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 IV

Program: B. Sc.

Course: Chemistry

Academic year

2025-26

(NEP-2020)

(To be effective from June, 2025)

SEMESTER IV

Major Course - VIII

COURSE NAME: Chemistry Paper - VIII

COURSE CODE: CHEMJ-S4P8-2CR25 [CREDITS - 02]

Course learning outcome
At the end of this course, Students will be able to 1. Define Lanthanides and Actinides; describe the significance of Lanthanide contraction and its implications in chemical behaviour and properties. 2. Explain the extraction processes of Lanthanides and Actinides using solvent extraction and ion exchange techniques. 3. Define Hydrogen bonds; understand the theory, classification, and importance of hydrogen bonding in various chemical contexts. 4. Demonstrate the influence of H-bonds on different physical and chemical properties across various fields of science and industry. 5. Define ion-exchange chromatography; Understand and comprehend the principles, synthesis, and characteristics of ion exchangers, including their basic requirements and types and its application in separating different ions. 6. Define paper chromatography; Understand the concept of R_f value and its significance in chromatography 7. Differentiate between various types of paper chromatography, such as one-dimensional, two-dimensional, and radial chromatography.
Module 1 | Basics of Chemistry III | [15 L]
Learning Objective ● To familiarize the student with an overview of the electronic configurations, sources, and occurrences of Lanthanide and Actinide elements and the theory of hydrogen bonding, including its classification and significance in chemical interactions.
1. Define Lanthanides and Actinides; describe the significance of Lanthanide contraction and its implications in chemical behaviour and properties. 2. Explain the extraction processes of Lanthanides and Actinides using solvent extraction and ion exchange techniques. 3. Define Hydrogen bonds; understand the theory, classification, and importance of

hydrogen bonding in various chemical contexts. 4. Demonstrate the influence of H-bonds on different physical and chemical properties across various fields of science and industry.		
1.1	**Chemistry of Lanthanide and Actinide Elements:** (a) Lanthanide and Actinide Elements, Electronic configuration, Sources. Occurrence, Extraction by solvent and ion exchange, Properties (Spectral and Magnetic). (b) Lanthanide contraction, Use of Lanthanide compounds. Industrial use Uranium and Plutonium, Mitch metal.	**[10 L]**
1.2	**Hydrogen Bonding:** Theory of hydrogen bonding, classification, importance of hydrogen bonding in ice, Effect of hydrogen bonding in various fields.	**[5 L]**
Module 2	**Chromatography**	**[15 L]**
Learning Objective ● To acquaint the students with the principles of ion-exchange chromatography, including the synthesis, characteristics, and types of ion-exchange resins, and to provide comprehensive understanding of the principles of chromatography and its classification based on mobile and stationary phases.		
Learning Outcomes: At the end of this module the learner will be able to 1. Define ion-exchange chromatography; Understand and comprehend the principles, synthesis, and characteristics of ion exchangers, including their basic requirements and types and its application in separating different ions. 2. Define paper chromatography; Understand the concept of Rf value and its significance in chromatography 3. Differentiate between various types of paper chromatography, such as one-dimensional, two-dimensional, and radial chromatography.		
2.1	**Ion-exchange chromatography:** Synthesis and Characteristics of ion exchanger, Basic requirements of ion exchange resin. Types of ion-exchange resin. Technique of ion exchange, Application of ion exchange for Separation.	**[7 L]**
2.2	**Paper chromatography:**	**[8 L]**

	Principles of chromatography, Classification of chromatography according to mobile phase and stationary phase. Types of paper chromatography, one dimensional, two dimensional and radial paper chromatography, R_f value, Use of paper chromatography in inorganic analysis (I, IIA, IIIB, IV, and halides).	

List of Major Textbooks:

1. Concise Inorganic Chemistry by J. D. Lee, 5/E, Oxford University Press, Indian Edition.
2. Basic Inorganic Chemistry by F. A. Cotton and G. Wilkinson, Wiley publication.
3. Inorganic Chemistry by Shriver & Atkins, 4/E, Oxford University Press, Indian Edition.
4. General and Inorganic Chemistry: Volume I by R. P. Sarkar, New Central Book Agency; 3rd Revised edition (1 July 2011), India.
5. Inorganic Chemistry: Principles of Structure and Reactivity by J. E. Huheey, E.A. Keiter, R.L. Keiter, Pearson; 4th edition (1997).
6. Inorganic Chemistry by Shriver, Atkins and Langford, Pubs: W H Freeman & Co (Sd) (1994).

e-Resources:

1. **https://archive.org/details/isbn_0408705965_7**
2. **https://tech.chemistrydocs.com/Books/General%20Chemistry/Lanthanide-and-Actinide-Chemistry-Simon-Cotton-Lanthanide-and-Actinide-Chemistry-by-Simon-Cotton.pdf**
3. **https://esarthi.lpcps.org.in/uploads/Notes/12/57/368/Unit%20III/Lanthenides_and_Actinides.pdf**
4. **Swayam Prabha: http://www.youtube.com/watch?v=q37BcEyJoHE ; http://www.youtube.com/watch?v=yDVDZisfqIs**
5. **Swayam Prabha: http://www.youtube.com/watch?v=OY3vJVKNu1I ; http://www.youtube.com/watch?v=0ESq5matPtg**
6. **Swayam Prabha: https://youtu.be/IgU2tcUiDVc?si=7r9kf2uzfYD0_pr7 ; https://youtu.be/cnYBNQOMpKk?si=PErj30Wf69TwiFb_**
7. **https://courses.lumenlearning.com/umes-cheminter/chapter/hydrogen-bonding/**
8. **https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000014ER/P000271/M026988/ET/1516344604paper16_module_32_etext.pdf**

9. https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Supplemental_Modules_(Analytical_Chemistry)/Instrumentation_and_Analysis/Chromatography/V._Chromatography/E._Paper_Chromatography

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 IV

Major Course - IX

COURSE NAME: Chemistry Paper - IX

COURSE CODE: CHEMJ-S4P9-2CR25 [CREDITS – 02**]**

Course learning outcome		
At the end of this course, Students will be able to 1. Write mechanisms and application of organic name reactions. 2. Solve the reaction using name reactions 3. Identify compounds that contain reactive methylene group. 4. Recognize the characteristic reaction of compounds with a reactive methylene group. 5. Define and explain the structure, properties and classification of organic nitrogen and sulfur compounds. 6. Identify the common methods of preparation and reactions of organic nitrogen and sulfur compounds. 7. Apply sulfur compound's reactions in drug intermediates.		
Module 1	**Organic Name reactions and Compounds containing reactive methylene groups**	**[15L]**
Learning Objective: ● To understand the importance and application of organic name reactions in organic synthesis. ● To define and explain the concept of a reactive methylene group.		
Learning Outcomes: At the end of this module the learner will be able to: 1. Write mechanisms and application of organic name reactions. 2. Solve the reaction using name reactions. 3. Identify compounds that contain reactive methylene group. 4. Recognize the characteristic reaction of compounds with a reactive methylene group.		
1.1	**Organic Name Reactions** General nature, reaction mechanism and application of the following reactions:	**[7 L]**

	1. Michael reaction 2. Wolf-Kishner reaction 3. Witting reaction 4. Mannich reaction 5. Benzoin condensation reaction 6. Aldol condensation reaction 7. Claisen condensation reaction	
1.2	**Compounds containing reactive methylene group** (a) Malonic ester: preparation from acetic acid and its synthetic applications (Preparation of n-butyric acid, n-valeric acid, succinic acid, adipic acid, Crotonic acid, Cinnamic acid and Barbichuric acid (b) Acetoacetic ester (ethyl acetoacetate) preparation and synthetic applications (Preparation of Propionic acid, n-butyric acid, succinic acid, adipic acid, Antipyrine) (c) Keto-enol tautomerism: factors affecting Keto-enol tautomerism and its mechanism	**[8L]**
Module 2	**Organic Nitrogen and Sulfur compounds**	**[15L]**
Learning Objective 1. To study general method of preparation, properties and classification of organic nitrogen and sulfur compounds.		
Learning Outcomes: At the end of this module the learner will be able to 1. Define and explain the structure, properties and classification of organic nitrogen and sulfur compounds. 2. Identify the common methods of preparation and reactions of organic nitrogen and sulfur compounds. 3. Apply sulfur compound's reactions in drug intermediates.		
2.1	**Organic Nitrogen compounds** (a) Preparation, physical properties and chemical reactions of nitriles, isonitriles, carbomates, semicarbazides and their application in synthetic organic chemistry.	**[9 L]**

	(b) Structure & nomenclature of amines, preparation of alkyl and aryl amines, physical properties and chemical reactions. Gabriel-phthalimide reaction, Hoffmann Bromamide reaction.	
2.2	**Organic Sulfur compounds** (a) Aliphatic sulfur compounds: nomenclature, general methods of preparation of mercaptans, thioethers, sulfinic and sulfonic acid (b) Aromatic sulfonic acid: nomenclature, preparation, reactions and uses of sulfonic acids of benzene, toluene.	**[6 L]**

List of Major Textbooks:

1. Reaction Mechanism and Reagents in Organic Chemistry by C. R. Chatwal, Himalaya Publishing House.
2. Organic Reactions and their Mechanisms by P. S. Kalsi, New Age international Publisher.
3. Organic Chemistry Reactions and Regents by O. P. Agrawal, Krishna Prakashan Media (P) Ltd.
4. A textbook of Organic chemistry by Arun Bahl and B. S. Bahl, S. Chand & Company Pvt. Ltd.
5. Organic chemistry Vol. I and Vol. II by I.L. Finar (Longman group).
6. Textbook of Organic chemistry by P. L. Soni and H. M. Chawla, S. Chand & Company Pvt. Ltd.
7. Organic chemistry by R. T. Morrison, R. N. Boyd & S. K. Bhattacharjee, Pearson Education India.
8. Organic chemistry Vol. I & Vol. II by B. K. Sharma & S. K. Sharma; Goel Pub. House, Merut.
9. Reaction mechanism in Organic Chemistry by S. M. Mukherji and S. P. Singh, Macmillan Publishers India Ltd.
10. Fundamentals of Organic chemistry by Soloman, John Wiely & Sons.
11. Organic Chemistry by L. G. Wade, J. W. Simek & M. S. Singh, Pearson Education.
12. Organic Chemistry by Bhupendra Mehta & Manju Mehta, PHI Learning Private Limited.

e-Resouces:

1. https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Basic_Principles_of_Org

anic_Chemistry_(Roberts_and_Caserio)/23%3A_Organonitrogen_Compounds_I_-_Amines

2. https://www.britannica.com/science/organosulfur-compound

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 IV

Major Course - X

COURSE NAME: Chemistry Paper - X

COURSE CODE: CHEMJ-S4P10-4CR25 [CREDITS - 04**]**

Course learning outcome
At the end of this course, Students will be able to 1. Explain Nernst's distribution law and its validity, solvent extraction processes, catalysis and types of catalysis. Classify between adsorption-absorption and sorption, Derive Langmuir and Freundlich adsorption isotherm equation. Calculate and solve numerical problems based on these theories. 2. Define and derive Gibb's free energy and Helmholtz free energy, Gibb's Helmholtz equation, Claypeyron and Clapeyron-Clausius equation. Explain Van't Hoff isotherm equation and Van't Hoff isochor equation. Illustrate molal elevation and molal depression constant. Calculate numerical based on below thermodynamic terms. 3. Describe and explain conductance and types of conductometric titrations. Derive relation of hydrolysis constant, concentration and pH for salts of strong acid- base and weak acid – base, Illustrate theories of acid base indicators and choice of indicators and its useful range. Calculate and solve numerical problems based on these theories. 4. Explain complexometric titration, stability constants. Define metallochromic indicators. Illustrate types of EDTA titrations and explain masking, demasking and kinetic masking. Construct titration curve for titration of Fe^{+2} with Ce^{+4}, Describe redox indicators and theory of redox indicators. Explain formal potential and calculate problems of redox titrations. Calculate and solve numerical problems based on these theories.
Module 1 | Physical Chemistry II | [15 L]
Learning Objective: ● To understand Nernst's distribution law, their complications and limitations. To understand solvent extraction process and problems based on it. ● To understand the difference between adsorption-absorption; physisorption-chemisorption, define the different adsorption isotherms and their derivation, catalyst and types of catalysts.
Learning Outcomes: At the end of this module the learner will be able to

1. Explain Nernst's distribution law and its validity, solvent extraction processes, catalysis and types of catalysis. 2. Classify between adsorption-absorption and sorption. 3. Derive Langmuir and Freundlich adsorption isotherm equation. 4. Calculate and solve numerical problems based on these theories.		
1.1	**Partition co-efficient:** Explanation of Nernst distribution law and its conditions for the validity. Complications arising in distribution law: (a) Association of solute in one of the phases. (b) Dissociation of solute in one the phases. (c) Dissociation of solute in both the phases. Derivation of distribution law from kinetic consideration explanation of solvent extraction process. Numerical Problems.	**[5 L]**
1.2	**Adsorption** Adsorption and Absorption, Heat of adsorption, Characteristics of adsorption, Physical adsorption and Chemical Adsorption. Distinction between physical adsorption and chemical adsorption. Freundlich's adsorption isotherm, Langmuir's adsorption isotherm. Catalysis, General features of catalysis. Heterogeneous catalysis, Adsorption theory of catalysis.	**[10 L]**
Module 2	**Thermodynamics**	**[15 L]**
Learning Objective ● To study basic concept of state functions and thermodynamics.		
Learning Outcomes: At the end of this module the learner will be able to 1. Define and derive Gibb's free energy and Helmholtz free energy, Gibb's Helmholtz equation, Clapeyron and Clapeyron-Clausius equation. 2. Explain Van't Hoff isotherm equation and Van't hoff isochor equation. 3. Illustrate molal elevation and molal depression constant. 4. Calculate numerical based on below thermodynamic terms.		
2.1	**Thermodynamics:** Free energy or work function [Gibbs free energy (G) and Helmholtz free energy (A). Derivation Gibbs Helmholtz equation. Derivation of	

	$G = G^{0}+RTlnP$. Helmholtz equation, Relation of ΔG and equilibrium constant Kp (Vant Hoff isotherm and isochore, Derivation of Clapeyron and Clapeyron-Clausius equation, Application of Clapeyron-Clausius equation in the derivation of Molal elevation constant & Molal depression constant. Numerical problem.	
Module 3	**Conductometric Titration and Ionic Equilibrium**	**[15 L]**
Learning Objective: ● To perceive basics of conductometric titrations and ionic equilibrium.		
Learning Outcomes: At the end of this module the learner will be able to 1. Describe conductance and types of conductometric titrations. 2. Derive relation of hydrolysis constant, concentration and pH for salts of strong acid- base and weak acid – base. 3. Illustrate theories of acid base indicators and choice of indicators and its useful range. 4. Calculate and solve numerical problems based on these theories.		
3.1	**Conductometric Titrations:** Principle, Types of conductometric titrations: (i) Strong acid v/s strong base, (ii) Strong acid v/s weak base, (iii) Weak acid v/s strong base, (iv) Weak acid v/s weak base and (v) Mixture of Strong acid and weak acid v/s strong base Precipitation titration of (i) $BaCl_2$ v/s K_2CrO_4 (ii) NaCl v/s $AgNO_3$ Advantages of conductometric titrations over indicator method.	**[7 L]**
3.2	**Ionic Equilibrium:** Relation between degree of hydrolysis, Hydrolysis constant and pH of solutions of: (i) Salts of weak acid v/s strong base, (ii) Salts of strong acid v/s weak base, and (iii) Salts of weak acid v/s weak base, Theories of acid-base indicators. Ostwald and Quinonoid theories, Choice of indicators, Indicator exponent and useful range of pH of an indicator. Numerical Problems.	**[8 L]**
Module 4	**Titrimetric methods of analysis**	**[15 L]**
Learning Objective: ● To perceive basics of complexometric titration and redox titration.		

Learning Outcomes:

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

1. Explain and define complexometric titration, stability constants, metallochromic indicators.
2. Illustrate types of EDTA titrations and explain masking, demasking and kinetic masking.
3. Construct titration curve for titration of Fe^{+2} with Ce^{+4}.
4. Describe and explain redox indicators and theory of redox indicators. formal potential.
5. Calculate and solve numerical problems based on these theories.

4.1	**[A] Complexometric titration:** EDTA titration, Distribution of various species of EDTA as function of pH. Absolute and conditional stability constants. Derivation of factors: α_4 for effect of pH, β_4 for the effect of auxiliary complexing agent. Construction of Titration curves: Theory of metallochromic indicators, Types of EDTA titrations, Masking, De-masking and kinetic masking. Problems. **[B] Redox Titrations:** Formal Potential, Construction of titration curve for titration of Fe^{+2} with Ce^{+4}, Types of redox indicators used in redox titration, Theory of redox indicators, Structural chemistry of indicators (Diphenyl amine, Ferroin), Numericals.	

List of Major Textbooks:

1. Physical chemistry by Gurdeep Raj.
2. Physical chemistry by K. L. Kapoor vol.-I to IV [Pub. Macmilan]
3. Advanced Physical chemistry by D. N. Bajpai.
4. Text book of Physical chemistry by S.C. Khetepal & Yogeshwar Sharma. [Pub. R. Chand]
5. Physical chemistry by Puri & Sharma [S. Nagin & Co.]
6. A text book of Physical chemistry by A. S. Negi & Anand [New age International]
7. Physical chemistry by P. L. Soni & O. P. Dharmraj.
8. Physical chemistry by B. K. Sharma.
9. Essential of Physical chemistry by Bahl Tuli & Bahl.

10. Elemental Physical chemistry by Glasston & Lewis.
11. Physical chemistry by K. K. Sharma, L. K. Sharma [Vikas Publication House, New Delhi.]
12. Instrumental Methods of Chemical Analysis by H. Kaur, Pragati Prakashan
13. Instrumental methods of analysis by B.K. Sharma
14. College analytical chemistry, Mangaonkar, Teckchandani, Sathe, Ghalsasi, Jain, Himalaya Publishing House.
15. Quantitative analysis by R.A. Day & A. L. Underwood, 6th ed. Pub. Prentice Hall of India ltd.
16. Vogel's text book inorganic qualitative analysis, 6th ed.

e-Resources:

1. **Adsorption Science and Technology: Fundamentals and Applications - Course (Adsorption)**
2. **11.-Distribution-Law-1.pdf (Partition theory)**
3. **Distribution_law.pdf (Partition theory)**
4. **Applied Thermodynamics - Course (Thermodynamics)**
5. **https://youtu.be/rHMZ1Dpk5Fc (Conductometric and Ionic Equilibrium)**
6. **Lesson-12.pmd (Conductometric and Ionic Equilibrium)**
7. **Microsoft Word - Unit 11 for CRC[1] 29310 corrected.doc (Complexometric and Redox titration)**
8. **Complexometric_Titration.pdf (Complexometric and Redox titration)**

Mapping of CLOs and PSOs:

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

SEMESTER IV
Minor Course - III

COURSE NAME: Chemistry Minor Paper - III

COURSE CODE: CHEMN-S4P3-2CR25 [CREDITS - 02**]**

Course learning outcome		
At the end of this course, Students 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. Describe and write the industrial production methods of organic compounds using fermentation techniques. 4. Describe and write synthesis, composition and uses of non-ferrous alloys.		
	Learning Objective	
Learning Objective ● To define and classify fertilizers based on their source (natural vs. synthetic) and their effect (direct vs. indirect), while identifying key elements involved in their composition. ● To define and classify Glasses and non-ferrous alloys, understand properties and uses of glasses & non-ferrous alloys		
Module 1	**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 properties and uses of glasses.		
1.1	**[A] Fertilizers:** Definition and classification of fertilizers, Direct and indirect fertilizers, natural and synthetic fertilizer, Symptoms of deficiency 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.	
1.2	**[B] Glasses:** Classification, manufacturing, properties, and uses of glasses	**[5L]**
Module 2	**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.

2.1	**(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]**
2.2	**(B) Non-Ferrous alloys:** Monel metal, Duralumin, Wood metal, Babit metal, Phosphorous bronze, Brass, German silver.	**[05L]**

List of Major Textbooks:

1. "Introduction to Agricultural Chemistry" by D. W. Martin and R. C. Gupta
2. "Fertilizer Technology" by B. N. Vaidya and M. S. V. Prasad
3. "Fermentation and Biochemical Engineering Handbook" by Henry C. Vogel and C. L. Todaro
4. "Introduction to Non-Ferrous Alloys" by C. H. A. Peters
5. "Industrial Chemistry" by B. K. Sharma

e-Resources:

1. **Swayam Prabha:** https://www.youtube.com/watch?v=gzeo1dmKvuw
2. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/environmental_chemistry/15.soil_pollution__fertilizers_and_pesticides/et/4782_et_et.pdf
3. 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
4. **Swayam:** https://archive.nptel.ac.in/courses/102/105/102105058/
5. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000014ER/P000284/M025601/ET/1513594624Paper15EMB_Module21__etext.pdf
6. https://archive.nptel.ac.in/courses/113/105/113105021/
7. https://courseware.cutm.ac.in/wp-content/uploads/2020/06/Non-ferrous-alloys-converted.pdf
8. https://youtu.be/F9SXMW16Stw?si=4_W89gfdZciHWIQ7
9. 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.	√	√							

SEMESTER IV

COURSE NAME: Chemistry Practical – VII & Chemistry Practical – VIII

COURSE CODE: CHEMJ-S4PR7-2CR25 & **CHEMJ-S4PR8-2CR25 [**CREDITS - 02 + 02**]**

Course Learning Objective
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.
Course Learning Outcome
Course learning outcome: 1. Interpret the solubility and reactivity of inorganic compounds in various solvents. Apply knowledge of chemical reactions to determine the presence of specific ions in mixtures, ensuring accurate qualitative analysis. 2. Synthesize organic compounds such as anthraquinone, m-dinitrobenzene, p-bromo acetanilide and naphthalene picrate etc. using standard laboratory procedures.

	INORGANIC QUALITATIVE ANALYSIS and ORGANIC PREPARATION (Chemistry Practical – VII) (CHEMJ-S4PR7-2CR25)	
	A. List of inorganic chemicals used for Inorganic Qualitative Analysis: CHLORIDES: Cu^{+2}, Cd^{+2}, Fe^{+3}, Mn^{+2}, Co^{+2}, Ni^{+2}, Ca^{+2}, Ba^{+2}, Sr^{+2}, Na^{+}, K^{+}, NH_4^{+} BROMIDES: Sr^{+2}, Na^{+}, K^{+}, NH_4^{+} IODIDES: K^{+} NITRITES: Na^{+}, K^{+} NITRATES: Pb^{+2}, Co^{+2}, Ni^{+2}, Ba^{+2}, Sr^{+2}, Na^{+}, K^{+}, NH_4^{+} SULPHITES: Na^{+} SULPHIDE: Zn^{+2}, Sb^{+3} SULPHATES: Cu^{+2}, Cd^{+2}, Fe^{+2}, Al^{+3}, Mn^{+2}, Co^{+2}, Ni^{+2}, Zn^{+2}, Mg^{+2}, Na^{+}, K^{+}, NH_4^{+} CARBONATES: Cu^{+2}, Zn^{+2}, Mn^{+2}, Co^{+2}, Ni^{+2}, Ca^{+2}, Ba^{+2}, Sr^{+2}, Mg^{+2}, Na^{+}, K^{+}, NH_4^{+} PHOSPHATES: Cu^{+2}, Al^{+3}, Fe^{+3}, Zn^{+2}, Mn^{+2}, Ni^{+2}, Ca^{+2}, Ba^{+2}, Sr^{+2}, Mg^{+2}, Na^{+}, K^{+}, NH_4^{+}	

(NOTE: Inorganic qualitative analysis of mixture containing four radicals. The mixture may be soluble in water or dilute hydrochloric acid or concentrated hydrochloric acid excluding Arsenite, Arsenate, Chromates and Borate.)

B. Organic Preparation:

1. Anthraquinone from Anthracene
2. p-Bromo acetanilide from Acetanilide
3. Naphthalene picrate from Naphthalene
4. m-Dinitrobenzene from Benzene

N.B. Preparation should be submitted with sample and justification (M.P. & C.T.)

ORGANIC ESTIMATION & PHYSICAL EXERCISE
(Chemistry Practical – VIII) (CHEMJ-S4PR8-2CR25)

A. Organic Estimations

1. To determine the amount of acetamide in the given solution hydrolysis by NaOH.
2. To determine the amount of phenol in the given solution by bromination.
3. To determine Aniline in the given solution by bromination.
4. To determine the number of -COOH group of given carboxylic acid.
5. Percentage purity of l-ascorbic acid (Vitamin-C)
6. Percentage purity of Glycine.

B. Physical Exercise

1. **pH metry:** To determine the normality of given mix acid in HAc + HCl pH-metrically using strong base.

2. **Conductometric Titration:** To determine the normality of given mixture (HAc + HCl) solution by conductometric titration with the given 0.1N NaOH solution.

3. **Heat of solution:** To determine the heat of solution of organic acid (benzoic acid, phthalic acid) by finding the solubility of the acid at two different temperature.

4. **Surface Tension:** To determine the parachor of $–CH_2$ group of liquid: (Benzene, Toluene, Xylene)

5. **Adsorption:** To study the adsorption of given organic acid (Acetic

	acid/oxalic acid) on animal charcoal. 6. **Relative strength:** To study the relative strength of two acids H_2SO_4 and HCl. 7. **pH metry** -Determination of Ka of weak acid: To determination of ionization constant of weak acid	

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).
3. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis Sixth Edition, Pearson, 2009.
4. Svehala 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 IV

COURSE NAME: Chemistry Practical Minor – III

COURSE CODE: CHEMN-S4PR3-2CR25 [CREDITS - 02**]**

Course learning outcome		
At the end of this course, Students will be able to 1. Identify and classify organic compounds such as acids, phenols, bases, aldehydes, ketones, esters, alcohols, hydrocarbons, nitro hydrocarbons, halogenated hydrocarbons, amides and anilides through systematic spotting techniques. 2. Quantitatively determine the concentration of acetamide, phenol, aniline, and carboxylic acids in given solutions using appropriate chemical reactions		
Learning Objective: ● To equip students with the knowledge of organic qualitative approach of compounds and organic estimations.		
	ORGANIC SPOTTING and ORGANIC ESTIMATIONS	
	A. Organic Spotting ACID: Salicylic acid, Cinnamic acid, Phenylacetic acid, Sulphanilic acid. PHENOL: α-Naphthol, β-Naphthol, o-Nitrophenol BASE: o-Nitro aniline, m-Nitro aniline, p-Nitro aniline, p-Toluidine, p-Chloroaniline, Diphenyl amine, Dimethylaniline, Diethylaniline NEUTRAL: ALDEHYDE: Glucose, KETONE: Methylethyl ketone, Acetophenone ESTER: Ethylacetate, Butylacetate ALCOHOL: Ethanol, Butanol HYDROCARBON: Anthracene, Naphthalene, Diphenyl NITRO HYDROCARBON: m-Dinitrobenzene, Nitrobenzene HALOGENATED HYDROCARBON: Chlorobenzene, Bromobenzene, p-Dichlorobenzene AMIDE: Benzamide, Thiourea ANILIDE: Acetanilide	

	B. Organic Estimations 1. To determine the amount of acetamide in the given solution hydrolysis by NaOH. 2. To determine the amount of phenol in the given solution by bromination. 3. To determine Aniline in the given solution by bromination. 4. To determine the number of -COOH group of given carboxylic acid. 5. Percentage purity of l-ascorbic acid (Vitamin-C) 6. Percentage purity of Glycine.	

List of Major Textbooks:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis Sixth Edition, Pearson, 2009.
2. Svehala 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 IV

COURSE NAME: Organic preparation

COURSE CODE: CHESEC-S4P1-2CR25 [CREDITS – 2**]**

Course learning outcome		
At the end of this course, Students will be able to 1. Demonstrate Proficiency in Performing Organic Preparation		
Learning Objective: ● To equip students with the knowledge of Performing Organic Preparation.		
	ORGANIC PREAPARATION	
	Organic Preparation: 1. To prepare 5-Nitro Salicylic Acid from Salicylic Acid. 2. To prepare Phthalamide from Phthalic anhydride. 3. To prepare p-Nitroacetanilide from acetanilide. 4. To prepare Picrate derivative of Naphthalene. 5. To prepare Phthalic anhydride from Phthalic acid. 6. To prepare Iodoform from Acetone. 7. To prepare m-Nitroaniline from m-dinitrobenzene. 8. To prepare Aniline from Nitrobenzene. 9. To prepare 1-Phenyl-Azo-2-Naphthol from Aniline. 10. To prepare benzoic acid from benzamide. 11. To prepare oxalate derivative from dimethyl aniline. 12. To perform based catalyzed Aldol condensation using LiOH H_2O as catalyst. 13. To prepare Salicylic acid by Nitration (Green route). 14. To prepare Acetanilide from Aniline and Acetic acid using Zn dust. (Green route)	
List of Major Textbooks: 1. Vogel's Practical Organic Chemistry by A. I. Vogel. 2. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, V. K. Ahluwalia, R. Aggarwal. 3. Practical Organic Chemistry: A Student Handbook of Techniques by J. R. Mohrig, D.		

F. Heathcock, and D. G. Mackean.

4. Organic Chemistry Laboratory Notebook by Hayden-McNeil.
5. Experimental Organic Chemistry: A Miniscale and Microscale Approach by John C. Gilbert and Stephen F. Martin.
6. Advanced Practical Organic Chemistry by Dorothy M. Conlon and Kevin O. Smi.

Mapping of CLOs and PSOs

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

SEMESTER IV

Indian Knowledge System (IKS)

COURSE NAME: Chemical Science in Ancient India-II

COURSE CODE: CHEIKS-S4P1-2CR25 [CREDITS – 2**]**

Course Learning Outcome		
After the successful completion of the course, the learner will be able to 1. Explain the *Panchamahabhuta* theory and relate it to the structure and behavior of organic compounds in modern chemistry. 2. Discuss future directions and interdisciplinary applications of Vedic chemical knowledge in pharmaceuticals, green chemistry, and sustainable development and evaluate Ayurvedic formulations and principles. 3. Explain Vedic and Upanishadic views of matter, cosmogenesis, and their philosophical frameworks like Samkhya-Yoga and classify ancient Indian chemical substances, processes, and tools (Yantras) in historical context 4. Describe traditional chemical arts such as dyeing, metallurgy, and fermentation with scientific reasoning and other best practices.		
Module 1	**PANCHMAHABHUTA AND ORGANIC COMPOUNDS**	**[15L]**
Learning Objectives: This module is intended • To introduce the foundational Vedic concept of *Panchamahabhuta* (Five Great Elements) and its correlation with modern chemical principles, especially organic compounds. • To explore Ayurvedic chemical knowledge through the lens of modern organic chemistry and validate ancient principles through scientific understanding and applications.		
Learning Outcome: After the successful completion of the module, the learner will be able to • Explain the Panchamahabhuta theory and relate it to the structure and behavior of organic compounds in modern chemistry. • Discuss future directions and interdisciplinary applications of Vedic chemical knowledge in pharmaceuticals, green chemistry, and sustainable development and evaluate Ayurvedic formulations and principles.		
1.1	• Introduction of Panchmahabhuta and organic compounds • Introduction to Ayurveda & Organic Chemistry.	

	• Chemical composition of Ayurvedic herbs. • Scientific validation of Ayurvedic Principles. • Applications & Future directions.	
Module 2	**INTRODUCTION TO VEDIC CHEMISTRY AND CHEMICAL TECHNOLOGY**	**[15L]**
Learning Objectives: This module is intended to • To introduce students to foundational Vedic chemical thought, including cosmogenesis, elemental classification, and ancient chemical substance taxonomy. • To provide insights into traditional Indian chemical technologies such as alchemy, laboratory apparatus (Yantras), and chemical practices related to metals, dyes, and fermentation.		
Learning Outcome: After the successful completion of the module, the learner will be able to 1. Explain Vedic and Upanishadic views of matter, cosmogenesis, and their philosophical frameworks like Samkhya-Yoga and classify ancient Indian chemical substances, processes, and tools (Yantras) in historical context 2. Describe traditional chemical arts such as dyeing, metallurgy, and fermentation with scientific reasoning and other best practices.		
2.1	**Introduction to Vedic Chemistry**: • Classification of Rasayana, • Alchemical Ideas in the Vedas, • Origin and Properties of Matter: Cosmogenesis, Samkhya-Patanjala Yoga View of Cosmic Evolution, Cosmic Evolution View in Upanishads, • Elemental nature of Matter, • Classification of Chemical Substances **Introduction to Ancient Chemical Technology:** • Yantras: Definition, Types of Yantra (Dola Yantra, Damaru Yantra, Sthali Yantra, Swedana Yantra, Patana Yantra, Urdhwapatana Yantra etc.) • Some Traditional Chemical Practices in India • Chemical Arts and Crafts: Dyes, Mordants and Pigments,	

	Fermentation Technology • Chemistry in Minerals and Metals • Purification Processes in Ayurveda	

REFERENCE BOOKS:

1. A History of Hindu Chemistry from the Earliest Times to the Middle of the Sixteenth Century A.D. by Prof. P. C. Ray, (1902) published by The Bengal Chemical and Pharmaceutical Works.
2. History of Science and Technology in Ancient India: Volume II – Metal Technology by Debiprasad Chattopadhyaya (1986) published by Firma KLM, Calcutta.
3. The Rustless Wonder: A Study of the Iron Pillar at Delhi
4. Introduction to Indian knowledge system concepts and Applications by B. Mahadevan, Vinayak Rajat Bhatt, Nagendra Pavana R. N.
5. "The Ayurvedic Pharmacopoeia of India" - Govt. of India
6. "History of Chemistry in Ancient India" - P.C. Ray
7. "Charaka Samhita"- Maharshi Charaka
8. Ray, P. (1956) History of Chemistry in Ancient and Medieval India, incorporating the History of Hindu Chemistry by Acharya Prafulla Chandra Ray. Calcutta: Indian Chemical Society
9. Purwar, Chhavi. Significant Contribution of Chemistry in Ancient Indian Science and Technology. International Journal of Development Research Vol. 06, Issue, 12, pp.10784-10788, December, 2016
10. Bose, D. M., Sen, S. N., & Subbarayappa, B. V. (1971). A concise history of science in India. New Delhi: Indian National Science Academy. pp. 274
11. Minerals and Their Exploitation in Ancient and Pre-modern India by Prof. A. K. Biswas
12. Chandogya Upanisad (S. Lokeswarananda, Trans.). (1995). Sri Ramakrishna Math.
13. Chattopadhyaya, D. (1982). Studies in the history of science in India (Vol. 1). Editorial Enterprises.
14. Bose, D. M., Sen, S. N., & Subbarayappa, B. V. (1971). A concise history of science in India. New Delhi: Indian National Science Academy. pp. 322-326
15. Bhagwat, V. S. R., Kurkute, B. R., Shinde, B. T., & Tapare, S. K. (2017). CLASSIFICATION OF RASADRAVYAS IN RASASHASTRA. World Journal of Pharmaceutical Research, 6(4), 792–802. https://doi.org/10.20959/wjpr20174-8226
16. G. T., C., Geethesh, R. R., & Angadi, R. (2018). Collocation Of Rasa Dravyas – An Exploration. International Ayurvedic Medical Journal, 6(9), 2102–2108. http://www.iamj.in/posts/images/upload/2102_2108.pdf
17. Danino. Michel, Technology in Ancient India
18. Tiwari, L. (n.d.). History of paper technology in India.
19. Jena, D. (2021). Concept of chemical science in Vedic literature. International Journal of Trend in Scientific Research and Development, 5(4), 43. https://www.ijtsrd.com/papers/ijtsrd41144.pdf
20. Story of Glass in India & the World by Pankaj Goyal
21. Mira Roy. (1997) History of Technology in India, Vol. 1, From Antiquity to c. 1200 A.D.

by A. K. Bag. New Delhi: Indian National Science Academy. (Chapter Fermentation Technology : Page 437)
22. Srinivasan, Sharada and Ranganathan, Srinivasa. (2013) Minerals and Metals Heritage of India. Bangalore:National Institute of Advanced Studies.
23. Joshi, Damodar. (1997) History of Technology in India, Vol. 1, From Antiquity to c. 1200 A.D. by A. K. Bag. New Delhi: Indian National Science Academy. (Chapter Mercurial and Metallic Compunds: Page 256)
24. Charaka Samhita. Ayurveda Dipika Commentary by Chakrapanidutta. Varanasi: Chaukhambha Surbharati Prakashan (2000). (Chikitsa Sthana 7/111 pp 456).
25. Chandrashekhar. J., et. al., Therapeutic Potentials of Minerals in Ancient India : A Review through Charaka Samhita. J Res Edu Indian Med, Jan - Mar 2014; Vol. XX (1): 9-20
26. Maurya, S. K., Seth, A., Laloo, D., Singh, N. K., Singh Gautam, D. N., & Singh, A. K. (2015). Śodhana: An Ayurvedic process for detoxification and modification of therapeutic activities of poisonous medicinal plants. Ancient Science of Life, 34(4), 188.

Mapping of CLOs and PSOs

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