Sir P. T. Sarvajanik College of Science

Autonomous

Affiliated to Veer Narmad South Gujarat University, Surat

Re-Accredited 'A+' with CGPA 3.35

SYLLABUS

FOR

SEM II

Program: B. Sc.

Course: Chemistry

Academic year

2025-26

(NEP-2020)

(To be effective from June, 2025)

SEMESTER II

Major Course - III

COURSE NAME: Chemistry Paper III

COURSE CODE: CHEMJ-S2P3-3CR24 **[CREDITS - 03]**

Course learning outcome
At the end ofo this course, Students will be able to 1. Define the laws of thermodynamics and its conceptual studies; basic concept of thermodynamic terms; entropy and change of entropy, Carnot cycle. 2. Interpret the basic terms specific conductance, equivalent conductance, molar conductance, and buffer, determination of cell constant of cell and buffer capacity. 3. Calculate different types of volume, viscosity, refraction using refractometer, identify properties of acids and bases; calculate pH and pOH; apply the concept of mole, mole fraction, molarity, molality, normality for solving numerical problems. 4. Define and describe fundamental laws of crystal structure, analyse lattice parameters, identify and draw seven crystal systems; explain Bragg's equation and analyse X-ray diffraction of the crystal system. 5. Compare and describe oxidizing/reducing in reaction, solve the problems based on equivalent weight of oxidants, reductants; oxidation number, solve problems involving standard reduction potential.

Module 1	**Physical Chemistry II**	**[15 L]**
Learning Objective • To familiarize the student with the fundamental concepts of thermodynamics and conductance and ionic equilibrium.		
Learning Outcomes: At the end of this module the learner will be able to 1. Define different laws of thermodynamics and its conceptual studies; describe basic concepts of thermodynamics and terms like entropy and their change of entropy, explain Carnot cycle and solve problems involving these laws. 2. Interpret and describe the basic terms viz. specific conductance, equivalent conductance, molar conductance, buffer, determination of cell constant of cell and buffer capacity and solve problems involving these concepts.		
1.1	**Thermodynamics:** [**Recapitulation:** Zeroth law, first law of thermodynamics,	**[7 L]**

	spontaneous and non-spontaneous process, reversible and irreversible process.] Second law of thermodynamics (in detail), Carnot cycle and its efficiency, Entropy concept, change of entropy for reversible isothermic, isobaric, isochoric, and adiabatic processes, Entropy change for ideal gases (T&V as variables, P&T as variables), Numerical Problems.	
1.2	**Conductance and Ionic Equilibrium:** Electrical conductance, Specific conductance, equivalent conductance, Molar conductance, Effect of dilution on concentration, Cell constant, Determination of Cell constant, Ostwald's dilution law and its limitations, Acid & Basic buffer actions (Henderson-Hasselbalch equation), Buffer capacity, Numerical Problems.	**[8 L]**
Module 2	**Basics of Chemistry II**	**[15 L]**
Learning Objective • To acquaint the students with the basic properties of chemistry e.g. physical properties of liquid state, acid-base theory and mole concept		
Learning Outcomes: At the end of this module the learner will be able to 1. Calculate different types of volume, viscosity, refraction using refractometer and refractive index. 2. Identify and explain properties of acids and bases; calculate pH and pOH. 3. Apply the concept of mole, mole fraction, molarity, molality, normality for solving numerical problems.		
2.1	**Liquid State:** Classification of physical properties (additive, constitutive, colligative, additive constitutive), Atomic volume, Molar volume and Chemical constitution, Kopp's law, Surface tension, Drop number method, Parachor, Viscosity, Determination of viscosity by Ostwald viscometer. Define: Refraction, Specific refraction, molar refraction. Determination of refractive index by Abbes Refractometer, Numerical Problems.	**[7 L]**
2.2	**Acid-base theory and mole concept:** Basic theory of acids and bases: Arrhenius theory, Brønsted-Lowry theory, and Lewis theory; Hard	**[8 L]**

	and Soft Acids and Bases (HSAB) principle, Concept of concentrations, strength, normality, molarity, molality, formality, mole fractions, %w/w, %w/v, %v/v, ppm, ppb & ppt. standardization of solutions, preparation of standard solution of acids and bases, Calculation of pH and pOH. Numerical Problems.	
Module 3	**Inorganic Chemistry II**	**[15 L]**

Learning Objective

- To help students perceive the basics of properties of solid state, methods of oxidation and reduction

Learning Outcomes:

At the end of this module the learner will be able to

1. Define and describe fundamental laws of crystal structure, analyze lattice parameters, identify and draw seven crystal systems; explain Bragg's equation and analyze X-ray diffraction of the crystal system.
2. Compare and describe oxidizing/reducing in reaction, solve the problems based on equivalent weight of oxidants, reductants; oxidation number, solve problems involving standard reduction potential.

3.1	**Solid State:** Properties of the solid state, Crystalline and amorphous solid, Crystal lattice and unit cell, Miller indices, seven crystal systems and Bravais lattices, X-ray diffraction, Bragg's law, Packing fraction and density of crystal, Packing efficiency, Crystal defects, Types of point defect.	**[8 L]**
3.2	**Oxidation-Reduction:** Definitions of oxidation and reduction, Oxidizing and reducing agents, Oxidation number, Rules to assign oxidation number; Calculation of equivalent weight of oxidants and reductants; Application to redox reactions. Standard reduction potential and its application in inorganic reactions and solving problems by two methods (half reaction method and oxidation number method)	**[7 L]**

List of Major Textbooks:

1. Essential of physical chemistry by A.S. Bahl and G.D. Tuli; Pub.: S. Chand.
2. Advance physical chemistry by D.N. Bajpai, Pub.: S. Chand.
3. Numerical problems by D.V.S. Jain, Pub.: Mac Graw Hill (Numericals).

4. Advanced Physical Chemistry by Gurdeep Raj, 19/E, Goel Publishing House, Meerut.
5. Physical Chemistry by P. W. Atkins, 10/E, 2002, Oxford University Press, Indian Eds.
6. Principles of physical chemistry by Puri, Sharma and Madan; Pub. Vishal publishing.
7. Nag, A. K, Physical Chemistry Vol. 1, 2, McGraw Hill.
8. Castellan, G. W. (2004), Physical Chemistry, 4th Edition, Narosa.
9. Kapoor, K.L. (2015), A Textbook of Physical Chemistry, Vol 1, 6th Edition, McGraw Hill Education.
10. Concise Inorganic Chemistry by J. D. Lee, 5/E, Oxford University Press, Indian Edition.
11. Basic Inorganic Chemistry by F. A. Cotton and G. Wilkinson, Wiley publication.
12. Inorganic Chemistry by Shriver & Atkins, 4/E, Oxford University Press, Indian Edition.
13. General and Inorganic Chemistry: Volume I by R. P. Sarkar, New Central Book Agency; 3rd Revised edition (1 July 2011), India.
14. Inorganic Chemistry: Principles of Structure and Reactivity by J. E. Huheey, E.A. Keiter, R.L. Keiter, Pearson; 4th edition (1997).
15. Inorganic Chemistry by Shriver, Atkins and Langford, Pubs: W H Freeman & Co (Sd) (1994).

e-Resources

1. **https://archive.nptel.ac.in/courses/104/106/104106089/**
2. **https://archive.org/details/chemicalthermodynamicsbasicconceptsandmethods_201908**
3. **https://courses.lumenlearning.com/suny-introductory-chemistry/chapter/introduction-to-chemical-thermodynamics/**
4. **https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/116**
5. **https://sathee.prutor.ai/ncert-books/jee-ncert-solutions/jee-chemistry/ionic-equilibrium/**
6. **https://archive.nptel.ac.in/content/storage2/courses/104103071/pdf/mod2.pdf**
7. **https://archive.org/details/mole-concept-practice**
8. **https://courses.lumenlearning.com/suny-mcc-introductorychemistry/chapter/arrhenius-acids-and-bases/**
9. **https://archive.nptel.ac.in/courses/104/104/104104101/**
10. **https://courses.lumenlearning.com/chemistryformajors/chapter/the-solid-state-of-matter-2/**

11. https://www.swayamprabha.gov.in/
    https://www.youtube.com/watch?v=11pVVp77p0c
12. https://courses.lumenlearning.com/suny-introductory-chemistry/chapter/oxidation-reduction-reactions/
13. https://www.swayamprabha.gov.in/
    https://www.youtube.com/watch?v=vhGAyyJceOA

Mapping of CLOs and PSOs:

Course Learning Outcomes	Programme Specific Outcomes								
	1	2	3	4	5	6	7	8	9
1.	√	√							
2.	√	√					√		
3.	√	√	√			√	√		
4.	√	√	√			√	√		
5.	√	√	√			√	√		

SEMESTER II

Major Course - IV

COURSE NAME: Chemistry Paper IV

COURSE CODE: CHEMJ-S2P4-3CR24 **[CREDITS - 03]**

Course learning outcome
At the end of this course, Students will be able to 1. Define and write the concept of reaction mechanism, types of fission, reagents and reactions. 2. Describe the formation and stability of reactive intermediates including carbonium ions, carbanions and carbenes. 3. Interpret the mechanism of electrophilic addition and substitution reactions and nucleophilic substitution reactions. 4. Apply the concept of homolytic and heterolytic fission to predict the product of Perkin, Cannizzaro and Reimer-Tiemann reaction. 5. Define the basic concepts, reactivity, physical and chemical properties of alkenes, dienes and alkynes. 6. Apply Markovnikov's rule and Saytzeff rule for addition and elimination reaction. 7. Write different chemical reactions of alkene, dines and acetylene. 8. Define Aromaticity and provide examples of aromatic compounds. 9. Explain the concept of delocalization and its role in aromaticity. 10. Apply Huckel's rule to predict the aromaticity of given compounds. 11. Define and calculate the empirical and molecular formula & their interrelation, molecular weight and apply the concept in solving numerical problems. 12. Define and classify carbohydrates. 13. Explain the structure and inter-conversion of glucose and fructose.

Module 1	**Organic Reactions and their Mechanism**	**[15 L]**

Learning Objective

- To familiarize the student with the fundamental concepts of reaction mechanism, types of fission, reagents and reactions

Learning Outcomes:

At the end of this module the learner will be able to

1. Define homolytic and heterolytic fission.

2. Describe the formation and stability of reactive intermediates including carbonium ions, carbanions and carbenes.
3. Interpret the mechanism of electrophilic addition and substitution reactions and nucleophilic substitution reactions.
4. Apply the concept of homolytic and heterolytic fission to predict the product of Perkin, Cannizzaro and Reimer-Tiemann reaction.

1.1	Homolytic and heterolytic fission, Reaction intermediates: carbonium ions, carbanions, free radicals, carbenes and Nitrene, Types of reagents for electrophilic & nucleophilic reactions, electrophiles, nucleophiles, inductive effect, mesomeric effect, electromeric effect, Acidity of carboxylic acid, Types of reaction: Addition, substitution, elimination, rearrangements. Addition and substitution with respect to electrophilic and nucleophilic SN^1, SN^2, Mechanism of (i) addition reaction to alkenes and dienes (ii) substitution in benzene ring nitration, sulphonation, alkylation, acylation, halogenation., cyanohydrin formation and acetal formation, Mechanism of Perkin reaction, Cannizzaro reaction, Reimer-Tiemann reaction	**[15 L]**
Module 2	**Alkenes, Dienes and Alkynes and Aromaticity**	**[15 L]**

Learning Objective

- To understand the basic concepts, reactivity, physical and chemical properties of alkenes, dienes and alkynes.
- To understand the fundamental concepts of aromaticity and its theories and their application in finding aromatic character in various classes of compounds

Learning Outcomes:

At the end of this module the learner will be able to

1. Define the basic concepts, reactivity, physical and chemical properties of alkenes, dienes and alkynes.
2. Apply Markovnikov's rule and Saytzeff rule for addition and elimination reaction.
3. Write different chemical reactions of alkene, dines and acetylene.
4. Define Aromaticity and provide examples of aromatic compounds.
5. Explain the concept of delocalization and its role in aromaticity.

6. Apply Huckel's rule to predict the aromaticity of given compounds.		
2.1	**Alkenes, Dienes and Alkynes** **(a) Alkenes**: Nomenclature, method of preparation, properties and uses of ethylene and propylene, Markovnikov's rule, Anti Markovnikov's rule and Saytzeff rule for addition and elimination reaction, Polymerization of ethylene styrene and vinylchloride. Reactions of Alkenes: Addition, Elimination, Oxidation, Epoxidation, Ozonolysis, Hydroxylation, Cis-Trans Epoxidation, Hydrohalogenation, Dehydrohalogenations, Hydration. **(b)Dienes**: Nomenclature, classification of dienes, Diels–Alder reaction (Pericyclic Reaction). **(c)Alkynes**: Nomenclature, methods of preparation, chemical reactions: Oxidation, metal ammonia reduction, oxidation	**[9 L]**
2.2	**Aromaticity** Introduction to Aromaticity, Theories of aromaticity: (i) Aromatic sextet theory (ii) Resonance theory (iii) Huckel's rule, Definition of Aromatic, Non-Aromatic, Anti-Aromatic Compounds, Aromaticity of three membered, four membered, five membered, six membered carbocyclic compounds, heterocyclic compounds	**[6 L]**
Module 3	**Empirical formula, Molecular formula and Structural formula & Carbohydrates**	**[15 L]**
Learning Objective: • To study the concepts of empirical and molecular formula & their interrelation, molecular weight. • To familiarize with the concept of carbohydrates, their classification and interconversion.		
Learning Outcomes: At the end of this module the learner will be able to 1. Define and calculate the empirical and molecular formula & their interrelation, molecular weight and apply the concept in solving numerical problems. 2. Define and classify carbohydrates. 3. Explain the structure and inter-conversion of glucose and fructose.		
3.1	**Empirical formula, Molecular formula and Structural formula** Determination of empirical formula and its relation with molecular	**[8 L]**

	formula, determination of molecular weight of (a) organic acid by titration and silver salt method and (b) organic base by chloroplatinate method and its limitations, Determination of molecular formula of gaseous hydrocarbons by explosion method, Numerical example.	
3.2	**Carbohydrates** Definition and classification, structure of D-glucose and D-fructose, Pyranose and Furanose Form of glucose, Mutarotation, step up reaction (Kiliani reaction, Sowden and Fischer method), Step down reaction (Wohl method, Ruff method), conversion of glucose to fructose and fructose to glucose.	**[7 L]**

List of Major Textbooks:

1. A textbook of Organic chemistry by Arun Bahl and B. S. Bahl, S. Chand & Company Pvt. Ltd.
2. Organic chemistry Vol. I and Vol. II by I.L. Finar (Longman group).
3. Textbook of Organic chemistry by P. L. Soni.
4. Organic chemistry by R. T. Morrison and Boyd Prentice Hall India.
5. Organic chemistry Vol. I and Vol. II by B. K. Sharma, & S. K. Sharma Goel Pub. House, Merut.
6. Organic reaction mechanism by Mukharji and Singh.
7. Fundamentals of Organic chemistry by Soloman, John Wiely.
8. Vogel's qualitative organic analysis.
9. Organic Chemistry by L. G. Wade Jr. Prentice Hall.

e-Resources:

1. **https://archive.nptel.ac.in/content/storage2/courses/104103071/pdf/mod4.pdf**
2. **https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/organic_chemistry-ii/01.types_of_organic_reactions/et/4784_et_et.pdf**
3. **https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S001174BS/P001199/M010853/ET/1479964601P4M18Feb22.pdf**
4. **https://archive.nptel.ac.in/content/storage2/courses/104103071/pdf/mod11.pdf**
5. **https://chemistry.ucr.edu/sites/default/files/2019-10/Chapter20.pdf**
6. **https://chem.libretexts.org/Courses/Heartland_Community_College/HCC%3A_Chem_161/3%3A_Chemical_Reactions_and_Quantities/3.4%3A_Determing_an_Empirical_and_Molecular_Formula**
7. **https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S001174BS/P001199/M010853/ET/1479964601P4M18Feb22.pdf**

Mapping of CLOs and PSOs:

Course Learning Outcomes	Programme Specific Outcomes								
	1	2	3	4	5	6	7	8	9
1.	√	√							
2.	√								
3.	√	√	√			√			
4.	√	√	√			√			
5.	√	√							
6.	√	√				√			
7.	√	√							
8.	√								
9.	√	√							
10.	√	√				√			
11.	√	√	√			√	√		
12.	√	√							
13.	√	√							

SEMESTER II

Minor Course - II

COURSE NAME: Chemistry Minor Paper II

COURSE CODE: CHEMN-S2P2-2CR25 **[CREDITS - 02]**

Course learning outcome
At the end of this course, Students will be able to 1. Define and write different methods of synthesis of alkanes and cycloalkanes. 2. Write mechanisms of chemical reaction of alkanes and cycloalkanes. 3. Apply the rules of IUPAC nomenclature to write the names and structure of organic compounds. 4. Interpret and describe the basic terms viz. specific conductance, equivalent conductance, molar conductance and buffer. 5. Calculate of cell constant, buffer capacity, pH and pOH and solve problems involving these concepts. 6. Define qualitative analysis and different reactions involved; explain the theory behind the Borax bead test and the flame test, including their applications for identifying metal ions. 7. Illustrate the structure of the non-luminous Bunsen flame; Identify metal ions through complexometric reactions; Understand the use of masking agents (e.g., for Cd^{2+} and Cu^{2+}) and learn techniques for the separation of ions like Ag^{+}, Hg^{2+}, Zn^{2+}, and Mn^{2+} in a qualitative analysis.

Module 1	**Basic Organic Chemistry II**	**[15 L]**
Learning Objective: ● To familiarize the student with the fundamental concepts, reactivity and chemical properties of alkanes and cycloalkanes. ● To make students understand and write the IUPAC nomenclature of organic compounds.		
Learning Outcomes: At the end of this module the learner will be able to: 1. Define and write different methods of synthesis of alkanes and cycloalkanes. 2. Write mechanisms of chemical reaction of alkanes and cycloalkanes. 3. Apply the rules of IUPAC nomenclature to write the names and structure of organic compounds.		
1.1	**Basic concepts of organic chemistry** Classification of Hydrocarbon, structural representation of organic	**[3 L]**

	compound, complete, condensed and bond-line structural formula, dipole moment, bond order, bond length, types of functional groups, hybridization.	
1.2	**Alkanes and cycloalkanes** **(A) Alkanes:** IUPAC nomenclature of branched and unbranched alkanes, Alkyl group, Classification of carbon atoms in alkanes. Isomerism in Alkanes, sources, methods of formation special reference to Wurtz and Wurtz-Fittig reaction Kolbe reaction and Corey-House reaction and decarboxylation of carboxylic acids). Physical properties and chemical reactions of alkanes. Mechanism of free radical halogenations of alkanes: orientation, reactivity &selectivity. **(B) Cycloalkanes:** Nomenclature, methods of formation, chemical reactions, Theory of strainless ring. The case of cyclopropane ring: banana bonds.	**[8 L]**
1.3	**IUPAC Nomenclature of organic compounds** Types of organic compounds, Functional group, Homologous series, IUPAC system for nomenclature, Nomenclature of poly functional compounds.	**[4 L]**
Module 2	**General Chemistry II**	**[15 L]**

Learning Objective:

- To make the students aware about some study basic properties of physical and inorganic chemistry e.g. conductance, ionic equilibrium and principals of inorganic qualitative analysis.

Learning Outcomes:

At the end of this module the learner will be able to

1. Interpret and describe the basic terms viz. specific conductance, equivalent conductance, molar conductance and buffer.
2. Calculate of cell constant, buffer capacity, pH and pOH and solve problems involving these concepts.
3. Define qualitative analysis and different reactions involved; Explain the theory behind the Borax bead test and the flame test, including their applications for identifying metal ions;
4. Illustrate the structure of the non-luminous Bunsen flame; Identify metal ions through

	complexometric reactions; Understand the use of masking agents (e.g., for Cd^{2+} and Cu^{2+}) and learn techniques for the separation of ions like Ag^{+}, Hg^{2+}, Zn^{2+}, and Mn^{2+} in a qualitative analysis.	
2.1	**Conductance and Ionic Equilibrium:** Electrical conductance, Specific conductance, equivalent conductance, Molar conductance, Effect of dilution on concentration, Cell constant, Determination of Cell constant, Ostwald's dilution law and its limitations, Acid & Basic buffer actions (Henderson-Hasselbalch equation), Buffer capacity, Numerical Problems.	**[7 L]**
2.2	**Basic Principle of Qualitative Analysis** A. Dry reaction: theory behind borax bead test with equation, Flame test [Theory, structure of non-luminous Bunsen flame] B. Analysis of cation: (a) Application of Common ion effect and Solubility product constant. (b) Complexometric reaction involved in qualitative analysis (c) For identification: Reaction between Cu (II) ion with ammonia, Fe(III) with thiocyanide, NH_4^{+} with Nessler reagent. (d) For masking [Cd^{+2}, Cu^{+2}] (e) Separation of two ion [Ag-Hg, Zn^{+2}, Mn^{+2}].	**[8 L]**

List of Major Textbooks:

1. A textbook of Organic chemistry by Arun Bahl and B. S. Bahl, S. Chand & Company Pvt. Ltd.
2. Organic chemistry Vol. I and Vol. II by I.L. Finar (Longman group).
3. Organic chemistry by R. T. Morrison and Boyd Prentice Hall India.
4. Organic chemistry Vol. I & II by B. K. Sharma, & S. K. Sharma Goel Pub. House, Merut.
5. Concise Inorganic Chemistry by J. D. Lee, 5/E, Oxford University Press, Indian Eds.
6. Basic Inorganic Chemistry by F. A. Cotton and G. Wilkinson, Wiley publication.
7. General and Inorganic Chemistry: Volume I by R. P. Sarkar, New Central Book Agency; 3rd Revised edition (1 July 2011), India.
8. Inorganic Chemistry by Shriver, Atkins and Langford, Pubs: W H Freeman & Co (1994).
9. Svehala G. and Sivasankar I. B, Vogel's Qualitative Inorganic Analysis, Pearson, India, 2012.
10. Vogel's Macro and semimicro qualitative inorganic analysis. First-3d ed. published under title: A text-book of qualitative chemical analysis; 4th ed.
11. Principles of Qualitative Inorganic Analysis: Precipitation, Separation and Identification of Cations; Authors: Huda S. Alhasan, Nadiyah Alahmadi 2021 Bentham Books (USA).
12. A Guidebook to Qualitative Inorganic Analysis by Parag S. Roy, 2021, Pubs: B P International (India).

e-Resources:

Module 1:

1. https://courses.lumenlearning.com/suny-potsdam-organicchemistry/chapter/3-1-nomenclature-of-alkanes-related-structures/
2. https://courses.lumenlearning.com/suny-potsdam-organicchemistry/chapter/3-2-nomenclature-of-unsaturated-hydrocarbons/
3. https://courses.lumenlearning.com/suny-potsdam-organicchemistry/chapter/1-3-representing-structures/
4. https://courses.lumenlearning.com/suny-potsdam-organicchemistry/chapter/1-7-3d-structure/
5. https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/chapt5.htm

Module 2:

1. https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/116
2. https://sathee.prutor.ai/ncert-books/jee-ncert-solutions/jee-chemistry/ionic-equilibrium/
3. https://egyankosh.ac.in/bitstream/123456789/68235/3/Block-2.pdf
4. https://courses.lumenlearning.com/suny-albany-chemistry/chapter/chemical-equilibria/
5. https://courses.lumenlearning.com/chemistryformajors/chapter/electrolytes/

Mapping of CLOs and PSOs:

Course Learning Outcomes	Programme Specific Outcomes								
	1	2	3	4	5	6	7	8	9
1.	√	√							
2.	√	√							
3.	√	√				√			
4.	√	√				√			
5.	√	√	√						
6.	√	√	√		√				
7.	√	√	√		√				

SEMESTER II

Multidisciplinary Course - II

COURSE NAME: General Chemistry II

COURSE CODE: CHEMDC-S2P1-4CR24 **[CREDITS - 04]**

Course learning outcome

At the end of this course, Students will be able to

1. Define the fundamental principles of radioactivity and discuss types of nuclear radiations, their properties, and types of radioactive decay.
2. Explain the concepts of disintegration series, rate of radioactive decay, and expressions like decay constant, half-life, and average life and solve problems based on them.
3. Define and describe the nuclear reactions, nuclear equations, and their applications in artificial radioactivity and nuclear isomerism.
4. Define and explain key concepts in environmental science and chemistry, including pollution types, pollutants, and their sources.
5. Discuss case studies of major environmental disasters and describe their causes, effects, and lessons for pollution prevention and management.
6. Define and classify Fertilizers, describe Fertilizer Production and its environmental impact.
7. Define and classify glass, describe manufacturing, properties and uses of glasses.
8. Describe and write the industrial production methods of organic compounds using fermentation techniques.
9. Describe and write synthesis, composition and uses of non-ferrous alloys.

Learning Objective

Learning Objective

- To study the characteristics and behaviours of radioactive materials, including types of radiation and their properties.
- To learn and apply principles of nuclear reactions and decay to solve problems related to half-life, average life, and radioactive dating.
- To understand the fundamental concepts of environmental science and chemistry, including pollution types, pollutants, and prevention methods.
- To study knowledge of environmental issues analyse case studies and propose solutions using green chemistry principles.
- To learn fertilizers based on their source (natural vs. synthetic) and their effect (direct

vs. indirect), while identifying key elements involved in their composition.

- To study glasses and understand manufacturing, properties and uses of glasses
- To understand the processes involved in fermentation and production of industrial products
- To learn and classify different types of non-ferrous alloys such as Monel metal, Duralumin, and Brass, based on their composition and applications.

Module 1	**Nuclear Chemistry**:	**[15 L]**

Learning Objective:

- To study the characteristics and behaviours of radioactive materials, including types of radiation and their properties.
- To learn and apply principles of nuclear reactions and decay to solve problems related to half-life, average life, and radioactive dating.

Learning Outcomes:

At the end of this module the learner will be able to

1. Define the fundamental principles of radioactivity and discuss types of nuclear radiations, their properties, and types of radioactive decay.
2. Explain the concepts of disintegration series, rate of radioactive decay, and expressions like decay constant, half-life, and average life and solve problems based on them.
3. Define and describe the nuclear reactions, nuclear equations, and their applications in artificial radioactivity and nuclear isomerism.

1.1	**Nuclear Chemistry**: Radioactivity, Types of Nuclear Radiations (α, β, γ-rays), Properties of Nuclear Radiations, Types of Radioactive Decay, The Group Displacement Law, Disintegration Series (Introduction of The Uranium Series, The Thorium Series, The Actinium Series), Rate of Radioactive Decay and expression of Decay Constant, Half-life & Calculation Half-life, Average life, Radioactive equilibrium, Radioactive Dating, Nuclear Reactions, Comparison of Chemical and Nuclear reactions, Nuclear Fission Reactions, Nuclear Fusion Reactions, Nuclear Isomerism, Problems based on half-life, Average life and carbon dating.	

Module 2	**Introduction to Environmental Chemistry**	**[15 L]**

Learning Objective:

- To understand the fundamental concepts of environmental science and chemistry,

including pollution types, pollutants, and prevention methods.

- To study knowledge of environmental issues analyse case studies and propose solutions using green chemistry principles.

Learning Outcomes:

At the end of this module the learner will be able to

1. Define and explain key concepts in environmental science and chemistry, including pollution types, pollutants, and their sources.
2. Discuss case studies of major environmental disasters and describe their causes, effects, and lessons for pollution prevention and management.

2.1	**Introduction to Environmental chemistry**: Introduction, Definition of Environmental science and Environmental chemistry, Environmental pollution, types of Environmental pollution, types of pollutants, Air pollution: Introduction, Sources, Monitoring, Air Quality Standards, Types of air pollutants, Classification, Economics of Air pollution, Acid rain, Depletion of Ozone layer, The Greenhouse Effect Photochemical smog, Water pollution: Introduction, Classification of Water pollutants, general aspects of Prevention and Control of Water pollution, Water softening, Water Treatments Systems, Soil pollution and agricultural pollution. Green chemistry approach. **Case Study**: The Bhopal Gas Disaster, Minamata Disaster, Chernobyl Disaster etc.	

Module 3	**Fertilizers & Glasses**	**[15 L]**

Learning Objective:

- To learn fertilizers based on their source (natural vs. synthetic) and their effect (direct vs. indirect), while identifying key elements involved in their composition.
- To study glasses and understand manufacturing, properties and uses of glasses

Learning Outcomes:

At the end of this module the learner will be able to

1. Define and classify Fertilizers, describe Fertilizer Production and its environmental impact.
2. Define and classify glass, describe manufacturing, properties and uses of glasses.

3.1	**[A] Fertilizers:** Definition and classification of fertilizers, Direct and indirect fertilizers, natural and synthetic fertilizer, Symptoms of deficiency	**[10L]**

	of some elements like N, P and K, Industrial preparation of: (a) Urea from natural gas (b) Single and triple super phosphate of lime (c) Ammonium sulphate Hazardous effect of used of Fertilizers and its preventive measures, mixed fertilizers, complex Fertilizers, Fertilizer grade, Fertilizer ratio, Fertilizer conditioner, Fertilizer filler.	
3.2	**[B] Glasses:** Classification, manufacture, properties and uses of glasses.	**[5L]**
Module 4	**Fermentation Industry & Non-Ferrous alloys**	**[15 L]**

Learning Objective:

- To understand the processes involved in fermentation and production of industrial products
- To learn and classify different types of non-ferrous alloys such as Monel metal, Duralumin, and Brass, based on their composition and applications.

Learning Outcomes:

At the end of this module the learner will be able to

1. Describe and write the industrial production methods of organic compounds using fermentation techniques.
2. Describe and write synthesis, composition and uses of non-ferrous alloys.

4.1	**(A) Fermentation Industry:** Manufacturing of Industrial alcohol, Absolute alcohol, beers, wines and liquors, Butyl alcohols and acetone, vinegar and acetic acid, Citric acid, Lactic acid, mono sodium glutamate, lysine, Dihydroxy acetone.	**[10L]**
4.2	**(B) Non-Ferrous alloys:** Monel metal, Duralumin, Wood metal, Babit metal, Phosphorous bronze, Brass, German silver.	**[05L]**

List of Major Textbooks:

1. Friendlander G, Kennedy G and Miller J. M. Nuclear and Radiochemistry, Wiley, Interscience
2. Harvey, B. G. Introduction to Nuclear Physics & Chemistry, Prentice – Hall,
3. Overman R. T, Basic concept of Nuclear Chemistry, Chapman & Hall.
4. A. N. Nesmeyanov, Radiochemistry, MIR Publication, Moscow.
5. Spinks J. W. T. and Woods R. J. An Introduction to Radiation Chemistry, Wiley
6. Arnikar H. J., Essentials of Nuclear Chemistry, Wiley Eastern, Second Edition.

7. Essential of Physical chemistry, Arun Bahl, B. S. Bahl, G.D. Tuli, S. Chand publication
8. De. A.K. Environmental Chemistry, Wiley Eastern Ltd, 1990.
9. Miller T.G. Jr., Environmental Science, Wadsworth publishing House, Meerut Odum.E.P.1971.
10. Odum, E.P. (1971) Fundamentals of Ecology. Third Edition, W.B. Saunders Co., Philadelphia
11. S. E. Manahan, Environmental chemistry, 1993, Boca Raton, Lewis publisher
12. Environmental Chemistry, Sharma and Kaur, 2016, Krishna publishers
13. Environmental Pollution, Monitoring and control, S.M. Khopker, 2007, New Age International.
14. Environmental chemistry, C. Baird, M. Cann, 5th Edn, 2012, W. H. Freeman publication.
15. G. S. Sodhi Fundamental Concepts of Environmental Chemistry (3rd Edition) Narosa (2009).
16. Principles of Instrumental analysis: D. A. Skoog, Fifth Edition, Sauns College Publishing (London)
17. Basic concepts of analytical chemistry: S. M. Khopkar, Wiley Eastern (1995)
18. Environmental Chemistry, Ajaykumar Bhagi & G. R. Chatwal, Himalaya Publishing House
19. "Introduction to Agricultural Chemistry" by D. W. Martin and R. C. Gupta
20. "Fertilizer Technology" by B. N. Vaidya and M. S. V. Prasad
21. "Fermentation and Biochemical Engineering Handbook" by Henry C. Vogel and C. L. Todaro
22. "Introduction to Non-Ferrous Alloys" by C. H. A. Peters
23. "Industrial Chemistry" by B. K. Sharma

e-Resources:

1. **Swayam Prabha:** https://www.youtube.com/watch?v=gzeo1dmKvuw
2. NPTEL :: Chemistry and Biochemistry - NOC:Nuclear and Radiochemistry
3. Microsoft Word - CHE_P4_M29_etext.docx
4. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/environmental_chemistry/15.soil_pollution__fertilizers_and_pesticides/et/4782_et_et.pdf
5. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/forensic_science/07._criminalistics_and_forensic_physics/16._physical_properties_of_glass_and_glass_fractures/lm/6274_lm_6274_lm_lm.pdf
6. **Swayam:** https://archive.nptel.ac.in/courses/102/105/102105058/
7. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000014ER/P000284/M025601/ET/1513594624Paper15EMB_Module21__etext.pdf
8. https://archive.nptel.ac.in/courses/113/105/113105021/
9. https://courseware.cutm.ac.in/wp-content/uploads/2020/06/Non-ferrous-alloys-converted.pdf
10. https://youtu.be/F9SXMW16Stw?si=4_W89gfdZciHWIQ7
11. https://youtu.be/bWxPpK7t5lE?si=M-dsCmEWtTsAf-u9

Mapping of COs and POs

Course Learning Outcomes	Programme Specific Outcomes								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1.	√								
2.	√		√			√			
3.	√								
4.	√								
5.	√								
6.	√								
7.	√								
8.	√								
9.	√	√							

SEMESTER II

COURSE NAME: Chemistry Practical – III & Chemistry Practical –IV

COURSE CODE: CHEMJ-S2PR3-1CR24 & CHEMJ-S2PR4-1CR24 **[CREDITS – 1+1]**

Course learning outcome		
At the end of this course, Students will be able to 1. Demonstrate practical knowledge of qualitative analysis of organic substance. 2. Perform various analytical methods of volumetric analysis especially acid-base and redox titration.		
Learning Objective: • To equip students with the knowledge of organic substances and it's spotting. • To make students understand the methods of volumetric exercises and quantitative approach.		
A	**Organic Qualitative Analysis (Chemistry Practical – III) (CHEMJ-S2PR3-1CR24)**	
	Acid: Benzoic acid, Phthalic acid and Succinic acid **Phenol:** α-Naphthol, β-Naphthol, Resorcinol **Base:** Aniline, p-toluidine **Neutral:** **Ketone:** Acetone, Acetophenone **Ester:** Methyl acetate, Methyl salicylate **Carbohydrate:** Glucose, Fructose **Hydrocarbon:** Naphthalene, Toluene, p-Xylene **Halogenated Hydrocarbon:** Carbon tetrachloride, Chloro benzene **Nitro compound:** Nitro benzene, m-dinitro benzene **Amide:** Urea **Anilide:** Acetanilide	
B	**Volumetric exercise (Chemistry Practical – IV) (CHEMJ-S2PR4-1CR24)**	
	HNO_3 NaOH $H_2C_2O_4 \cdot 2H_2O$ H_2SO_4 $NaHCO_3$ HNO_3 $KMnO_4$ $H_2C_2O_4 \cdot 2H_2O$ KOH $KMnO_4$ $FeSO_4 \cdot 7H_2O$ $K_2Cr_2O_7$ $K_2Cr_2O_7$ $FeSO_4(NH_4)_2SO_4 \cdot 6H_2O$ $KMnO_4$	

	$H_2C_2O_4 \cdot 2H_2O$ $KMnO_4$	$KMnO_4$ $H_2C_2O_4 \cdot 2H_2O$	$FeSO_4 \cdot 7H_2O$ NaOH	

List of Major Textbooks:

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).

Mapping of CLOs and PSOs:

Course Learning Outcomes	Programme Specific Outcomes								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1.	√	√		√	√		√	√	
2.	√	√		√			√	√	

SEMESTER II

COURSE NAME: Chemistry Practical Minor - II

COURSE CODE: CHEMN-S2PR2-2CR24 **[CREDITS - 02]**

Course learning outcome		
At the end of this course, Students will be able to 1. Demonstrate practical knowledge of qualitative analysis of inorganic salts. 2. Perform standardization and various preparation of standard solutions.		
Learning Objective: • To equip students with the knowledge of inorganic qualitative approach of salts. • To make students understand the methods of preparation of standard solutions and quantitative approach.		
A	**Inorganic Qualitative Analysis**	
	CHLORIDES: Cu^{+2}, Fe^{+3}, Mn^{+2}, Co^{+2}, Ni^{+2}, Ba^{+2}, Sr^{+2}, Na^{+}, K^{+}, NH_4^{+} **BROMIDES** : Sr^{+2}, Na^{+}, K^{+}, NH_4^{+} **IODIDE** : K^{+} **NITRATE** : Pb^{+2}, Co^{+2}, Ni^{+2}, Ba^{+2}, Sr^{+2}, Na^{+}, K^{+}, NH_4^{+} **SULPHIDE** : Zn^{+2}, Sb^{+3} **SULPHATE** : Cu^{+2}, Al^{+3}, Fe^{+2}, Zn^{+2}, Mn^{+2}, Co^{+2}, Ni^{+2}, Mg^{+2}, Na^{+}, K^{+}, NH_4^{+} **CARBONATE**: Cu^{+2}, Mn^{+2}, Co^{+2}, Ni^{+2}, Zn^{+2}, Ca^{+2}, Ba^{+2}, Sr^{+2}, Mg^{+2}, Na^{+}, K^{+}, NH_4^{+} **PHOSPHATE**: Cu^{+2}, Al^{+3}, Fe^{+3}, Zn^{+2}, Mn^{+2}, Ba^{+2}, Sr^{+2}, Mg^{+2}, Na^{+}, K^{+}, NH_4^{+} **OXIDE** : As^{+3}, Sb^{+3}, Zn^{+2} **CHROMATE**: Na^{+}, K^{+}	
B	**Preparation of standard solution (by students) of following**	
	1. 0.1N succinic acid against NaOH 2. 0.1N KHP against NaOH/KOH 3. 0.01N $Na_2S_2O_3$ against I_2 solution 4. 0.1N $H_2C_2O_4 2H_2O$ against $KMnO_4$ solution 5. 0.1N $K_2Cr_2O_7$ against $FeSO_4.7H_2O$ or $FeSO_4,(NH_4)_2SO_4.10H_2O$solution	
List of Major Textbooks:		

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis Sixth Edition, Pearson, 2009.
2. Svehla G. and Sivasankar I. B, Vogel's Qualitative Inorganic Analysis, Pearson, India,2012.

Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1.	√	√		√	√		√	√	
2.	√	√		√			√	√	

SEMESTER II

COURSE NAME: Water Analysis and Paper Chromatography

COURSE CODE: CHESEC-S2P1-2CR24 **[CREDITS - 02]**

Course learning outcome		
At the end of this course, Students will be able to 1. Describe the water analysis methods like pH, acidity and alkalinity. 2. Illustrate the determination of Dissolved oxygen (DO) in water sample using Winkler's (azide modification) method. 3. Determine different parameters involving water sample e.g. temporary, permanent, total hardness and TDS. 4. Identify the amino acid in the given sample by paper chromatography technique.		
Learning Objective ● To impart basic knowledge and make students perform practical of pH, acidity and alkanity of water. ● To make students aware about determination of Dissolved oxygen (DO) in water sample using Winkler's (azide modification) method. ● To make students able to calculate different hardness of water and amount of dissolved solids in water sample. ● To make students able to identify the amino acid in the given sample by paper chromatography technique.		
A	**Water Analysis**	
	1. Determination of pH of water (a) Using pH paper and (b) Using pH meter 2. Acidity of water: determination of acidity or water 3. Alkalinity of water: determination of hydroxide, carbonate and bicarbonate alkalinity of water 4. Determination of permanent hardness of water sample. 5. Determination of temporary hardness of water sample. 6. Determination of total dissolved solid (TDS) of water sample. **7.** Determination of Dissolved oxygen (DO) in water sample using Winkler's (Azide modification) method	
B	**Paper Chromatography**	

	To identify the amino acid in the given sample by paper chromatography technique. Amino acids: Alanine, Leucine, Glycine, Aspartic acid, Histidine, Methionine, Tyrosine, Valine	

List of Major Textbooks:

1. Vogel's Textbook of Quantitative Inorganic Analysis by G. Svehia and B. Sivasankar.
2. Practical Chemistry by Dr O. P. Pandey, D. N. Bajpai, Dr. S. Giri.
3. Advance inorganic analysis by Agarwal, Keemti lall.
4. Inorganic practical by Chatwal and Anand; Himalaya Publishing House, New Delhi.

Mapping of CLOs and PSOs:

Course Learning Outcomes	Programme Specific Outcomes								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1.	√	√			√	√	√	√	
2.	√	√			√	√	√	√	
3.	√	√			√	√	√	√	