



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 III & IV

Program: B. Sc.

Course: Chemistry

For

Academic year

2025-26

(NEP-2020)

(To be effective from June, 2025)



Board of Studies in Chemistry

Undergraduate and Post graduate

	Name	Designation	Institute/Industry
Head of the Department			
1	Dr. Hemlata D. Desai	Chairperson	Sir P. T. Sarvajanic College of Science
Subject Expert nominated by Vice-Chancellor			
1	Dr. Kishor H. Chikhalia	Professor	Department of Chemistry, V.N.S.G.U, Surat
Representative from Industry/corporate sector/allied area			
1	Dr. Yogen Talia	Technical Director	Veer Pharmachem, Bharuch
Meritorious Alumnus			
1	Mr. Ketan Desai	Proprietor	Primer Dye Chem.
Three experts from other than the parent University			
1	Dr. Shushilkumar Dhanmane	Associate Professor	Fergusson College (Autonomous), Pune
2	Dr. Harichandra Parbat	Professor & Head	Wilson College, (Autonomous), Mumbai
3	Dr. Gajanan H. Rashinkar	Professor	Department of Chemistry, Shivaji University, Kolhapur
Faculty of the specialisation			
1	Dr. Hemlata D. Desai	Associate Professor & Head	Sir P. T. Sarvajanic College of Science
2	Dr. Sandeep A. Joshi	Associate Professor & PG-In-charge	Sir P. T. Sarvajanic College of Science
3	Dr. Ketan C. Desai	Associate Professor	Sir P. T. Sarvajanic College of Science
4	Dr. Hetalkumar B. Gajjar	Associate Professor	Sir P. T. Sarvajanic College of Science
5	Dr. Sambhav P. Vora	Associate Professor	Sir P. T. Sarvajanic College of Science
6	Dr. Mukesh H. Chaudhari	Associate Professor	Sir P. T. Sarvajanic College of Science
7	Dr. Bhavesh M. Patel	Assistant Professor	Sir P. T. Sarvajanic College of Science
8	Dr. Ketan C. Parmar	Assistant Professor	Sir P. T. Sarvajanic College of Science
9	Dr. Nimesh R. Kamdar	Assistant Professor	Sir P. T. Sarvajanic College of Science
10	Dr. Sutapa Mondal Roy	Adhyapak Sahayak	Sir P. T. Sarvajanic College of Science



11	Dr. Ishanki Bhardwaj	Adhyapak Sahayak	Sir P. T. Sarvajanik College of Science
12	Dr. Amitkumar C. Purohit	Adhyapak Sahayak	Sir P. T. Sarvajanik College of Science
13	Dr. Chiragkumar B. Mistry	Adhyapak Sahayak	Sir P. T. Sarvajanik College of Science
14	Dr. Mimanshaben P. Mali	Adhyapak Sahayak	Sir P. T. Sarvajanik College of Science



Acknowledgement

At the outset, I would like to thank our, Principal Dr. Pruthul R. Desai for his guidance and support during the curriculum restructuring process. I am also grateful to all the esteemed members of the Board of Studies, for their constructive suggestions and contributions.

Above all, I am deeply indebted to all the young and vibrant colleagues in the Department of Chemistry for the long and arduous work they have put in during the compiling of the restructured syllabus.

Dr. Hemlata D. Desai

Chairperson

Board of Studies in Chemistry



Graduate Attributes (GA)

After the successful completion of modules in different courses of B.Sc., the learner will be able to:

Disciplinary knowledge and skills: Capable of demonstrating (i) comprehensive knowledge and understanding of major concepts, theoretical principles and experimental findings in chemistry and its different subfields (analytical, inorganic, organic and physical), and other related fields of study, including broader interdisciplinary subfields; (ii) ability to use modern instrumentation for chemical analysis and separation.

Skilled communicator: Ability to transmit complex technical information relating to chemistry in a clear and concise manner in writing and oral skills.

Critical thinker and problem solver: Ability to employ critical thinking and efficient problem solving skills in the four basic areas of chemistry (analytical, inorganic, organic, and physical).

Sense of inquiry: Capability for asking relevant/appropriate questions relating to issues and problems in the field of chemistry, and planning, executing and reporting the results of an experiment or investigation.

Team player/worker: Capable of working effectively in diverse teams in both classroom, laboratory and in industry and field-based situations.

Skilled project manager: Capable of identifying/mobilising appropriate resources required for a project, and manage a project through to completion, while observing responsible and ethical scientific conduct; and safety and chemical hygiene regulations and practices.

Digitally literate: Capable of using computers for chemical simulation and computation and appropriate software for analysis of data, and employing modern library search tools to locate, retrieve, and evaluate chemistry-related information.

Ethical awareness/reasoning: Avoiding unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, and appreciate environmental and sustainability issues.

Lifelong learners: Capable of self-paced and self-directed learning aimed at personal development and for improving knowledge/skill development and reskilling.



Programme Specific Outcomes (PSO)

After the successful completion of modules in different courses of B. Sc. CHEMISTRY, the learner will be able to

PSO1	Define the fundamental concepts in Physical, Inorganic, Organic and Analytical Chemistry
PSO2	Correlate and apply the theoretical chemistry knowledge in explaining practical schemes (examples)
PSO3	Solve numerical problems, mechanisms, analytical interpretation using chemistry concepts and knowledge.
PSO4	Synthesize, separate and characterize compounds using laboratory and instrumental techniques.
PSO5	Analyse chemical species (both organic and inorganic) qualitatively and quantitatively using appropriate analytical techniques.
PSO6	Apply knowledge acquired in different fields of chemistry to develop state of art technologies to improve the quality of life.
PSO7	Develop mathematical skills, analytical skills, and problem solving skills for the applications of chemical principles
PSO8	Develop deep knowledge in some applied areas of chemistry, which helps in employability
PSO9	Develop time management, confidence, and leadership skills to achieve the goals in competitive examinations for higher learning courses in chemistry.



Course Content

Sr. No	Semester	Course Type	Course Code	Course Name
COURSES THEORY & PRACTICAL				
1	III	CC V	CHEMJ-S3P5-2CR25	Chemistry Paper - V
2		CC VI	CHEMJ-S3P6-2CR25	Chemistry Paper - VI
3		CC VII	CHEMJ-S3P7-4CR25	Chemistry Paper - VII
4		MDC	CHEMDC-S3P1-4CR25	Chemistry in Everyday Life
5		CC V PRACTICAL	CHEMJ-S3PR5-2CR25	Chemistry Practical – V
6		CC VI PRACTICAL	CHEMJ-S3PR6-2CR25	Chemistry Practical – VI
7		SEC PRACTICAL	CHESEC-S3P1-2CR25	Food adulteration and type of organic binary mixture
1	IV	CC VIII	CHEMJ-S4P8-2CR25	Chemistry Paper - VIII
2		CC IX	CHEMJ-S4P9-2CR25	Chemistry Paper - IX
3		CC X	CHEMJ-S4P10-4CR25	Chemistry Paper - X
4		MN III	CHEMN-S4P3-2CR25	Chemistry Paper - III
5		CC VIII PRACTICAL	CHEMJ-S4PR8-2CR25	Chemistry Practical – VIII
6		CC IX PRACTICAL	CHEMJ-S4PR9-2CR25	Chemistry Practical – IX
7		MN PRACTICAL	CHEMN-S4PR3-2CR25	Chemistry Practical -III
8		SEC PRACTICAL	CHESEC-S4P1-2CR25	Organic preparation

Credit Framework of S. Y. B. Sc. Chemistry Syllabus

Semester	Major (Core) Courses	Minor (Elective) Courses	Multi/ Interdisciplinary	SEC	Total Credit
3	12	-	4	2	18
4	12	4	-	2	18
Total Credit (Year wise)					36



Distribution of Credit S. Y. B. Sc. Syllabus with effect from the Academic year 2025-26

Sr. No.	Course Name	Course Code	Credits	Hour	Module	Lectures per module (1 Hr)	Examination		
							Internal Marks	External Marks	Total Marks
SEMESTER III									
COURSES THEORY & PRACTICAL									
1	Chemistry Paper - V	CHEMJ-S3P5-2CR25	2	30	2	15	25	25	50
2	Chemistry Paper - VI	CHEMJ-S3P6-2CR25	2	30	2	15	25	25	50
3	Chemistry Paper - VII	CHEMJ-S3P7-4CR25	4	60	4	15	50	50	100
4	Chemistry in Everyday Life	CHEMDC-S3P1-4CR25	4	60	4	15	50	50	100
5	Chemistry Practical – V	CHEMJ-S3PR5-2CR25	2	60	-	-	25	25	50
6	Chemistry Practical – VI	CHEMJ-S3PR6-2CR25	2	60	-	-	25	25	50
7	Food adulteration and type of organic binary mixture	CHESEC-S3P1-2CR25	2	60	-	-	25	25	50
Total Credits			18						

SEMESTER IV									
Major courses THEORY & PRACTICAL									
1	Chemistry Paper - VIII	CHEMJ-S4P8-2CR25	2	30	2	15	25	25	50
2	Chemistry Paper - IX	CHEMJ-S4P9-2CR25	2	30	2	15	25	25	50
3	Chemistry Paper - X	CHEMJ-S4P10-4CR25	4	60	4	15	50	50	100
4	Chemistry Paper - III	CHEMN-S4P3-2CR25	2	30	2	15	25	25	50
5	Chemistry Practical – VIII	CHEMJ-S4PR8-2CR25	2	60	-	-	25	25	50
6	Chemistry Practical – IX	CHEMJ-S4PR9-2CR25	2	60	-	-	25	25	50
7	Chemistry Practical -III	CHEMN-S4PR3-2CR25	2	60	-	-	25	25	50
8	Organic preparation	CHESEC-S4P1-2CR25	2	60	-	-	25	25	50
Total Credits			18						



SEMESTER III

Major Course - V

COURSE NAME: Chemistry Paper - V

COURSE CODE: CHEMJ-S3P5-2CR25 [CREDITS - 02]

Course learning outcome

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

1. Derive and solve the time-independent Schrödinger equation and a particle in a one-dimensional box.
2. Define and derive the key operators including linear, commutator, vector, and Laplacian operators, Eigen value equation, Analyse Hermitian & Hamiltonian operators.
3. Define LS coupling and J-J coupling, Interpret Term Symbols and Microstates, Determine the term symbols for various elements and ions.
4. Describe and analyse the physical and chemical properties of the elements of the first transition series including colour, magnetic, catalytic properties, variable valences etc.
5. Define CFSE and magnetic moment; Understand key concepts including the shape of d-orbitals, crystal field theory (CFT), and the splitting of d-orbitals in different systems.
6. Analyze and calculate CFSE; Analyze the stability of complexes based on their oxidation states.

Module 1 Quantum Chemistry

[15 L]

Learning Objective:

- To familiarize the student with the fundamental concepts of quantum chemistry, role of operators, L-S coupling, J-J coupling, Term symbols.

Learning Outcomes:

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

1. Derive and solve the time-independent Schrödinger equation and a particle in a one-dimensional box.
2. Define and derive the key operators including linear, commutator, vector, and Laplacian operators, Eigen value equation, Analyse Hermitian & Hamiltonian operators.
3. Define LS coupling and J-J coupling, Interpret Term Symbols and Microstates, Determine the term symbols for various elements and ions.

1.1 Quantum Mechanics:

(A) Fundamental equation for the independent Schrodinger equation,

[10 L]



	Wave function and probability function, Well behaved wave function, Particle in one-dimensional box. (B) Operators (definition and derivation). Linear operators, Commutator operators. Vector operators, Laplacian operators, Hamiltonian operators, Hermitian operators. Derivation of Hamiltonian equation, Hamiltonian operators for H atom, H_2^+ , H_2 molecule, He_2^+ and Li atom. Eigen value equation.	
1.2	Electronic configuration of atom; L-S coupling: Introduction, L-S coupling, J-J coupling (introduction), Term symbol, Determination of microstate of P^2 , P^3 system, Term symbol of C, N, O, Ni, Ni^{2+} , Fe, Fe^{2+} , Fe^{3+} , Cr, Cr^{3+} , Co^{2+} , V, V^{3+} , Cl^-	[5 L]
Module 2	Coordination Chemistry	[15 L]
Learning Objective		
<ul style="list-style-type: none"> To study properties of first transition series and coordination chemistry 		
Learning Outcomes:		
At the end of this module the learner will be able to		
<ol style="list-style-type: none"> Describe and analyse the physical and chemical properties of the elements of the first transition series including colour, magnetic, catalytic properties, variable valences etc. Define CFSE and magnetic moment, Understand key concepts including the shape of d-orbitals, crystal field theory (CFT), and the splitting of d-orbitals in different systems. Analyze and calculate CFSE, Analyze the stability of complexes based on their oxidation states. 		
2.1	Chemistry of elements of first transition series Characteristic properties of d-block elements, physical and chemical properties of the elements of the first transition series [density, melting and boiling point, ionization potential, colour, magnetic properties, spin only magnetic moment, catalytic property, chemical properties], variable valency, complexes illustrating relative stability of their oxidation states.	[7 L]
2.2	Coordination chemistry Shape of d-orbitals, CFT – Basic assumption, splitting of d-orbitals in Octahedral, Tetrahedral and Square planer complexes, Distribution of	[8 L]



d^x electrons in Octahedral and Tetrahedral complexes, Calculation of CFSE.

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://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/02.physical_chemistry-i_/01.introduction_to_quantum_chemistry/et/7419_et_et.pdf
2. <https://archive.nptel.ac.in/courses/104/108/104108057/>
3. <https://courses.lumenlearning.com/suny-albany-chemistry/chapter/development-of-quantum-theory-2/>
4. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/08.physical_spectroscopy/10.zeeman_effect/lm/5578_lm_lm.pdf
5. <https://www.nat.vu.nl/~wimu/LSCoup.html>
6. <http://wwwchem.uwimona.edu.jm/courses/RScoupling.html>
7. Swayam Prabha: <https://www.youtube.com/watch?v=UbDvWARaVOU> ;
<https://www.youtube.com/watch?v=fZ4s7LKj1d4> ;
<https://www.youtube.com/watch?v=JAVODjnYiYs>
8. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/07.inorganic_chemistry-ii/31.magnetic_properties_of_transition_metal_ions/et/6388_et_che_p7_m31_e-text.pdf
9. <https://courses.lumenlearning.com/chemistryformajors/chapter/coordination-chemistry-of-transition-metals-2/>
10. Swayam Prabha: <https://www.youtube.com/embed/Ota8FidPJM> ;



<https://www.youtube.com/embed/K2vufV5rkIs>

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.	√	√		√					



B. Sc. SEMESTER III

Major Course - VI

COURSE NAME: Chemistry Paper - VI

COURSE CODE: CHEMJ-S3P6-2CR25 [CREDITS - 02]

Course learning outcome

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

1. Define heterocyclic compounds and explain their importance in organic chemistry. Identify and classify different types of heterocyclic compounds.
2. Design a of synthesis of condensed heterocyclic compounds.
3. Define elimination reaction and explain general mechanism. Identify the types of elimination reactions and analyze the reaction mechanism of elimination reaction.
4. Identify and explain the difference between elimination and substitution reaction.
5. Define and explain the structure, properties and preparation of diazonium salts. Identify general reaction of diazonium salts.
6. Recognize the importance of diazonium salts in organic synthesis. Apply general reaction condition for coupling and displacement reaction to synthesize dyes.
7. Define and explain the structures, properties and nomenclature of carboxylic acid derivatives.
8. Identify the general method of preparation and reaction of each derivative.

Module 1

Heterocyclic compounds and Elimination reactions

[15L]

Learning Objective:

- To study synthesis and chemical reactions of condensed heterocyclic compounds.
- To define elimination reactions and write its types and mechanism.

Learning Outcomes:

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

1. Define heterocyclic compounds and explain their importance in organic chemistry. Identify and classify different types of heterocyclic compounds.
2. Design a of synthesis of condensed heterocyclic compounds.
3. Define elimination reaction and explain general mechanism. Identify the types of elimination reactions and analyze the reaction mechanism of elimination reaction.
4. Identify and explain the difference between elimination and substitution reaction.



1.1	Heterocyclic compounds (a) Classification and nomenclature of heterocyclic compounds (b) Synthesis, chemical properties and reaction of (1) Benzopyrrole (Indole) (2) Benzofuran (Coumarone) (3) Benzothiophene (Thionaphthene) (4) Quinoline (5) Isoquinoline	[10L]
1.2	Elimination reactions Types of elimination reactions, β -elimination, E2 mechanism, E1 mechanism, elimination and stereo chemistry, elimination Vs substitution reaction. α -elimination, Generation of carbenes and ketenes.	[5L]
Module 2	Diazonium salt and Carboxylic acid derivatives	[15L]
Learning Objectives: <ul style="list-style-type: none">• To define diazonium salts and to predict the products of reaction involving diazonium salts.• To identify different carboxylic acid derivatives and to write method formation and chemical reactions.		
Learning Outcomes: <p>At the end of this module the learner will be able to</p> <ol style="list-style-type: none">1. Define and explain the structure, properties and preparation of diazonium salts. Identify general reaction of diazonium salts.2. Recognize the importance of diazonium salts in organic synthesis. Apply general reaction condition for coupling and displacement reaction to synthesize dyes.3. Define and explain the structures, properties and nomenclature of carboxylic acid derivatives.4. Identify the general method of preparation and reaction of each derivative.		
2.1	Diazonium salts (a) Mechanism of diazotization, reagent for checking completion of diazotization (b) Nomenclature of diazonium salts (c) Reaction of diazonium salts, replacement reaction in which nitrogen is eliminated, reaction in which nitrogen atom are retained, its application in the synthesis of aromatic compounds,	[9 L]



	(d) Laws of coupling, coupling agents, synthesis of diazoamino and aminoazo compounds (e) Synthesis and uses of Methyl orange, Methyl red, Congo red and Eriochrome Black-T	
2.2	Carboxylic acid derivatives Structure & nomenclature of acid chloride, ester, amides and acid anhydrides, method of formation carboxylic acid derivatives and chemical reactions.	[6 L]

List of Major Textbooks:

1. Heterocyclic chemistry by V. K. Ahluwalia, Narosa publishing house.
2. Heterocyclic Chemistry-II- R R Gupta, M Kumar, V Gupta, Springer (India) pvt. ltd.
3. Heterocyclic Chemistry, 4th Edition by J. A. Joule & K. Mills, Published by Chapman & Hall (1995)
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 & 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 India.

e-Resources:

1. https://youtu.be/e-Nkiqr18u0?si=DZjPwqzo_Y40n-ma
2. <https://youtu.be/FgX98uCFTRw?si=hN3cFUb4wQLVLQpk>
3. <https://youtu.be/MxAbAsmRhFU?si=RBDOAC77Qf8joSJ8>



4. [https://www.uou.ac.in/lecturenotes/science/MSCCH-17/CHEMISTRY%20LN.%203%20HETEROCYCLIC%20COMPOUNDS-converted%20\(1\).pdf](https://www.uou.ac.in/lecturenotes/science/MSCCH-17/CHEMISTRY%20LN.%203%20HETEROCYCLIC%20COMPOUNDS-converted%20(1).pdf)
5. <https://archive.nptel.ac.in/content/storage2/courses/104103022/download/module7.pdf>
6. <https://terna.digimat.in/nptel/courses/video/104106131/L27.html>

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.	√	√	√			√		√	



SEMESTER III

Major Course- VII

COURSE NAME: Chemistry Paper - VII

COURSE CODE: CHEMJ-S3P7-4CR25 [CREDITS - 04]

Course learning outcome

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

1. Explain the Arrhenius theory and collision theory of reaction rate. Define photochemical laws, photochemical reactions, quantum yield and efficiency, types of luminescence and calculate and solve numerical problems based on these theories.
2. Define and identify the types of conductance, transport number, moving boundary methods. Explain the migration of ions and Kohlrausch law. Calculate the transport number, degree of dissociation, ionic product and solubility product. Solve numerical problems based on these theories.
3. Define the electromagnetic radiation and their terms. Illustrate energy equation of rotational, vibrational and Raman spectra and problems based on it. Distinguish Stoke, Anti-stokes and Rayleigh line and their relation with each other. Calculate and solve numerical problems based on these theories.
4. Explain the compare chemical and instrumental analysis methods. Define factors affecting and the choice of different analytical methods. Distinguish between determinant and in-determinant errors. Apply statistical treatment to experimental data, data analysis by accuracy and precision. Calculate and solve numerical problems based on these theories.

Module 1 Physical Chemistry I

[15 L]

Learning Objective:

- To familiarize the student with the fundamental concepts of Arrhenius equation, rate of reaction, activation energy and effect of catalyst on activation energy.
- To learn photon, basics of EMR, photochemical laws, photochemical reactions, quantum yield, quantum efficiency, types of luminescence and factors affecting on it, photosensitization process.

Learning Outcomes:

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

1. Explain the Arrhenius theory and collision theory of reaction rate.
2. Define photochemical laws, photochemical reactions, quantum yield and efficiency, and



types of luminescence.		
3. Calculate and solve numerical problems based on these theories.		
1.1	Theories of reaction rate: Derivation of Arrhenius equation. Lindemann's theory, Collision theory of reaction rate, Energy of activation including determination, Effect of catalysis on energy activation. Numerical problems	[5 L]
1.2	Photochemistry: Introduction of photochemistry, Basics of electromagnetic radiations, Photons, Thermal and photochemical laws (a) Grotthuss-Draper's law (b) Lambert Beer's law (c) Einstein's law of photochemical equivalence. Quantum yield or quantum efficiency. Primary and secondary photochemical reactions, Factors affecting quantum yield. (i.e. temperature, light intensity and inert gases). Isomeric changes, Polymerization, Photosensitization, Photo physical process [Fluorescence, Phosphorescence]. Chemiluminescence, Factor affecting fluorescence, phosphorescence. Numerical problems.	[10 L]
Module 2	Electrochemistry	[15 L]
Learning Objective		
<ul style="list-style-type: none">To study basic principle and terms of electrochemistry, determination of degree of dissociation, ionic product, solubility product and problems based on it.		
Learning Outcomes:		
At the end of this module the learner will be able to		
1. Define and identify the types of conductance, transport number, moving boundary methods.		
2. Explain the migration of ions and Kohlrausch law.		
3. Calculate the transport number, degree of dissociation, ionic product and solubility product. Solve numerical problems based on these theories.		
2.1	(A) Ions in solution, formation of ion in solution metallic conductance, Electrolytic conductance, Electrolysis migration of ions, Transport number of ions and its determination by moving boundary method, Numerical problems.	



	(B) Kohlrausch law of ionic conductance. Application of Kohlrausch law to: (a) Determination of degree of dissociation of weak electrolyte. (b) Determination of equivalent conductivity of weak electrolyte at infinite dilution. (c) Determination of solubility and solubility product of sparingly soluble salts. (d) Determination of ionic product of water. Numerical Problems.	
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Module 3	Molecular Spectroscopy	[15 L]
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Learning Objective:

- To perceive basics of electromagnetic radiation, terms of spectroscopy, types of spectra, derivation of energy equation of vibrational rotational spectra.

Learning Outcomes:

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

1. Define the electromagnetic radiation and their terms.
2. Illustrate energy equation of rotational, vibrational and Raman spectra.
3. Distinguish Stoke, Anti-stokes and Rayleigh line and their relation with each other.
4. Calculate and solve numerical problems based on these theories.

3.1	Electromagnetic radiation with wavelength and energy, radio frequency, microwave, IR, UV/visible region, pure rotational spectra, vibrational and vibrational-rotational spectra, Raman spectra. Rotational spectra, calculation of bond-length. Vibrational-rotational spectra, Hook's law, vibrational energy level. Numerical Problems.	
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Module 4	Introduction to Analytical Chemistry & Treatment of Analytical data	[15 L]
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Learning Objective:

- To study basics of different analytical terms, difference, application between classical and instrumental analytical methods. To understand different errors occurring during analysis and their minimization of errors. To calculate errors by different statistical terms and methods to retain or reject the data.

Learning Outcomes:

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

1. Explain and compare chemical and instrumental analysis methods.
2. Define factors affecting and the choice of different analytical methods.



3. Distinguish between determinant and in-determinant errors,
4. Apply statistical treatment to experimental data, data analysis by accuracy and precision, Calculate and solve numerical problems based on these theories.

4.1

[A] Introduction to Analytical Chemistry:

Chemical and Instrumental analysis (advantages and disadvantages), Overview of methods used in Quantitative analysis (Classification of classical and instrumental analysis), Factors affecting the choice of analytical methods (in brief)

[B] Treatment of Analytical Data:

Definition of error, types of errors: determinates errors, indeterminate errors, constant and proportional errors, define and explain the following terms: accuracy and precision, mean, median, deviation, average deviation, standard deviation, variance, coefficient of variation, relative mean deviation, range, absolute errors, and relative errors. Minimization of determinates errors, Rejection of results from a set of results: 2.5 d rule, 4d rule and Q-test. Numerical.

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. <https://youtu.be/lx7WpEOP-G8> (Rate of Reaction)
2. [Photochemistry : Introduction to Basic Theory of Photochemical Process \[Part 1\]](#) (Photochemistry)
3. [Elementary Electrochemistry - Course](#) (Electrochemistry)
4. [Molecular Spectroscopy: A Physical Chemist's perspective - Course](#) (Molecular spectroscopy)
5. [Sr.Secondary : Chemistry \(313\) - Course](#) (Basics of Physical Chemistry)
6. [PPT - STATISTICAL TREATMENT OF ANALYTICAL DATA PowerPoint Presentation - ID:8911648](#) (Treatment of Analytical data)

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 III

Multidisciplinary Course - I

COURSE NAME: Chemistry in Everyday Life

COURSE CODE: CHEMDC-S3P1-4CR24 [CREDITS - 04]

Course learning outcome

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

1. Define nutrients and its types.
2. Define, write examples and importance of energy sources: carbohydrates, lipids, vitamins, proteins, minerals.
3. Define and write types of adulteration present in common food items.
4. Write different methods to identify adulterants present in common food items.
5. Write composition of edible oils and methods to detect purity of oil sample.
6. Define detergents and classify them.
7. Write anionic detergents and cationic detergents in detail.
8. Define dyes, chromophore and auxochromes.
9. Classify dyes based on source, constitution and application.
10. Define drugs and different terms related to drugs.
11. Classify drugs with definition and examples.

Module 1 Nutrients and energy sources [15 L]

Learning Objective:

- To study the definition and types of nutrients.
- To familiarize the student with the fundamental concepts of energy sources: carbohydrates, lipids, vitamins, proteins, minerals.

Learning Outcomes:

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

1. Define nutrients and its types.
2. Define, write examples and importance of energy sources: carbohydrates, lipids, vitamins, proteins, minerals.

1.1	Nutrients- definition, types of nutrients: macronutrient and micronutrient, Energy sources (definition, examples and importance): carbohydrates, lipids, vitamins, proteins, minerals, water.	[15 L]
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Module 2 Adulteration and identification in common food items [15 L]

Learning Objective



- To study different types of adulteration in common food items and methods to detect it.

Learning Outcomes:

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

- Define and write types of adulteration present in common food items.
- Write different methods to identify adulterants present in common food items.

2.1	Define Adulteration, reasons of adulteration, types of adulterants, Methods for detection of different adulterants in some common food items: (1) Milk (2) Milk products: Sweet curd, Rabdi, Khoa & its product, Chhana or Paneer, Ghee, Cottage cheese, condensed milk, Khoa, Ghee, Butter (3) Oil and Fats Oil and Fats, Mustard oil, Edible oil, Coconut oil (4) Sweetening agents: Sugar, Pithi sugar, Honey, Jaggery, Bura sugar (5) Food grain and their product: (Wheat, Rice, Maize, Jowar, Bajra, Chhana and Barley etc.), Maida, Wheat flour, Besan, Suji(Rawa) Dal whole and Spilt, pulses. (6) Spices: Wholes spices, Black Pepper, Cloves, Mustard seed and Powdered spices (7) Turmeric whole and Turmeric powder (8) Chilli powder, Asafoetida (9) Miscellaneous Product: Common salt, Tea, Coffee powder	[15 L]
Module 3	Oils, fats and detergents	[15 L]

Learning Objective:

- To familiarize students with basic concepts of oils and fats.
- To study basic concepts and classification of detergents.

Learning Outcomes:

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

- Write composition of edible oils and methods to detect purity of oil sample.
- Define detergents and classify them.
- Write anionic detergents and cationic detergents in detail.

3.1	Oils and Fats Natural fats, edible and industrial oils of vegetable origin, common	[15 L]
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	<p>fatty acids, glycerides, saponification, saponification value and iodine value of an oil</p> <p>Detergents</p> <p>Introduction, principles of detergency, classification of detergents, bio-soft and bio-hard detergents, Anionic detergents and cationic detergents</p>	
Module 4	Dyes and drugs	[15 L]
<p>Learning Objective:</p> <ul style="list-style-type: none"> To familiarize students with basic concepts of dyes and their classification. To study basic concepts, classification and different terms related to drugs. To study definition and examples of different types of drugs. 		
<p>Learning Outcomes:</p> <p>At the end of this module the learner will be able to</p> <ol style="list-style-type: none"> Define dyes, chromophore and auxochromes. Classify dyes based on source, constitution and application. Define drugs and different terms related to drugs. Classify drugs with definition and examples. 		
4.1	<p>Dyes</p> <p>Definition, chromophore, auxochromes, classification of dyes based on source, constitution and application</p> <p>Drugs</p> <p>Definition of the term drug, drugs obtained from plants, different class of the drugs, explanation of the following terms: Agonist, Antagonist, Receptors, Pharmacophore, Prodrug, Softdrug, CNS depressants, CNS stimulants</p> <p>Classification of drugs on the basis of their therapeutic action.</p>	[15 L]
<p>List of Major Textbooks:</p> <ol style="list-style-type: none"> Chemistry of organic Natural Product Vol. I & II by O. P. Agarwal. B. K. Sharma: Introduction to Industrial Chemistry, Goel Publishing, Meerut (1998). Chemical Analysis of Foods – H. E. Cox and Pearson. Foods: Facts and Principles. N. Shakuntala Manay and S. Swamy, 4th ed. New Age 		



International (1998)

5. Organic Chemistry by I. L. Finar, Vol. 1 & 2.
6. Srilakshmi B. (2017): Nutrition Science, 6th Multicolour Ed. New Age International (P) Ltd.
7. Mann J. and Truswell S. (2017): Essentials of Human Nutrition, 5th Ed. Oxford University Press.
8. Chemistry of drugs by Ener and Caldwell.
9. Synthetic drugs by Tyagi and Yadav.

e-Resources:

Module 1: <https://openoregon.pressbooks.pub/nutritionscience2e/>

Module 2:

https://fssai.gov.in/upload/knowledge_hub/1878035b34b558a3b48DART%20Book.pdf

Module 3:

1. [https://chem.libretexts.org/Courses/Eastern_Mennonite_University/EMU%3A_Chemistry_for_the_Life_Sciences_\(Cessna\)/17%3A_Lipids/17.2%3A_Fats_and_Oils](https://chem.libretexts.org/Courses/Eastern_Mennonite_University/EMU%3A_Chemistry_for_the_Life_Sciences_(Cessna)/17%3A_Lipids/17.2%3A_Fats_and_Oils)
2. https://edscl.in/pluginfile.php/3950/mod_resource/content/1/pdf.pdf

Module 4:

1. <https://dducollegedu.ac.in/Datafiles/cms/ecourse%20content/DYES.pdf>
2. <https://rushim.ru/books/praktikum/fpdc.pdf>
3. https://nios.ac.in/media/documents/SrSec313NEW/313_Chemistry_Eng/313_Chemistry_Eng_Lesson30.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.	√								



SEMESTER III

Major Practical Course – V & VI

COURSE NAME: Chemistry Practical – V & Chemistry Practical – VI

COURSE CODE: CHEMJ-S3PR5-2CR25 & CHEMJ-S3PR6-2CR25 [CREDITS – 2+2]

Learning Objective

- To equip students with the knowledge of gravimetric and volumetric estimation

Course Learning Outcomes

- Apply analytical techniques including gravimetric and volumetric methods to accurately determine the concentration of metals and other compounds in various chemical solutions, demonstrating proficiency in quantitative chemical analysis and laboratory skills.
- Identify and classify a diverse range of organic compounds through qualitative analysis, applying knowledge of functional groups and chemical properties, thereby enhancing proficiency in organic chemistry laboratory techniques and analysis.
- Develop proficiency in experimental techniques such as pH-metry, conductometric titrations, viscosity measurements, chemical kinetics, and partition coefficient determination to analyse physical properties of substances, fostering practical skills

Chemistry Practical -V	Gravimetric Estimation and Volumetric Estimation (CHEMJ-S3PR5-2CR25)	
	<p>Gravimetric Estimation: (Any Four)</p> <p>(1) Fe²⁺ as Fe₂O₃ (Given solution of Fe-NH₄-SO₄ + H₂SO₄)</p> <p>(2) Ba²⁺ as BaSO₄ (Given solution of BaCl₂ 2H₂O + HCl)</p> <p>(3) Ni²⁺ as Ni (DMG)₂ (Given solution of NiCl₂ 6H₂O + HCl)</p> <p>(4) Al³⁺ as Al₂O₃ from Al₂(SO₄)₃</p> <p>(5) Brass Alloy (Cu volumetrically & Zn gravimetrically)</p> <p>Volumetric Estimation: (Any Eight)</p> <p>(1) To determine the amount of Nickel by EDTA.</p> <p>(2) To determine the amount of Copper by EDTA.</p> <p>(3) To determine the amount of Zinc by EDTA.</p> <p>(4) To determine the amount of Calcium by EDTA.</p> <p>(5) To determine the amount of Magnesium by EDTA.</p>	



	(6) To determine the amount of Bismuth by EDTA. (7) Determination of acetic acid content of Vinegar (8) Determination of the alkalinity of Soda ash (9) Determine the amount of Hydrochloric acid present in given solution (10) Determine the amount of Sodium hydroxide present in given solution	
Chemistry Practical -VI	ORGANIC SPOTTING and PHYSICAL EXERCISES (CHEMJ-S3PR6-2CR25)	
	ORGANIC SPOTTING [Minimum 10 organic substances] ACID: Salicylic acid, Cinnamic acid, Phenylacetic acid, Sulphanilic acid. PHENOL: α -Naphthol, β -Naphthol, o-Nitrophenol BASE: o-Nitroaniline, m-Nitroaniline, p-Nitroaniline, p-Chloroaniline, Diphenyl amine, Dimethylaniline, Diethylaniline NEUTRAL: ALDEHYDE: Glucose KETONE: Methyl ethyl ketone, Acetophenone ESTER: Ethylacetate, Butylacetate ALCOHOL: Ethanol, Butanol HYDROCARBON: Anthracene, Naphthalene, Diphenyl NITRO HYDROCARBON: m-Dinitrobenzene, Nitrobenzene HALOGENATED HYDROCARBON: Chlorobenzene, Bromobenzene, p-Dichloro benzene AMIDE: Benzamide, Thiourea ANILIDE: Acetanilide PHYSICAL EXERCISES: (Any Five) (Atleast 2 electrical instrumental exercise should be performed per Semester) 1. pH metry: To determine the normality of weak acid pH-metrically using strong base. [$\text{CH}_3\text{COOH} \rightarrow \text{NaOH}$] 2. Conductometric Titration: To determine the normality of strong acid conductometrically using strong base [$\text{HCl} \rightarrow \text{NaOH}$]	



	<p>3. Conductometric Titration: To determine the solubility of PbSO_4.</p> <p>4. Viscosity: To determine the viscosity of the liquids and the % of unknown mixture 'C'.</p> <p>5. Chemical kinetics- Ester hydrolysis: To study the hydrolysis of methyl acetate at two different concentrations in 0.5N HCl. [mono molecular reaction]</p> <p>6. Partition co-efficient</p>	
<p>List of Major Textbooks:</p> <ol style="list-style-type: none">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.		√		√	√		√		
3.		√		√			√		



SEMESTER III

SEC Practical Course – I

COURSE NAME: Food adulteration and type of organic binary mixture

COURSE CODE: CHESEC-S3P1-2CR25 [CREDITS – 2]

Learning Objective

- To equip students with the knowledge of food adulteration and type of insoluble binary mixture

Course Learning Outcomes

- Analyse experimental results to determine the presence and quantity of adulterants in food samples.
- Interpret data obtained from qualitative tests to make informed decisions regarding the purity and authenticity of food products.
- Analyse the solid insoluble organic binary mixture and determine the type present in it.

A	Food Adulteration	
	1) Identification of adulterants in milk products (Sweet curd, Rabdi, Khoa & its product, Chhana or Paneer, Ghee, Cottage cheese, condensed milk, Khoa, Ghee, Butter) 2) Identification of adulterants in Oil and fats (Mustard oil, Edible oil, Coconut oil) 3) Identification of adulterants in Sweetening agents (Sugar, Pithi sugar, Honey, Jaggery, Bura sugar) 4) Identification of adulterants in Spices (Whole spices, Black Pepper, Cloves, Mustard seed and Powdered spices) 5) Identification of adulterants in Tea and Coffee powder 6) Identification of adulterants in Turmeric and Chilli powder 7) Identification of adulterants in Asafoetida Note: Identification to be performed from each category (Any 7)	
B	Type of water insoluble organic solid binary mixture	
	Type of water insoluble organic solid binary mixture (Minimum 05 Mixtures)	

List of Major Textbooks:

- <http://www.fssi.gov.in/Portals/0/pdf/Final-test-manual-part-II>.



2. Vogel's qualitative Inorganic analysis.
3. Vogel's qualitative Organic analysis.

Mapping of CLOs and PSOs:

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



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, Misch 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		
<ul style="list-style-type: none"> 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 R _f 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: Principles of chromatography, Classification of chromatography	[8 L]



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://e-sarthi.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=vDVDZisfqIs>
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](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.	√	√	√				√		



B. Sc. 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:		
<ul style="list-style-type: none">● 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]



	<ol style="list-style-type: none">1. Michael reaction2. Wolf-Kishner reaction3. Wittig reaction4. Mannich reaction5. Benzoin condensation reaction6. Aldol condensation reaction7. Claisen condensation reaction	
1.2	Compounds containing reactive methylene group <p>(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)</p> <p>(b) Acetoacetic ester (ethyl acetoacetate) preparation and synthetic applications (Preparation of Propionic acid, n-butyric acid, succinic acid, adipic acid, Antipyrine)</p> <p>(c) Keto-enol tautomerism: factors affecting Keto-enol tautomerism and its mechanism</p>	[8L]
Module 2	Organic Nitrogen and Sulfur compounds	[15L]
Learning Objective <ol style="list-style-type: none">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 <ol style="list-style-type: none">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 <p>(a) Preparation, physical properties and chemical reactions of nitriles, isonitriles, carbomates, semicarbazides and their application in synthetic organic chemistry.</p>	[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 Solomon, John Wiley & 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 Orga](https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Basic_Principles_of_Orga)



nic Chemistry (Roberts and Caserio)/23%3A Organonitrogen Compounds I -
Amines

2. <https://www.britannica.com/science/organosulfur-compound>
- 3.

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.		
<ol style="list-style-type: none"> Classify between adsorption-absorption and sorption. Derive Langmuir and Freundlich adsorption isotherm equation. Calculate and solve numerical problems based on these theories. 		
1.1	<p>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.</p>	[5 L]
1.2	<p>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.</p>	[10 L]
Module 2	Thermodynamics	[15 L]
Learning Objective		
<ul style="list-style-type: none"> To study basic concept of state functions and thermodynamics. 		
Learning Outcomes:		
At the end of this module the learner will be able to		
<ol style="list-style-type: none"> Define and derive Gibb's free energy and Helmholtz free energy, Gibb's Helmholtz equation, Clapeyron 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. 		
2.1	<p>Thermodynamics: Free energy or work function [Gibbs free energy (G) and Helmholtz free energy (A). Derivation Gibbs Helmholtz equation. Derivation of $G = G^{\circ} + RT \ln P$. Helmholtz equation, Relation of ΔG and equilibrium</p>	



	constant K_p (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:		
<ul style="list-style-type: none"> To perceive basics of conductometric titrations and ionic equilibrium. 		
Learning Outcomes:		
At the end of this module the learner will be able to		
<ol style="list-style-type: none"> Describe 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. 		
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:		
<ul style="list-style-type: none"> 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, Absolute and conditional stability constant, 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. Macmillan]
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 Paper - III

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

Course learning outcome		
At the end of this course, Students will be able to		
<ol style="list-style-type: none"> 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		
<ul style="list-style-type: none"> • 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:		
<ul style="list-style-type: none"> • 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		
<ol style="list-style-type: none"> 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	<p>[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:</p> <p>(a) Urea from natural gas</p>	[10L]



	(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]
<p>Learning Objective:</p> <ul style="list-style-type: none"> 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. 		
<p>Learning Outcomes:</p> <p>At the end of this module the learner will be able to</p> <ol style="list-style-type: none"> Describe and write the industrial production methods of organic compounds using fermentation techniques. 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, Babbit metal, Phosphorous bronze, Brass, German silver.	[05L]
<p>List of Major Textbooks:</p> <ol style="list-style-type: none"> “Introduction to Agricultural Chemistry” by D. W. Martin and R. C. Gupta “Fertilizer Technology” by B. N. Vaidya and M. S. V. Prasad “Fermentation and Biochemical Engineering Handbook” by Henry C. Vogel and C. L. Todaro “Introduction to Non-Ferrous Alloys” by C. H. A. Peters “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_frastructures/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

Major Practical Course – VIII & IX

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

COURSE CODE: CHEMJ-S4PR8-2CR25 & CHEMJ-S4PR9-2CR25 [CREDITS - 02 + 02]

Course Learning Objective

Learning Objective:

- To equip students with the knowledge of organic substances and its 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-bromoacetanilide and naphthalene picrate etc. using standard laboratory procedures.

VIII

INORGANIC QUALITATIVE ANALYSIS and ORGANIC PREPARATION (CHEMJ-S4PR8-2CR25)

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^{+}



	<p>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^{+}</p> <p>(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.)</p> <p>[Minimum 10 should be done]</p> <p>Organic Preparation:</p> <ol style="list-style-type: none">1. Anthraquinone from Anthracene2. p-Bromo acetanilide from Acetanilide3. Naphthalene picrate from Naphthalene4. m-Dinitrobenzene from Benzene <p>N.B. Preparation should be submitted with sample and justification (M.P. & C.T.)</p>	
IX	ORGANIC ESTIMATION & PHYSICAL EXERCISE (CHEMJ-S4PR9-2CR25)	
	<p>ORGANIC ESTIMATIONS (Minimum 5 should be performed)</p> <ol style="list-style-type: none">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. <p>PHYSICAL PRACTICALS (Minimum 5 should be performed)</p> <ol style="list-style-type: none">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.	



<p>4. Surface Tension: To determine the parachor of $-\text{CH}_2$ group of liquid: (Benzene, Toluene, Xylene)</p> <p>5. Adsorption: To study the adsorption of given organic acid (Acetic acid/oxalic acid) on animal charcoal.</p> <p>6. Relative strength: To study the relative strength of two acids H_2SO_4 and HCl.</p> <p>7. pH metry -Determination of K_a of weak acid: To determination of ionization constant of weak acid</p>	
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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

Minor Practical Course - III

COURSE NAME: Chemistry Practical – III

COURSE CODE: CHEMN-S4PR3-2CR24 [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

ORGANIC SPOTTING [Minimum 08 should be performed]

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: Methyl ethyl 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



<p>ORGANIC ESTIMATIONS (Minimum 4 should be performed)</p> <ol style="list-style-type: none">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.	
<p>List of Major Textbooks:</p> <ol style="list-style-type: none">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

SEC Practical Course – I

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 PREPARATION

Organic Preparation: (Minimum 12)

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 base catalyzed Aldol condensation using LiOH H₂O 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.		√		√	√		√		



B. Sc. (CHEMISTRY) SEMESTER III

Core Course – 1

COURSE NAME: Chemical Science in Ancient India-1

COURSE CODE: CHEBSC-S3BKS1-2CR25 [CREDITS - 02]

Course Learning Outcome

After the successful completion of the course, the learner will be able to

1. Demonstrate an understanding of the development of chemistry in ancient India.
2. Identify and describe ancient Indian chemical techniques and their relevance today.
3. Discuss the scientific contributions of Indian chemists and their legacy.
4. Explain the role of ancient Indian metallurgy, dyes, and cosmetics in shaping modern chemistry.
5. Recall and discuss key contributions of Prof. P. C. Ray to Indian chemistry, and list traditional Indian practices in metallurgy, mining, and metal extraction techniques including copper, zinc, iron, and Wootz steel.
6. Explain the significance of ancient Indian metallurgical techniques, including Wootz steel, gold and copper extraction, and relate their impact on modern scientific research and traditional knowledge systems.

Module 1

CHEMISTRY IN ANCIENT INDIA

[15L]

Learning Objectives:

This module is intended

- To understand the fundamental aspects of chemistry as practiced in ancient India.
- To explore the evolution of chemical techniques in Indian history.
- To analyze the contributions of ancient Indian chemists and their impact on modern science.
- To learn about the role of Ayurveda and its chemical formulations.
- To appreciate the significance of metallurgy, dyes, and cosmetics in ancient chemistry.

Learning Outcome:

After the successful completion of the module, the learner will be able to

1. Demonstrate an understanding of the development of chemistry in ancient India.
2. Identify and describe ancient Indian chemical techniques and their relevance today.
3. Discuss the scientific contributions of Indian chemists and their legacy.
4. Explain the role of ancient Indian metallurgy, dyes, and cosmetics in shaping modern



chemistry.

1.1

Chemistry In Ancient India - General Introduction, Alchemy - main objectives, Chemical Techniques In Ancient India, Metallurgy In Ancient India, Chemistry of Dyes In Ancient India, Pigments In Ancient India, Cosmetics In Ancient India, Ayurveda, Charaka Samhita – Structure.

Ancient Indian chemists : Contributions and books:- Maharshi Acharya Kanad, Acharya Nagarjuna, Vagbhatta, Govindacharya, Yashodhar, Ramchandra, Somadeva, Gopalbhatta, Indian chemist of 19th century “Acharya Prafulla Chandra Ray”

Module 2

ANCIENT INDIAN METALLURGY AND CHEMISTRY

[15L]

Learning Objectives:

This module is intended to

Understand the historical contributions of Prof. P. C. Ray and recognize ancient Indian advancements in metallurgy, mining, and metal extraction techniques, including Wootz steel and Ayurvedic copper use, highlighting their relevance to modern science and traditional practices.

Learning Outcome:

After the successful completion of the module, the learner will be able to

1. Recall and discuss key contributions of Prof. P. C. Ray to Indian chemistry, and list traditional Indian practices in metallurgy, mining, and metal extraction techniques including copper, zinc, iron, and Wootz steel.
2. Explain the significance of ancient Indian metallurgical techniques, including Wootz steel, gold and copper extraction, and relate their impact on modern scientific research and traditional knowledge systems.

2.1

Prof. P. C. Ray: A Pioneer in Reviving Ancient Indian Metallurgy and Chemistry

Contribution: Prof. Prafulla Chandra Ray, the "Father of Indian Chemistry," highlighted India's advanced metallurgical practices and linked ancient mining and metalworking techniques showcasing India's scientific achievements and inspiring modern research.

Wootz steel: The rise and fall of a great Indian technology.



	<p>Mining and ore extraction.</p> <p>Metal and metal working technology.</p> <p>Gold extraction process.</p> <p>Zinc production</p> <p>Copper mining and extraction process.</p> <p>Extraction of copper for Ayurvedic purposes.</p> <p>Copper alloys, Mercury, Lead and silver.</p> <p>Iron and steel in India.</p>	
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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

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.	√	√									
6.	√	√									



B. Sc. (CHEMISTRY) SEMESTER IV

Core Course – 1

COURSE NAME: Chemical Science in Ancient India-2

COURSE CODE: CHEBSC-S4BKS2-2CR25 [CREDITS - 02]

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.

	<ul style="list-style-type: none"> • Chemical composition of Ayurvedic herbs. • Scientific validation of Ayurvedic Principles. • Applications & Future directions. 	
Module 2	INTRODUCTION TO VEDIC CHEMISTRY AND CHEMICAL TECHNOLOGY	[15L]
<p>Learning Objectives:</p> <p>This module is intended to</p> <ul style="list-style-type: none"> • 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. 		
<p>Learning Outcome:</p> <p>After the successful completion of the module, the learner will be able to</p> <ol style="list-style-type: none"> 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	<p>Introduction to Vedic Chemistry:</p> <ul style="list-style-type: none"> • 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 <p>Introduction to Ancient Chemical Technology:</p> <ul style="list-style-type: none"> • 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

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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.	√	√	√	√	√	√	√	√		√	√