed.). (Year of Publication). Riegel's Handbook of Industrial Chemistry (9th ed.).CBS Publishers.
3. Satyaprakash, Tuli, & Basu. (Year of Publication). Advanced Inorganic Chemistry (pp. 458-463).
4. Satyaprakash, Tuli, & Basu. (Year of Publication). Advanced Inorganic Chemistry (pp. 830-849).
5. Kent, J. A., Bommaraju, T. V., & Barnicki, S. D. (Year of Publication). Handbook of IndustrialChemistry and Biotechnology (13th ed.). Springer.

Semester - I

.1.5 Vocational Skill Courses (VSC)

Course Title	**Practical of chemistry (Lab)**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to,
	1. Apply titration and hydrolysis techniques to determine the concentrations of iodine, phenol, aniline, acetamide, and ethyl benzoate usingstandard methods.
	2. Analyze complexometric and Mohr's titrations to quantify sodiumcarbonate, sodium bicarbonate, carbonate, hydroxide, and magnesium in mixtures.
	3. Evaluate the precision and effectiveness of analytical methods likebromination and hydrolysis for determining chemical compositions.
	4. Design experiments to measure concentrations of ferrous and ferricions, Mohr's salt, and oxalic acid using internal indicator methods and standardized solutions.
Module 1 (Credit 1) - Quantitative Chemical Analysis	
Learning Outcomes	After learning the module, learners will be able to,
	1. Utilize titration techniques to determine the concentration of iodine usingstandardized sodium thiosulphate and potassium dichromate solutions.
	2. Examine bromination methods to quantify phenol and aniline accurately.
	3. Assess hydrolysis methods for determining the concentrations of acetamideand ethyl benzoate.
	4. Develop and conduct experiments to accurately measure the concentration ofvarious compounds using standard analytical techniques.

Content Outline	• Determination of iodine using sodium thiosulphate (Standardize sodium thiosulphate solution) using standard potassium dichromate solution. • Determination of phenol by bromination method. • Determination of aniline by bromination method. • Determination of acetamide by hydrolysis method. • Determination of ethyl benzoate by hydrolysis method.
Module 2 (Credit 1) - Analytical Methods for Salt Mixtures	
Learning	After learning the module, learners will be able to,
Outcomes	1. Utilize titration techniques to determine the concentrations of sodiumcarbonate and sodium bicarbonate in a mixture. 2. Examine the presence and quantification of carbonate and hydroxide togetherin a mixture. 3. Assess the concentrations of Mohr's salt and oxalic acid separately using standardized KMnO4 solution. 4. Determine the concentrations of ferrous and ferric ions in a solution using theinternal indicator method with a standard K2Cr2O7 solution. 5. Develop accurate measurements of magnesium using standardized EDTA andzinc sulfate solutions.
Content Outline	• Determination of sodium carbonate and sodium bicarbonate in a mixture. • Determination of carbonate and hydroxide present together in a mixture. • Determination of Mohr's salt and oxalic acid separately using standardized KMnO4 solution. • Determination of ferrous and ferric ions in a solution using standard solutionof K2Cr2O7 byinternal indicator method (diphenylamine or N- phenylanthranilic acid). • Determination of magnesium using standard EDTA solution (StandardizeEDTA solution using standard zinc sulfate solution).

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Project 1: Iodine Determination

Design an experiment to determine the concentration of iodine in a sample using titration with standardized sodium thiosulphate and potassium dichromate solutions. Prepare a detailed report analyzing the procedure, results, and potential sources of error.

Project 2: Phenol and Aniline Quantification

Conduct bromination reactions to accurately quantify the concentrations of phenol and aniline in given samples. Document the experimental setup, observations, and evaluate the effectiveness of the bromination method.

Project 3: Hydrolysis of Acetamide and Ethyl Benzoate

Perform hydrolysis reactions to determine the concentrations of acetamide and ethyl benzoate in mixtures. Include a step-by-step procedure, results interpretation, and a discussion on the precisionof the hydrolysis method.

Project 4: Complexometric and Mohr's Titrations

Utilize complexometric titration to measure magnesium using standardized EDTA and perform Mohr's titration to quantify sodium carbonate and bicarbonate in mixtures. Write a comprehensive report on the methodologies, results, and accuracy of the titrations.

References:

1. Sharma, B. K. (2014). Industrial Chemistry (18th ed.). Goel Publishing House.
2. Kent, J. A. (1997). Riegel's Handbook of Industrial Chemistry (9th ed.). CBS Publishers.
3. Prakash, S., Tuli, G. D., & Basu, S. K. (1944). Advanced Inorganic Chemistry - Volume II (pp.458-463, 830-849). Perfect Paperba

Semester - I

.1.6 Skills Enhancement Course (SEC)

Course Title	**Leadership Development Program**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	1. Apply leadership theories and models to enhance their understanding ofleadership traits, styles, and behaviors. 2. Explore the impact of different personality types, as per the Five Factor Model,on leadership effectiveness. 3. Examine the applicability and effectiveness of diverse leadership theories, suchas Trait, Behavioral, and Contingency theories, in varying organizational contexts. 4. Develop personalized leadership development and succession plans, integrating essential qualities of effective leaders and followers, to fostercollaboration and long-term organizational success
Module 1 (Credit 1) - Leadership Fundamentals	
Learning Outcomes	After learning the module, learners will be able to, 1. Apply leadership theories and models to enhance their understanding ofleadership traits, styles, and behaviors. 2. Explore the impact of different personality types, as per the Five Factor Model,on leadership effectiveness.
Content Outline	● Traits, styles, skills, behaviors, vision, inspiration and momentum of leadership ● International framework for analyzing leadership ● Personality Types and Leadership ● Five factor model of personality Great Man Theory ● Trait theory ● Behavioral Theories: Michigan studies, Ohio State University studies, LeadershipGrid, Role theory ● Contingency Theories: Casual model of Leadership, Normative Decision model,Hersey Blanchard situational model, Vroom & Jago's model,House's Path Goal theory ● Contemporary leadership styles
Module 2 (Credit 1) - Leadership Development Strategies	

Learning Outcomes	After learning the module, learners will be able to, 1. Identify characteristics, types, and methods for evaluating LeadershipDevelopment and Leadership Succession. 2. Select appropriate successors, considering emotional aspects and strategies fordeveloping a pool of successors. 3. Assess essential qualities of effective followership and promote collaborationbetween leaders and followers
Content Outline	● Characteristics, types and evaluation of Leadership Development ● Leadership Succession ● Choosing a successor, Emotional aspects of leadership succession, developingpool of successors, Follower ship ● Essential qualities of effective followers, Collaboration between leaders andfollowers.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Project 1: Leadership Traits Analysis

Students will select a historical or contemporary leader and analyze their traits, styles, and behaviors. They will apply relevant leadership theories and models learned in the course to interpret the leader's effectiveness. The project will involve presenting findings on how different leadership traits and styles contribute to organizational success. Through this project, students will enhance their understanding of leadership dynamics and their applicability in real-world scenarios.

Project 2: Personality Impact Assessment

Students will conduct a survey or interview to assess how different personality types influence leadership effectiveness. They will explore the impact of personality traits, as per the Five Factor Model, on leadership styles and behaviors. The project will involve analyzing the data collected to draw conclusions about the relationship between personality and leadership. Through this project, students will gain insights into the complexities of leadership and the role of personality in shaping leadership effectiveness.

Project 3: Leadership Theory Application

Students will choose a specific organizational context and apply diverse leadership theories, such asTrait, Behavioral, and Contingency theories, to analyze leadership challenges. They will identify relevant theories and models to address leadership issues and propose solutions. The project will involve presenting recommendations based on the applicability and effectiveness of selected leadership theories. Through this project, students will develop critical thinking skills and practical problem-solving abilities in the field of leadership.

Project 4: Succession Planning Simulation

Students will simulate a leadership succession scenario within a hypothetical organization. They will develop personalized leadership development and succession plans, considering essential qualities of effective leaders and followers. The project will involve role-playing exercises to evaluate emotional aspects of leadership succession and foster collaboration between leaders and followers. Through this project, students will gain hands-on experience in succession planning and develop strategies for ensuring long-term organizational success.

Reference Books:

1. Northouse, P. G. (2015). Leadership (6th ed.). Sage Publications.
2. Lussier, R. N., & Achua, C. F. (2016). Effective Leadership (3rd ed.). Cengage Learning.
3. Daft, R. L. (2015). Leadership. Cengage Learning.
4. Yukl, G. (2016). Leadership in Organizations (6th ed.). Pearson Education

Course Syllabus

Semester - II

.2.1 Major (Core)

Course Title	**Aromatic Chemistry**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	1. Apply principles of hybridization and VSEPR theory to predict covalent moleculegeometry, distinguishing polar and no polar structures.
	2. Analyze covalent bond polarization factors, including polarizing power and ionpolarizability, to understand bond characteristics as per Fajan's rule.
	3. Evaluate dipole moment data to interpret percentage ionic character and deduce molecular structure, assessing characteristics of coordinate covalent compounds and metallic bonds.
	4. Design experiments to investigate preparation methods, structural properties,and reactivity of benzene and aromatic compounds, applying Huckel's rule to discern aromaticity and orientation in substitution reactions.
Module 1 (Credit 1) - Molecular Geometry & Polarity	
Learning Outcomes	After learning the module, learners will be able to
	1. Implement principles of hybridization and VSEPR theory to construct modelsdepicting the geometry of covalent molecules and discern between polar and nonpolar structures.
	2. Formulate experiments to explore covalent bond polarization, considering factors like polarizing power and ion polarizability, to analyze bond characteristicsand determine the percentage of ionic character using dipole moment measurements.

Content Outline	• Hybridization and geometry of covalent molecules, including VSEPR theory anddifferentiation between polar and nonpolar molecules. • Covalent bonds, polarization of covalent bonds, polarizing power, polarizabilityof ions, Fajan's rule, dipole moment, determination of percentage ionic character from dipole moment, relationship between dipole moment and molecular structure. • Coordinate covalent compounds and their characteristics, metallic bond, free electron model, valence bond theory, band theory, weak chemical bonds including intermolecular and intramolecular hydrogen bonds, and van der Waalsforces.
Module 2 (Credit 1) - Aromatic Reactivity & Aromaticity Analysis	
Learning Outcomes	After learning the module, learners will be able to
	1. Examine the structure of benzene, the nomenclature of aromatic compounds, and general methods of preparation, alongside their physical and chemical properties. 2. Scrutinize the reactivity of aromatic compounds through electrophilic and nucleophilic substitution reactions, analyzing orientation in aromatic disubstitution,and determining aromaticity based on Huckel's rule.
Content Outline	• Structure, nomenclature, and general methods of preparation of aromaticcompounds. • Physical and chemical properties, including electrophilic and nucleophilicsubstitution reactions, and orientation in aromatic disubstitution. • Aromaticity, including Huckel's rule, anisotropic ring current, and differentiationof aromatic, nonaromatic, and antiaromatic compounds.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

No Internal Assessment for this course

Reference Books:

1. F. A. Cotton, G. Wilkinson and P. L. Gaus, „Basic Inorganic Chemistry", 5th edition, John Wiley,1987.

2. C. N. R. Rao, ,University General Chemistry", Macmillan, India, 2000.

3. Manas Chanda, „Atomic Structure and Chemical Bond", 4th edition, Tata McGraw-Hill, NewDelhi, 2000.

Semester - II

.2.6 Open Elective Courses/ Generic (OEC)

Course Title	**Science Café**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to, 1. Apply principles of nutrition to promote good health. 2. Analyze the composition and properties of nutrients. 3. Evaluate the significance of macro and micro elements. 4. Design balanced dietary plans for optimal health.
Module 1 (Credit 1) - Fundamentals of Nutrition	
Learning Outcomes	After learning the module, learners will be able to, 1. Utilize insights into food functions, nutrition, and nutrients to discern differentlevels of nutrition and recognize signs of malnutrition. 2. Explore the correlation between nutrition and health, identifying visible signs ofwell-being and understanding the significance of adhering to food guides for optimal nutrient utilization
Content Outline	• Functions of foods, definition of nutrition, nutrients, adequate optimum andgood nutrition, malnutrition. Food as a source of nutrients. • Interrelationship between nutrition and health, visible symptoms of goodhealth. • Food guide-basic five food groups and usage of food guide. Use of food in body-digestion, absorption, transport, and utilization of nutrients in the body.
Module 2 (Credit 1) Water and Energy in Nutrition	
Learning Outcomes	After learning the module, learners will be able to, 1. Examine the role of moisture in food, including concepts like hydrogen bonding,bound water, free water, water activity, and their influence on food stability. 2. Assess the concept of energy, encompassing its unit, food as an energy source,the energy value of food, the body's energy requirements, and the utilization of food for energy needs.

Content Outline	• Water as a nutrient, function, sources, requirement, structure, water balance – effect of deficiency. Introduction to chemistry of water and ice. • Moisture in food: Hydrogen bonding, Bound water, Free water, Water activityand Food stability. • Energy – UNIT of energy, food as a source of energy, energy value of food, the body's need for energy, B.M.R. activities. Utilization of food for energy requirements. Acid – base balance.
Module 3 (Credit 1) - Carbohydrates and Lipids in Food Science	
Learning Outcomes	After learning the module, learners will be able to, 1. Apply knowledge of carbohydrates for dietary analysis. 2. Investigate the role of sweetening agents in food. 3. Assess the properties of lipids for physiological understanding. 4. Develop processes for handling fats and oils in food processing.
Content Outline	• Carbohydrates- composition, classification, sources, functions, structure,physical & chemical properties. • Other sweetening agents, functions of sugar in food (Browning reaction),changes during cooking and processing. • Lipids – composition, nomenclature, saturated, unsaturated fatty acids, classification, food sources, functions of fats. Physical and chemical properties,emulsions, chemistry & technology of fat and oil processing. Role of food lipids in flavour
Module 4 (Credit 1) - Minerals and Pigments in Nutrition	
Learning Outcomes	After learning the module, learners will be able to, 1. Utilize knowledge of mineral functions, sources, bio availability, and deficienciesto evaluate the importance of calcium, iron, iodine, fluorine, sodium, and potassium in human health. 2. Examine the pigments indigenous to food, including their structure, chemicaland physical properties, and analyze the effects of processing and storage on these pigments. 3. Explore the diversity of flavors present in vegetables, fruits, spices, fermentedfoods, meats, and seafood, discerning their sensory attributes and culinary applications.

Content Outline	• Mineral functions, sources, Bio-availability, and deficiency of following minerals – calcium, Iron,Iodine, Fluorine, sodium, potassium. • Pigments indigenous to food, structure, chemical and physical properties. Effectof processing and storage. • Flavors – Vegetables, fruit and spice flavour, fermented food, Meat and seafood.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1 - Fundamentals of Nutrition

Project: Nutritional Analysis of Daily Diet

Description: Students will conduct a nutritional analysis of their daily diet using readily available online tools or smartphone applications. They will record their food intake for a week and input the data into the software to calculate the intake of macronutrients (carbohydrates, proteins, and fats), micronutrients (vitamins and minerals), and total energy intake. Through analysis, students will identify any deficiencies or excesses in their diet and make recommendations for dietary improvements. This project not only reinforces classroom learning but also equips students with practical skills to make informed dietary choices in their personal and professional lives.

Module 2 - Water and Energy in Nutrition

Project: Water Activity in Common Foods

Description: Students will investigate the concept of water activity in various common food items using easily accessible materials and equipment. They will collect samples of fresh fruits, bread, dried snacks, and other foods from their local grocery store or kitchen. Using a simple homemade water activity meter or by measuring relative humidity, students will determine the water activity of each food sample. Through this hands-on experiment, students will gain insights into the relationshipbetween water activity and food stability, which is crucial for food preservation and safety. This project allows students to apply theoretical knowledge to practical scenarios and enhances their understanding of food science concepts.

Module 3 - Carbohydrates and Lipids in Food Science

Project: Investigating Carbohydrate Content in Everyday Foods

Description: Students will analyze the carbohydrate content of everyday food items using basic qualitative tests that can be performed at home or in a school laboratory. They will select a varietyof food samples such as fruits, vegetables, grains, and processed foods from their kitchen or local grocery store. Using simple tests like Benedict's test for reducing sugars and iodine test for starch, students will qualitatively assess the presence of carbohydrates in each food sample. Through this hands-on activity, students will deepen their understanding of carbohydrate composition in foods and its significance in human nutrition. This project fosters practical skills and

encourages students to make informed dietary choices based on carbohydrate content.

Module 4 - Minerals and Pigments in Nutrition

Project: Exploring Minerals and Pigments in Everyday Foods

Description: Students will investigate the presence of minerals and pigments in everyday foods through a simple kitchen-based experiment. They will select a variety of fruits, vegetables, grains, and dairy products from their kitchen or local market. Using basic household items like vinegar, iodine solution, and pH paper, students will test for the presence of minerals such as calcium, iron, and potassium, as well as natural pigments like anthocyanins and carotenoids. Through this hands- on exploration, students will gain practical experience in identifying essential nutrients and bioactive compounds in foods. This project not only reinforces classroom learning but also empowers students to make healthier food choices for themselves and others.

References Books:

1. Damodaran, S., Parkin, K. L., & Fennema, D. R. (2007). Fennema's Food Chemistry (4th ed.).
   CRC Press.

2. Guthrie, H. A. (1983). Introductory Nutrition (5th ed.). Mosby.

3. Meyer, L. H. (2004). Food Chemistry. Textbook Publishers. ISBN: 0758149204.

4. Mudambi, S. R., Rao, S. M., & Rajagopal, M. V. (2006). Food Science (2nd ed.). New AgeInternational.

5. Mudambi, S. R., & Rajgopal, M. V. (2001). Fundamentals of Foods and Nutrition (4th ed.). NewAge International Publishers.

6. Shakuntla, M. N., & Shadaksharaswamy, M. (2013). Food Facts and Principles. New AgeInternational.

Semester - II

.2.7 Skill Enhancement Courses (SEC)

Course Title	**Personality And Communication**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to, 1. Critically analyze Personality constructs, elucidate Determinants ofDevelopment, and examine Perception dynamics. 2. Evaluate Factors impacting Association, delineate Personality Traits, and fosterEffective Habit formation.] 3. Explore Motivation theories, engage in rigorous Self-Assessment, and implementEmotional Intelligence strategies. 4. Proficiently navigate Effective Communication channels, demonstrateAssertiveness, and exhibit proficient Decision-making prowess
Module 1 (Credit 1) - Leadership and Effective Decision Making	
Learning Outcomes	After learning the module, learners will be able to, 1. Define Personality, explore Determinants of Personality Development, andexamine the Perception process to comprehend individual behavior and interactions. 2. Investigate Factors of Association, including Relationship dynamics, PersonalityTraits, and the development of Effective Habits and Emotional Intelligence for interpersonal effectiveness
Content Outline	• Define Personality, Determinants of Personality Development, Perception-Definition,Perceptual Process • Factors of Association –Relationship, Personality Traits, Developing Effective Habits, Emotional Intelligence, Motivation, Introspection, Self-Assessment, Self-Appraisal & Self-development, Sigmund Freud Id, Ego & SuperEgo • Self Esteem and Maslow, Self Esteem & Erik Erikson, Mind Mapping, Competency Mapping & 360 Degree Assessment, Types of Personalities – Introvert, Extrovert & Ambivert person, Effective Communication & Its key aspects, Assertiveness, Decision making skills, Conflict: Process & Resolution, • Leadership & Qualities of Successful Leader

Module 2 (Credit 1) - Attitude and Stress Management	
Learning Outcomes	After learning the module, learners will be able to, 1. Implement strategies for developing a positive attitude, drawing insights fromCarl Jung's contributions to personality development theory. 2. Delve into Stress Management, including an introduction to stress, its causes,and techniques for managing stress effectively. 3. Examine the importance of Time Management, learning various techniques andstyles to optimize productivity and efficiency.
Content Outline	● Interpersonal Relationship, Personality – Spiritual journey beyond managementof change,Good manners & Etiquettes,Effective Speech, Understanding Body language, projective positive body language. ● Attitude - Concept -Significance -Factors affecting attitudes – Positive attitude–Advantages–Negative attitude-Disadvantages –Ways to develop positive attitude ● Carl Jung ‘s contribution to personality development theory ● Stress Management: Introduction, Causes, stress management techniques ● Time management: Importance of time management, Techniques of timemanagement, Time management styles.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Project 1: Personality Development Analysis

Students will critically analyze the constructs of personality and determine the factors influencing personality development. They will conduct a survey to gather data on how different determinants, such as genetics, environment, and experiences, shape personality. The project will also involve anin-depth study of the perception process and how it affects individual behavior and interactions. Students will compile their findings into a detailed report, presenting insights and implications for personal growth.

Project 2: Habit Formation and Emotional Intelligence

Students will evaluate the factors affecting relationships and personality traits to develop effective habits and emotional intelligence. They will create a habit formation plan that incorporates strategies for building positive habits and enhancing emotional intelligence. The project will involvemonitoring their progress over a set period and documenting changes in their interpersonal effectiveness. Students will present their results and reflections in a comprehensive report, highlighting the role of emotional intelligence in personal and professional settings.

Project 3: Motivation and Self-Assessment

Students will explore various motivation theories and engage in self-assessment exercises to understand their motivations and strengths. They will conduct a self-appraisal using tools like mindmapping, competency mapping, and 360-degree feedback to identify areas for self-development. The project will include creating a personal development plan that outlines specific goals and strategies for improving self-esteem and achieving personal growth. Students will present their development plans and the rationale behind their strategies.

Project 4: Communication and Decision-Making Skills

Students will develop and demonstrate effective communication channels and decision-making skills. They will design and implement a communication plan that includes assertive communication techniques and strategies for conflict resolution. The project will involve role- playing scenarios to practice these skills in various contexts, such as workplace settings and personal relationships. Students will document their experiences and evaluate the effectiveness of their communication and decision-making strategies, presenting their findings and reflections in a report.

References Books:

1. Trotter, J. (2022). Perfect Communication: How to Improve Your Communication Skills. JeffreyTrotter.
2. Dubey, A., & Shukla, A. (2023). Personality Development and Communication Skills. LaxmiPublications Pvt. Ltd.

Course Syllabus

Semester – III

.3.1 Major (Core)

Course Titles	**Physical Chemistry - I (Th+Pr)**
Course Credits	**4 Credit's (2 Th + 2 Pr)**
Course Outcomes	After going through the course, learners will be able to
	1. 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
	1. Understand the basic principles of atomic structure, including the arrangement of electrons, protons, and neutrons within an atom.
	2. Explain how the periodic table is organized based on atomic structure.
	3. Predict the properties of elements based on their atomic structure.
Content Outline	• 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 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
	• **Bonding:**
	1. Differentiate between different types of chemical bonds, such as

	covalent, ionic, and metallic bonds.
	2. Describe the factors that influence bond formation and strength.
	3. Predict the type of bonding in a given compound based on its chemical formula
Content Outline	• 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'srulcs, ioniccharacter in covalent compounds, dipole moment and percentage ionic character. • Covalent bonding: VB Approuch: 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 theLCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-pcombinations of atomic orbitals, nonbonding combination of orbitals, MO treatment ofhomonuclear diatomic molecules of Ist and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO". Comparison of VB and MỘ approaches
Module 3 (Credit 1):	
Learning Outcomes	After learning the module, learners will be able to
	1. This course aims to build hands-on experience in the experimental aspects of physical chemistry.
	2. It introduces students to the measurement and interpretation of physicochemical properties such as conductivity, viscosity, surface tension, and reaction kinetics.
	3. It also develops skills in the use of analytical instruments, data plotting, and interpretation of results.
Content Outline	• Determination of enthalpy of neutralization of a strong acid with a strong base. • Determination of enthalpy of dissolution of salts like KNO_3 or $CuSO_4$. • Determination of rate constant of the reaction between potassium iodide and potassium persulphate (iodine clock reaction). • 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
	1. Students will perform experiments to determine heats of solution, neutralization, or hydration.

	2. Study of the kinetics of the acid-catalyzed hydrolysis of methyl acetate
Content Outline	• 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):

<u>Module I: Solutions and Liquid State</u>

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

Assignment Type: Report + Optional PPT

Task:

1. **Choose a real-life binary solution such as:**
   - Alcohol–water mixture
   - Seawater
   - Acetone–chloroform
   - Blood plasma

2. **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.

3. **Optional: Prepare a PowerPoint presentation (3–5 slides) for in-class discussion**.

<u>Module II: Surface Tension and Viscosity</u>

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 (H_2CO_3/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‘, 35thedition, Goel Publishing House,
2. 2009.
3. Puri, Sharma Pathania, _Principles of Physical Chemistry‘, 42ndedition, Vishal Publishing& Co, 2007.
4. R. Stephen Berry, Stuart A. Rice & John Ross, _Physical Chemistry‘, 2ndedition, Oxford
5. University press, 2000..Levin, _Physical Chemistry‘, 6thedition, Tata Mcgraw-Hill Education,2011.

Semester – III

.3.2 Major (Core)

Course Titles	**Organic Chemistry (Th+Pr)**
Course Credits	**4 Credit's (2 Th + 2 Pr)**
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
	1. Students understand the process of preparation of organic through various reactions
	2. Students understand reactive intermediate
Content Outline	• 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
	1. Students learn about Baeyer's strain theory
	2. Students understand Geometrical isomerism:
Content Outline	• 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	After learning the module, learners will be able to
	1. To develop skills in synthesizing and purifying organic compounds.
	2. To train students in identification of organic compounds via functional group analysis.
	3. To enhance understanding of organic reactions and compound characterization.
Content Outline	• 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	After learning the module, learners will be able to
	1. To develop skills in synthesizing and purifying organic compounds
	2. To train students in identification of organic compounds via functional group analysis.
	3. To enhance understanding of organic reactions and compound characterization.
Content Outline	• 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:

1. **Choose any 3–5 reactions from the following:**
   - Dehydration of alcohols
   - Dehydrohalogenation
   - Saytzeff's elimination vs. Hofmann orientation
   - Hydroboration–oxidation
   - Peroxide effect
   - Ozonolysis
   - $KMnO_4$ oxidation
2. **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.
3. **Compare the acidity/basicity of 2–3 organic acids/bases using pKa 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:

1. **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

<u>Module IV: Advanced Synthesis & Green Chemistry</u>

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 Guidebook 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, Oxford University Press, 2012.

Semester – III

.3.3 Major (Core)

Course Titles	**Inorganic Chemistry-I (Th+Pr)**
Course Credits	**4 Credit's (2 Th + 2 Pr)**
Course Outcomes	After going through the course, learners will be able to
	1. Understanding of anomalous behavior of elements
	2. Ability to understand, explain predict various rules involved in chemical bonding
	3. In-depth knowledge about standard electrode potential and volumetric analysis
	4. Understand the importance and application of chemical bonds, intermolecular and intramolecular weak chemical forces and their effect.
	5. 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
	1. Students will understand general characteristics of f- block elements
	2. Students will learn the different Extraction lanthanides series.
Content Outline	• 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
	1. Understand coordination number, ligand types, and geometry
	2. Apply IUPAC rules for nomenclature of coordination complexes
	3. Identify and differentiate ligands (monodentate, bidentate, polydentate).
Content Outline	• 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
	1. To train students in synthesis and purification of inorganic compounds.
	2. To observe and record physical and chemical changes during reactions.
	3. To understand concepts like hydration, oxidation state, and crystal structure.
Content Outline	• Preparation of Cuprous chloride (Cu_2Cl_2) from copper sulphate Reduction, precipitation, redox • Preparation of Manganese phosphate \[$MnPO_4 \cdot xH_2O$] from $Mn(NO_3)_2$ Precipitation, coordination • Preparation of Chrome Alum \[$K_2SO_4 \cdot Cr_2(SO_4)_3 \cdot 24H_2O$] Redox reaction between $K_2Cr_2O_7$ and SO_2 • Preparation of Potash Alum \[$K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$ Double salt crystallization • Preparation of Ferric alum \[$K_2SO_4 \cdot Fe_2(SO_4)_3 \cdot 24H_2O$] Salt hydrolysis and crystallization
Module 4 (Credit 1):	
Learning Outcomes	After learning the module, learners will be able to
	1. To train students in synthesis and purification of inorganic compounds.
	2. To observe and record physical and chemical changes during reactions.
	3. To understand concepts like hydration, oxidation state, and crystal structure.
Content Outline	• Synthesis of Tetrammine Copper(II) Sulphate \[$Cu(NH_3)_4]SO_4 \cdot H_2O$] Ligand coordination, complex Formation • Synthesis of Potassium Trioxalatoferate(III) \[K_3\[$Fe(C_2O_4)_3$]] Coordination complex, redox, light sensitivity • Preparation of Nickel-DMG Complex \[$Ni(DMG)_2$] • Synthesis of Sodium Cobaltinitrite \[Na_3\[$Co(NO_2)_6$] Oxidation, complex ion formation

	• Preparation of Mohr's Salt \[$(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O$] Mixed salt crystallization

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):
<u>Module I: d-Block and f-Block Elements</u>

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.**

<u>Module II: Types of Coordination compounds.</u>

Activity Title: Classification of Coordination compounds

Assignment Type: Report + Structure Drawing

Choose 3–4 topics from below:

- Tetrahedral Compounds
- Square Planner compounds
- Octahedral Compounds

Your report should include:

- Structures of coordination compounds
- Classification in tabular form

<u>Module III: Inorganic Preparations and Salt Analysis</u>

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 ($MnPO_4 \cdot xH_2O$)
- 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 – $[Cu(NH_3)_4]SO_4 \cdot H_2O$
- Potassium Trioxalatoferate(III) – $K_3[Fe(C_2O_4)_3]$
- Nickel-DMG complex – $[Ni(DMG)_2]$
- Sodium Cobaltinitrite – $Na_3[Co(NO_2)_6]$
- Mohr's salt – $(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O$

References:

1. Puri B R, Sharma L R, Kalia K K, _Principles of Inorganic Chemistry`, 23rd edition,
2. Shoban Lal Nagin Chand & Co, New Delhi, 1993.
3. Lee J. D., _Concise Inorganic Chemistry`, Black Well Science, UK. 2006
4. 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.
2. Chand &Co,New Delhi, 2006.
3. S. F. A. Kettle, _Physical Inorganic Chemistry`, Spectrum, 1996.
4. B. E. Dogulas DH McDaniel`s and Alexander, _Concepts and Models of InorganiChemistry`,Oxford IBH, 1983

Semester – III

.3.4 Minor Stream

Course Titles	**Analytical Chemistry – I (Th)**
Course Credits	**2 Credit's**
Course Outcomes	After going through the course, learners will be able to
	1. Imparting skills in the scientific method of planning, conducting, reviewing, reporting experiments and problem solving in chemical analysis.
	2. 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
	1. Students understand solids phase extraction.
	2. Students will learn solvent extraction, types of solvent extraction, batch continuous
Content Outline	• 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. • Comparison of Solid phase extraction and solvent extraction.
Module 2 (Credit 1):	
Learning Outcomes	After learning the module, learners will be able to
	1. Students learn about analysis of water.
	2. Students will learn the resources for contaminated water
Content Outline	• 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):

<u>Module I: Solvent Extraction and Solid Phase Extraction</u>

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:

- Collect water samples from two different sources (e.g., tap water, river water, borewell).
- Test 2–3 quality parameters (as listed above).
- Interpret the results and comment on water quality.
- Suggest purification or treatment methods based on findings.
- 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,
3. Merrut,1997.

Semester – III

.3.5 Open Elective Courses (OEC)

Course Titles	**Environmental Pollution (Th)**
Course Credits	**2 Credit's**
Course Outcomes	After going through the course, learners will be able to
	1. This course introduces 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 knowledge about environmental pollution.
	5. Apply the principles of key environmental treaties and legislation to case studies.
Module 1 (Credit 1):	
Learning Outcomes	After learning the module, learners will be able to
	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.
	3. Identify and explain the major sources and types of air pollutants, including both primary and secondary pollutants.
	4. Describe the characteristics and health impacts of key criteria pollutants (CO, Pb, NO_x, O_3, PM, SO_2), as well as other significant pollutants such as VOCs, PAN, PAHs, and POPs.
Content Outline	• 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), Peroxyacetylnitrate (PAN), Polycyclic aromatic hydrocarbons and Persistent organic compounds (POPs) • Adverse health impacts of air pollutants
Module 2 (Credit 1):	
Learning Outcomes	After learning the module, learners will be able to
	1. Understand and explain the microbially mediated aquatic reactions

	2. Classify water pollutants and distinguish between organic and inorganic contaminants such as pesticides
	3. Analyze key water pollution issues including eutrophication
Content Outline	• 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):

<u>Module I: Air Pollution and Its Impact</u>

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 (SO_2)
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.**

<u>Module II: Water Pollution and Microbial Reactions</u>

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

Semester – III

.3.7 Major (Core)

Course Titles	**Inorganic Chemistry - II – Part I (Th)**
Course Credits	**2 Credit's**
Course Outcomes	After going through the course, learners will be able to
	1. Understand crystal structures, defects, and properties of solids & explain superconductivity
	2. Describe bonding, structure, and classification of organometallic compounds
	3. Interpret electronic (d–d and charge transfer) spectra & understand role of catalyst in TM
	4. Explain trends such as lanthanide contraction, oxidation states, magnetic properties & hapticity
Module 1 (Credit 1	**Solid State and Superconducting Materials Chemistry**
Learning Outcomes	After learning the module, learners will be able to
	1. Understand crystal structures using unit cell parameters and packing efficiency concepts
	2. Explain superconductivity, Meissner effect, critical temperature, apply hapticity concept to understand structure and bonding in transition metal complexes
	3. Identify and classify f-block elements into lanthanides and actinides

Content Outline	Solids classification on the basis of bonding. Explanation of terms: crystal lattices, lattice points, unit cell, lattice constant, closest packing of rigid spheres (hcp, ccp), packing density in simple cubic, bcc, fcc lattice. Tetrahedral & octahedral voids Superconductor: introduction, critical temperature, Meissner effect Introduction, definition, classification on the basis of hapticity and nature of metal carbon bond
Module 2 (Credit 1): Organometallic & Electronic Spectra	
Learning Outcomes	After learning the module, learners will be able to
	1. Apply Crystal Field Theory (CFT) to explain electronic structure of coordination compounds
	2. Interpret electronic spectra including d–d transitions and charge transfer transitions
	3. Correlate spectral properties with geometry, oxidation state, and ligand field strength
	4. Understand the role of homogeneous catalysis in TM complexes
Content Outline	• Crystal Field Theory (CFT) applied to coordination compounds. Assumptions of CFT, splitting of d orbitals in octahedral, tetrahedral and square planar complexes, Jahn- • Teller effect Term symbols for d^1 to d^{10} system, rules for electronic transitions, Laporte and spin selection rules, Orgel diagrams for d^1, d^4, d^6, d^9 metal ions. Electronic spectra of $[Ti(H_2O)_6]^{3+}$ • Hydrogenation & hydroformylation of alkenes Introduction, types of reaction in complexes, ligand substitution reactions, basic mechanisms, labile and inert complexes.

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 B_{12}
- 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 $[Ni(CN)_4]^{2-}$, $[Fe(CN)_6]^{3-}$, $[Co(NH_3)_6]^{3+}$,

$[CuCl_4]^{2-}$ ○ 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,
2. Shoban Lal Nagin Chand & Co, New Delhi, 1993.
3. Lee J. D., _Concise Inorganic Chemistry‘, Black Well Science, UK. 2006 4. 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.
2. Chand &Co,New Delhi, 2006.
3. S. F. A. Kettle, _Physical Inorganic Chemistry‘, Spectrum, 1996.
4. B. E. Dogulas DH McDaniel‘s and Alexander, _Concepts and Models of InorganiChemistry‘,Oxford IBH, 1983
5. Raj, G., Advanced Practical Inorganic Chemistry, Krishna Prakashan, Meerut (2013).
6. Mendham, J.; Denney, R. C., Barnes, J. D.; Thomas, M.; Sivasankar, B., Vogel’s

Course Syllabus

Semester – IV

.4.1 Major (Core)

Course Titles	**Analytical Chemistry (Th+Pr)**
Course Credits	**4 Credit's (2 Th + 2 Pr)**
Course Outcomes	After going through the course, learners will be able to
	1. Imparting skills in the scientific method of planning, conducting, reviewing, reporting experiments and problem solving in chemical analysis.
	2. Developing skills in contemporary methods of separation and appropriate selection of instruments for the successful analysis of chemical compounds
	3. 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
	1. Students understand the concept of QA QC
	2. Students understand samplings types
Content Outline	• 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. • 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
	1. Students learn about analysis of water.
	2. Students will learn the resources for contaminated water.
Content Outline	• 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 solids, analysis of total dissolved solids, analysis of oil & grease in water
Module 3 (Credit 1):	
Learning Outcomes	After learning the module, learners will be able to
	1. Apply chromatographic techniques (paper and TLC) for the separation and identification of cations, sugars, dyes, and amino acids.
	2. Determine Rf values accurately and interpret them for qualitative analysis.
	3. Perform solvent extraction techniques to isolate specific components from mixtures and quantify them using spectrophotometry.
	4. Analyze the pH of commercial products (aerated drinks, fruit juices, shampoos, and soaps), applying pH measurement techniques.
	5. Develop analytical skills in separation, quantification, and identification of chemical species.
	6. Enhance laboratory proficiency in handling chromatographic and spectrophotometric instruments while maintaining safety protocols.
Content Outline	• Separate and identify cations (Fe^{2+}, Mn^{2+}, and Cd^{2+}) by paper chromatography and calculate their Rf values, applying ion-exchange principles • Separate monosaccharides (glucose and fructose) by paper chromatography, accurately determining their Rf values

	• Separate a mixture of dyes by TLC and identify them based on their Rf values, mastering thin-layer chromatography techniques • Separate and identify amino acids by TLC, applying principles of adsorption chromatography and calculating Rf values • Separate cations (Pb^{2+} and Cd^{2+}) by TLC, determining their Rf values and interpreting the separation efficiency
Module 4 (Credit 1):	
Learning Outcomes	After learning the module, learners will be able to
	1. Extract iodine from an aqueous solution, demonstrating skills in liquid-liquid extraction techniques.
	2. Separate Ni^{2+} and Fe^{2+} by complexation with DMG and extract the Ni^{2+}-DMG complex into chloroform, applying the principles of metal-ligand complexation.
	3. Determine the concentration of the Ni^{2+}-DMG complex by spectrophotometry, mastering quantification techniques through absorbance measurements
Content Outline	• **Solvent extractions:** ○ Extraction of iodine from an aqueous solution ○ Separation of a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+}-DMG complex in chloroform, and determine its concentration by spectrophotometry ○ Determine the pH of the given aerated drinks, fruit juices, shampoos, and soaps

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

<u>Module I: Quality Assurance and Sampling</u>

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 Rf values
- pH analysis of products (aerated drinks, juices, soaps, shampoos)

Your report should include:

- Aim, chemicals used, and procedure
- Diagram of setup
- Rf 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 Ni^{2+} & Fe^{2+} by DMG complexation
- Estimation of Ni^{2+} 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. J. K., *Vogel's Textbook of Quantitative Chemical Analysis*, 7th Ed., Pearson Education, 2008.
2. Sharma, B. K., *Instrumental Methods of Chemical Analysis*, Goel Publishing House, Meerut, 1997.

Semester – IV

.4.2 Major (Core)

Course Titles	**Inorganic Chemistry (Th+Pr)**
Course Credits	**4 Credit's (2 Th + 2 Pr)**
Course Outcomes	After going through the course, learners will be able to
	1. Understanding of anomalous behavior of elements
	2. Ability to understand, explain predict various rules involved in chemical bonding
	3. In-depth knowledge about standard electrode potential and volumetric analysis
	4. Understand the importance and application of chemical bonds, intermolecular and intramolecular weak chemical forces and their effect.
	5. 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
	1. Students will understand the properties of s-block elements.
	2. Students will understand different types of bonding.
Content Outline	• 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
	1. Understand the fundamental concepts of gravimetric estimation, including precipitation, filtration, drying, and weighing
	2. Identify conditions for ideal precipitation
	3. Understand factors affecting precipitation such as common ion effect, temperature, and pH
Content Outline	• 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	After learning the module, learners will be able to
	1. Apply fundamental principles of acid-base and redox titrations to determine the concentration of unknown substances in various samples.
	2. Perform quantitative estimations of calcium, iron, oxalate, carbonate, bicarbonate, and free alkali in different mixtures.
	3. Demonstrate skills in inorganic synthesis by preparing compounds such as cuprous chloride, manganese phosphate, and alums.
	4. Enhance analytical and laboratory skills by using internal and external indicators in redox titrations
Content Outline	• **Acid-Base Titrations** ○ Determination of alkali content of antacid tablets using HCl ○ Estimation of calcium content in chalk as calcium oxalate ○ Estimation of carbonate and hydroxide present together in mixture ○ Estimation of carbonate and bicarbonate present together in a mixture ○ Estimation of free alkali present in different soaps/detergents • **Oxidation-Reduction Titrations** ○ Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution ○ Estimation of oxalic acid and sodium oxalate in a given mixture ○ Estimation of Fe(II) with $K_2Cr_2O_7$ using internal diphenylamine, anthranilic acid and external indicator
Module 4 (Credit 1):	
Learning Outcomes	After learning the module, learners will be able to
	1. Demonstrate Understanding of Gravimetric Principles.
	2. Use correct concentrations and understand stoichiometric relationships in gravimetric reactions.
	3. Apply techniques like **digestion**, **coagulation**, and **filtration** using sintered glass crucibles, silica crucible or filter papers.
	4. Calculate the amount or percentage of analyte from the mass of

	the final precipitate.
Content Outline	• Estimation of **barium** as **$BaSO_4$** • Estimation of **iron (III)** as **Fe_2O_3** • Estimation of **nickel** as **Ni-DMG** • Estimation of **chromium** as **Cr_2O_3** • Estimation of **aluminium** as **Al_2O_3**

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

<u>Module I: Bioinorganic Chemistry</u>

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 B_{12}
   - 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.**

<u>Module II: Crystal Field Theory (CFT)</u>

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.

<u>Module III: Theories of Bonding in Coordination Compounds</u>

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 $[Ni(CN)_4]^{2-}$, $[Fe(CN)_6]^{3-}$, $[Co(NH_3)_6]^{3+}$, $[CuCl_4]^{2-}$
   - Geometry, number of unpaired electrons, and nature of ligand
3. **Draw orbital overlap diagrams or MO diagrams where applicable.**

<u>Module IV: Gravimetric Estimation</u>

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,
2. Shoban Lal Nagin Chand & Co, New Delhi, 1993.
3. Lee J. D., _Concise Inorganic Chemistry`, Black Well Science, UK. 2006
4. 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.

2. Chand &Co,New Delhi, 2006.
3. S. F. A. Kettle, ‗Physical Inorganic Chemistry‘, Spectrum, 1996.
4. B. E. Dogulas DH McDaniel‘s and Alexander, ‗Concepts and Models of InorganiChemistry‘,Oxford IBH, 1983
5. Raj, G., Advanced Practical Inorganic Chemistry, Krishna Prakashan, Meerut (2013).
6. Mendham, J.; Denney, R. C., Barnes, J. D.; Thomas, M.; Sivasankar, B., Vogel's

Semester – IV

.4.3 Major (Core)

Course Titles	**Organic Chemistry (Th+Pr)**
Course Credits	**4 Credit's (2 Th + 2 Pr)**
Course Outcomes	After going through the course, learners will be able to,
	1. To expand on fundamental organic chemistry with a focvus on application-driven understanding.
	2. 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
	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** ○ 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):	
Learning Outcomes	After learning the module, learners will be able to
	1. To encourage critical thinking in organic reactivity, design, and sustainability.
	2. To bridge academic organic chemistry with real-world utility and industrial relevance
Content Outline	• Functional Groups in Everyday Organic Molecules • Alcohols, phenols, ethers, aldehydes, ketones, carboxylic acids, esters – structure, synthesis, uses • Functional groups in drugs, fragrances, dyes, polymers • Case studies: Paracetamol, menthol, ethyl acetate, citral
Module 3 (Credit 1):	

Learning Outcomes	After learning the module, learners will be able to
	1. To encourage critical thinking in organic reactivity, design, and sustainability.
	2. To bridge academic organic chemistry with real-world utility and industrial relevance
Content Outline	• Preparation of Nitrobenzene from benzene using nitrating mixture – Electrophilic aromatic substitution • Synthesis of Benzil from Benzoin – Oxidation using nitric acid • Preparation of Phenylazo-β-naphthol (Orange dye) – Advanced diazotization and coupling • Preparation of Benzilic acid from benzil – Rearrangement reaction • Synthesis of Phthalimide from phthalic anhydride – Ammonolysis reaction
Module 4 (Credit 1):	
Learning Outcomes	After learning the module, learners will be able to
	1. To perform multi-step or mechanism-specific organic syntheses.
	2. To analyze organic reaction outcomes through observation and characterization.
	3. To develop skills in qualitative identification of unfamiliar organic compounds.
	4. To expose students to eco-friendly synthetic strategies and reagent handling
Content Outline	• 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):

<u>Module I: Aromaticity and Electrophilic Substitution</u>

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.**

<u>Module II: Carbonyl Compounds and Nucleophilic Addition</u>

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.**

<u>Module III: Carboxylic Acids and Their Derivatives</u>

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.**

<u>Module IV: Organic Synthesis and Multistep Reactions</u>

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.

Semester – IV

.4.4 Open Elective Courses/ Generic Courses (OEC)

Course Titles	**Waste Management (Th)**
Course Credits	**2 Credit's**
Course Outcomes	After going through the course, learners will be able to
	1. To provide basic understanding of waste types, sources, and characteristics. 2. To familiarize students with sustainable waste handling, treatment, and disposal techniques. 3. To promote awareness of waste legislation and community involvement. 4. 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
	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	• **Definition and classification of waste** o Solid waste, municipal waste, industrial waste, agricultural waste, biomedical waste, hazardous waste, e-waste, plastic waste o Sources and composition of various wastes o Collection, segregation, storage, and transportation of waste o Problems associated with unscientific waste disposal (health, environment, economy) o 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
	1. Introduction to Circular Economy and Zero Waste Practices
	2. Case studies: Indian municipalities with successful waste management systems
Content Outline	• Waste treatment methods:

	○ 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):

<u>Module I: Classification and Sources of Waste</u>

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**.

<u>Module II: Waste Collection and Segregation</u>

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.**

<u>Module III: Waste Treatment Methods</u>

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
1. **For each method:**
   - Write pros and cons
   - Cost-effectiveness
   - Environmental impact
   - Suitability for different waste types
2. **Optional: Visit or virtually explore a local composting or waste facility and include your observations.**

<u>Module IV: Waste Management Laws and Sustainability</u>

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

Semester – IV

.4.5 Skill Enhancement Courses (SEC)

Course Titles	**Green Chemistry (Th)**
Course Credits	**2 Credit's**
Course Outcomes	After going through the course, learners will be able to
	1. To introduce students to the fundamental concepts and goals of green chemistry.
	2. To develop skills in identifying and implementing sustainable chemical practices.
	3. To promote critical thinking about the role of chemists in environmental responsibility and innovation.
	4. 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
	1. Understand the principles and scope of green chemistry.
	2. Evaluate environmental aspects of chemical synthesis and industrial processes.
	3. Design safer chemical processes using green chemistry tools.
	4. Reflect on how green chemistry contributes to environmental protection and sustainable development goals.
Content Outline	• 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
	1. Assess environmental hazards of common laboratory and industrial processes.
	2. Suggest and design greener alternatives for traditional chemical reactions.v
	3. Reflect critically on the ethical responsibilities of chemists toward society
Content Outline	The 12 Principles of Green Chemistry

	Detailed explanation of each principle with examples: 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 Activities: Create posters/infographics on assigned principles.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

<u>Module I: Principles of Green Chemistry</u>

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.

<u>Module II: Green Synthesis</u>

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 benzilic 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

Semester – IV

.4.7 Minor Stream

Course Titles	**Industrial Chemistry (Th)**
Course Credits	**2 Credit's**
Course Outcomes	After learning the module, learners will be able to,
	1. List the importance of Chemical industry products, define the basic concepts, terminologies and recall reactions learned in chemical industries
	2. Explain the basic requirements, general terms, processes of chemical industries
	3. Apply the knowledge and interpret application of various soap products and examine the MSDS and safety measures of hazardous chemicals
	4. Conclude the reasons for different observations and facts and justify the principle involved in chemical processes of chemical industry products
Module 1 (Credit 1) - Modern Approach to Chemical Industry	
Learning Outcomes	After learning the module, learners will be able to,
	1. Describe the concepts of process industries, unit operations, unit processes, and process flow diagrams used in chemical manufacturing
	2. Identify the raw materials, energy sources, and utilities required in chemical industries
	3. Explain the manufacturing processes of basic industrial chemicals such as sulphuric acid & ammonia
Content Outline	• Introduction, Basic requirements of chemical industries, Chemical production, Raw materials, Unit process, Unit operation, Quality control, Quality assurance, Process control, Research and Development, Pollution control • Manufacture of basic chemicals: ○ Ammonia: Manufacture of NH_3 by Modified Haber–Bosch process, Physico-chemical principles involved, uses of NH_3 ○ Sulphuric acid: Manufacture of H_2SO_4 by Contact process, Physico-chemical principles involved, uses of H_2SO_4
Module 2 (Credit 2) - Sugar, Fermentation, Soap & Detergent Industries	
Learning Outcomes	After learning the module, learners will be able to,
	1. Explain the steps involved in sugar production, including extraction, purification, concentration, crystallization, and refining
	2. Discuss the principles of fermentation and identify factors

	affecting industrial fermentation processes
	3. Describe the chemistry, manufacture, and properties of soaps and detergents
Content Outline	1. Sugar Industry: Introduction, Importance of sugar industry, Manufacture of cane sugar: Raw material, Extraction, Clarification and Concentration of cane juice, Crystallization of sucrose 2. Fermentation Industry: Introduction, Importance, Basic requirement of fermentation process 3. Manufacture of Industrial alcohol (Ethyl alcohol) from a) Molasses b) Food grains & Grades of alcohol: Silence spirit, Rectified spirit 4. Soap industry: Introduction, Importance, Raw materials for soaps, Manufacture soap. Detergent industry: Meaning of the terms- Detergent, Surfactants, Emulsion and Emulsifying agents & Types of surfactants

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1: Chemical Industries & Basic Chemical Manufacturing

- **Flow Chart Preparation**
  - Draw neat flow charts for: Haber–Bosch process (NH_3) and Contact process (H_2SO_4)
  - Include raw materials, conditions, and catalysts
- **Comparative Study Chart**
  - Prepare table on: Unit Process vs Unit Operation, QC vs QA and Process Control vs R&D
- **Industrial Principles Assignment**
  - Explain physico-chemical principles involved in: Ammonia synthesis and Sulphuric acid production
  - Include effect of temperature, pressure, catalyst
- **Pollution Control Case Study**
  - Write short note on: Industrial pollution sources and Control methods (scrubbers, ETP, recycling)

Module 2: Agro-based & Fermentation Industries

- **Sugar Industry Process Diagram**
  - Draw labeled diagram of: Cane sugar manufacturing process and Steps: extraction → clarification → concentration → crystallization
- **Fermentation Case Study**

- Study ethanol production from: Molasses and Food grains
- Include microorganisms, conditions, and products

- **Alcohol Grades Chart**
  - Prepare chart showing: Rectified spirit and Silent spirit
  - Include composition and uses
- **Soap vs Detergent Comparison**
  - Create comparison table covering: Raw materials, Properties, Environmental impact and Hard water behavior
- **Surfactant Classification Activity**
  - Write and classify surfactants: Anionic, Cationic, Non-ionic and Amphoteric

Reference Books

1. B. K. Sharma – Industrial Chemistry, Goel Publishing House
2. R. K. Sharma – Industrial Chemistry, Krishna Prakashan Media
3. A. K. De – A Textbook of Industrial Chemistry, New Age International Publishers
4. E. Stocchi – Industrial Chemistry, Wiley / Ellis Horwood
5. G. T. Austin & Shreve – Shreve's Chemical Process Industries, McGraw Hill Education
6. P. H. Groggins – Unit Processes in Organic Synthesis, McGraw Hill Education
7. M. Gopala Rao & Marshall Sittig – Principles of Industrial Chemistry, CBS Publishers & Distributors
8. Kirk-Othmer – Chemical Technology (Vol. 1 & 2), Wiley
9. K. H. Davis – Handbook of Industrial Chemistry, McGraw Hill Education
10. C. N. R. Rao – Selected Industrial Chemistry Reference Material, IISc editions