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 I & II

Program: B. Sc.

Course: Chemistry

For

Academic year

2024-25

(NEP-2020)

(To be effective from June, 2024)

Board of Studies in Chemistry

Undergraduate and Post graduate

	Name	Designation	Institute/Industry
Head of the Department			
1	Dr. Mahendrasinh B. Mahida	Chairman	Sir P. T. Sarvajanik College of Science
Subject Expert nominated by Vice-Chancellor			
1	Dr. Kishor H. Chikhaliya	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.
Two experts from other than the parent University			
1	Dr. Shushilkumar Dhanmane	Associate Professor	Fergusson College (Autonomous), Pune
2	Dr. Harichandra Parbat	Associate Professor & Head	Wilson College, (Autonomous), Mumbai
Faculty of the specialisation			
1	Dr. Mahendrasinh B. Mahida	Associate Professor& Head	Sir P. T. Sarvajanik College of Science
2	Dr. Sandeep A. Joshi	Associate Professor& PG-Incharge	Sir P. T. Sarvajanik College of Science
3	Dr. Hemlata D. Desai	Associate Professor	Sir P. T. Sarvajanik College of Science
4	Dr. Ketan C. Desai	Associate Professor	Sir P. T. Sarvajanik College of Science
5	Dr. Hetalkumar B. Gajjar	Associate Professor	Sir P. T. Sarvajanik College of Science
6	Dr. Sambhav P. Vora	Associate Professor	Sir P. T. Sarvajanik College of Science
7	Dr. Mukesh H. Chaudhari	Associate Professor	Sir P. T. Sarvajanik College of Science
8	Dr. Bhavesh M. Patel	Assistant Professor	Sir P. T. Sarvajanik College of Science
9	Dr. Ketan C. Parmar	Assistant Professor	Sir P. T. Sarvajanik College of Science
10	Dr. Nimesh R. Kamdar	Assistant Professor	Sir P. T. Sarvajanik College of Science
11	Dr. Sutapa Mondal Roy	Adhyapak Sahayak	Sir P. T. Sarvajanik College

			of Science
12	Dr. Ishanki Bhardwaj	Adhyapak Sahayak	Sir P. T. Sarvajanik College of Science
13	Dr. Amitkumar C. Purohit	Adhyapak Sahayak	Sir P. T. Sarvajanik College of Science
14	Dr. Chiragkumar B. Mistry	Adhyapak Sahayak	Sir P. T. Sarvajanik College of Science
15	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. Mahendrasinh B. Mahida

Chairman

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 Title
COURSES THEORY & PRACTICAL				
1	**I**	Major Theory-1	CH-MJ-101	Chemistry Major Paper I
2		Major Theory-2	CH-MJ-102	Chemistry Major Paper II
3		Minor Theory-1	CH-MN-101	Chemistry Minor Paper I
4		MDC Theory-1	CH-MDC-101	General Chemistry I
5		SEC Theory-1	CH-SEC-101	Chemistry Lab operations and Safety Measures
6		IKS -1	IKS-101	IKS-1: Introduction to Indian Knowledge System
7		Major Practical-1	CHP-MJ-101	Chemistry Laboratory – Major
8		Minor Practical-1	CHP-ME-101	Chemistry Laboratory – Minor
9		MDC Practical-1	CHP-MDC-101	Chemistry Laboratory – MDC
10		SEC Practical-1	CHP-SEC-101	Chemistry Laboratory – SEC
1	**II**	Major Theory-1	CH-MJ-201	Chemistry Major Paper I
2		Major Theory-2	CH-MJ-202	Chemistry Major Paper II
3		Minor Theory-1	CH-MN-201	Chemistry Minor Paper I
4		MDC Theory-1	CH-MDC-201	General Chemistry II
5		SEC Theory-1	CH-SEC-201	Water Analysis
6		VAC -1	VAC-201	VAC-201
7		Major Practical-1	CHP-MJ-201	Chemistry Laboratory – Major
8		Minor Practical-1	CHP-ME-201	Chemistry Laboratory – Minor
9		MDC Practical-1	CHP-MDC-201	Chemistry Laboratory – MDC
10		SEC Practical-1	CHP-SEC-201	Chemistry Laboratory – SEC

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

Semester	Major (Core) Courses	Minor (Elective) Courses	Multi/Interdisciplinary	AEC	SEC	VAC/IKS	Total Credit
1	8	4	4	2	2	2	22
2	8	4	4	2	2	2	22
Total Credit (Year wise)							44

Distribution of Credit F. Y. B. Sc. Syllabus with effect from the Academic year 2024-25

Sr. No.	Course Title	Course Code	Credits	Hour	Module	Lectures per module (1 Hr)	Examination		
							Internal Marks	External Marks	Total Marks
SEMESTER I									
COURSES THEORY& PRACTICAL									
1	Chemistry Major Paper I	CH-MJ-101	3	45	3	15	35	35	70
2	Chemistry Major Paper II	CH-MJ-102	3	45	3	15	35	35	70
3	Chemistry Minor Paper I	CH-MN-101	2	30	2	15	25	25	50
4	General Chemistry-I	CH-MDC-101	2	30	2	15	25	25	50
5	Chemistry Lab operations and Safety Measures	CH-SEC-101	1	15	1	15	13	13	26
6	Chemistry Laboratory – Major Paper1 & Paper-2	CHP-MJ-101	1 + 1	60	2	30	30	30	60
7	Chemistry Laboratory – Minor	CHP-ME-101	2	60	-	-	25	25	50
8	Chemistry Laboratory – MDC	CHP-MDC-101	2	60	-	-	25	25	50
9	Chemistry Laboratory – SEC	CHP-SEC-101	1	30	-	-	12	12	24
10	AEC	AEC-I	2	30	2	15	25	25	50
11	IKS-1	IKS-1	2	2	2	15	25	25	50
Total Credits			**22**	**30**	**2**	**15**	**25**	**25**	**50**

SEMESTER II									
Major courses THEORY & PRACTICAL									
1	Chemistry Major Paper I	CH-MJ-201	3	45	3	15	35	35	70
2	Chemistry Major Paper II	CH-MJ-202	3	45	3	15	35	35	70
3	Chemistry Minor Paper I	CH-MN-201	2	30	2	15	25	25	50
4	General Chemistry-II	CH-MDC-201	2	30	2	15	25	25	50
5	Water Analysis	CH-SEC-201	1	15	1	15	13	13	26
6	Chemistry Laboratory – Major Paper1 & Paper-2	CHP-MJ-201	1 + 1	60	2	30	30	30	60
7	Chemistry Laboratory – Minor	CHP-ME-201	2	60	-	-	25	25	50
8	Chemistry Laboratory – MDC	CHP-MDC-201	2	60	-	-	25	25	50
9	Chemistry Laboratory – SEC	CHP-SEC-201	1	30	-	-	12	12	24
10	AEC	AEC-II	2	30	2	15	25	25	50
11	VAC-1	VAC-I	2	2	2	15	25	25	50
Total Credits			**22**	**22**	**30**	**2**	**15**	**25**	**25**

SEMESTER I

Major Course- I

COURSE TITLE: Chemistry Major Paper I

COURSE CODE: CH-MJ-101 **[CREDITS - 03]**

Course learning outcome		
At the end of this course, Students will be able to 1. Calculate changes in vapour pressure, melting point, and boiling point of solutions; calculate the osmotic pressure of solutions; calculate the compressibility factor, viscosity, different collision parameters, solve numerical problems involving gas laws, laws of continuity of states, laws of corresponding states etc. 2. Define and identify the orders of reactions and basic terms of chemical kinetics; identify factors affecting rate of reactions; define kinetics of catalytic reactions. 3. Define basic physical properties, outline the fundamental concepts of atomic structure; calculate quantum numbers and effective nuclear charge; interpret atomic spectrum and depict different orbitals in atoms. 4. Describe the periodic table; state the principal resemblances of elements within each main group of the periodic table; compare the trends in the properties of the elements in the periodic table. 5. Compare and describe theories of chemical bonding; classify the types of hybridization, apply the theories for predicting the geometric structures of molecules; calculate bond order of different molecules.		
Module 1	**Physical Chemistry I**	**[15 L]**
Learning Objective: • To familiarize the student with the fundamental concepts of gaseous phase, kinetics and processes of mathematical calculations.		
Learning Outcomes: At the end of this module the learner will be able to 1. Calculate changes in vapour pressure, melting point, and boiling point of solutions; calculate the osmotic pressure of solutions; calculate the compressibility factor, viscosity, different collision parameters. 2. Solve numerical problems involving gas laws, laws of continuity of states, laws of corresponding states etc.		
1.1	**Chemical Mathematics:** Chemical Mathematics: Scientific notation,	**[4 L]**

	powers and roots, Logarithms, graphical presentation of functions, differential calculus, Integral calculus. Problems.	
1.2	**Gaseous State: [**Recapitulation: Definition, equation and terms involved in Ideal gas law, Boyle's law, Charles law, Gay Lussac's law, Avogadro's law and Dalton's law (No derivation)] Elementary aspects of kinetic theory of gases, Ideal and real gases. Boyle temperature (derivation not required), Molecular velocity, Collision parameters (frequency, diameter, cross section, number and mean free path), Coefficient of viscosity, calculation of σ and η, variation of viscosity with temperature and pressure.	**[5 L]**
1.3	**Behaviour of real gases:** Deviation from ideal gas behaviour. Compressibility factor (Z) and its variation with pressure for different gases. Causes of deviation, van der Waals equation of state (No derivation) and application in explaining real gas behaviour. Critical phenomena - Andrews isotherms of CO_2. Numerical problems.	**[6 L]**
Module 2	**Basics of Chemistry I**	**[15 L]**
Learning Objective • To study basic properties of chemistry e.g. chemical kinetics and atomic structure		
Learning Outcomes: At the end of this module the learner will be able to 1. Define and identify the orders of reactions and basic terms of chemical kinetics; identify factors affecting rate of reactions; define kinetics of catalytic reactions. 2. Define basic physical properties, outline the fundamental concepts of atomic structure; calculate quantum numbers and effective nuclear charge; interpret atomic spectrum and depict different orbitals in atoms.		
2.1	**Chemical Kinetics:** Chemical kinetics and its scope, rate of reaction, factors affecting rate of reaction: temperature, concentration, pressure, solvent, light and catalyst, Molecularity of reaction, Classification of chemical reaction, Order of reaction with illustration (first order, second order, third order, zero order, pseudo first order) reaction, second order (a=b), half-life and mean life. Numerical Problems.	**[7 L]**
2.2	**Atomic Structure:** Rutherford atomic model, Bohr's theory and it's	**[8 L]**

	limitations, atomic spectrum of hydrogen atom, de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Quantum numbers and their significance, Shapes of s, p, d and f orbitals, Aufbau principle, Hund's rule, Pauli exclusion principle, Effective nuclear charge (Slater Rule).	
Module 3	**Inorganic Chemistry I**	**[15 L]**
Learning Objective: • To perceive basics of periodic properties, chemical bonding, VSEPR theory, structure and bonding in complexes		
Learning Outcomes: At the end of this module the learner will be able to 1. Describe the periodic table; state the principal resemblances of elements within each main group of the periodic table; compare the trends in the properties of the elements in the periodic table. 2. Compare and describe theories of chemical bonding; classify the types of hybridization, apply the theories for predicting the geometric structures of molecules; calculate bond order of different molecules.		
3.1	**Periodic properties:** Long form of periodic table, Classification of elements, general properties of period and group elements; variation of orbital energy with atomic number, Discussion of the general properties of the elements along the period and group, Pauling's scale of electronegativity, Diagonal relationship	**[7 L]**
3.2	**Chemical Bonding:** Definition of chemical bonds, Types of bonds – ionic, covalent, coordinate, metallic bonds. Valence Bond Theory, Concept of hybridization. Types of hybridization involving s, p, & d orbitals, VSEPR theory with examples, Basics of MO theory, MO – bonding, non-bonding, anti-bonding, MO diagram of O_2, N_2, CO and NO; Bond order.	**[8 L]**
List of Major Textbooks: 1. Essential of physical chemistry by A.S. Bahl and G.D. Tuli; Pub.: S. Chand 2. Advance physical chemistry by D.N. Bajpai, Pub.: S. Chand. 3. Numerical problems by D.V.S. Jain, Pub.: Mac Graw Hill (Numericals)		

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

Mapping of CLOs and PSOs:

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

SEMESTER I

Major Course - II

COURSE TITLE: Chemistry Major Paper II

COURSE CODE: CH-MJ-102 **[CREDITS - 03]**

Course learning outcome		
At the end of this course, Students will be able to 1. Define and explain the basics of alkanes, cycloalkanes, their chemical & physical properties, reactivity and reaction mechanisms and IUPAC of organic compounds. 2. Explain and classify the stereochemistry of organic molecules – conformation and configuration, asymmetric molecules and nomenclature. 3. Define and explain hybridization and geometry of atoms, 3-D structure of organic molecules, identifying chiral centres. 4. Explain different types of organic reactions with their examples. 5. Illustrate the basics, methods of synthesis and chemical reactions of heterocyclic compounds, aromatic hydrocarbons.		
Module 1	**Alkanes, cycloalkanes & IUPAC nomenclature**	**[15 L]**
Learning Objective: ● To familiarize the student with the fundamental concepts, reactivity and chemical properties of alkanes and cycloalkanes. ● To make students understand and write the IUPAC nomenclature of organic compounds.		
Learning Outcomes: At the end of this module the learner will be able to: 1. Define and write chemical & physical properties of alkanes and cycloalkanes 2. Write reaction mechanisms of alkanes and cycloalkanes 3. Write IUPAC names of organic compounds		
1.1	**Basic concepts of organic chemistry** Classification of Hydrocarbon, structural representation of organic compound, complete, condensed and bond-line structural formula, dipole moment, bond order, bond length, types of functional groups, hybridization. Industrial application of Benzene and Naphthalene.	**[3 L]**

1.2	**Alkanes and cycloalkanes** **(A) Alkanes:** IUPAC nomenclature of branched and unbranched alkanes, Alkyl group, Classification of carbon atoms in alkanes. Isomerism in Alkanes, sources, methods of formation special reference to Wurtz and Wurtz-Fittig reaction Kolbe reaction and Corey-House reaction and decarboxylation of carboxylic acids). Physical properties and chemical reactions of alkanes. Mechanism of free radical halogenations of alkanes: orientation, reactivity &selectivity. **(B) Cycloalkanes:** Nomenclature, methods of formation, chemical reactions, Theory of strainless ring. The case of cyclopropane ring: banana bonds.	**[8 L]**
1.3	**IUPAC Nomenclature of organic compounds** Types of organic compounds, Functional group, Homologous series, IUPAC system for nomenclature, Nomenclature of poly functional compounds.	**[4 L]**
Module 2	**Stereochemistry & Preparation**	**[15 L]**
Learning Objective • To study fundamentals of stereochemistry and few chemical preparations.		
Learning Outcomes: At the end of this module the learner will be able to 1. Define and identify the different types of isomers and their properties. 2. Sketch Flying-Wedge representation, Fisher Projection, sawhorse (perspective) formula, Newman projection. 3. Illustrate Interconversions of Projection and Perspective formula. 4. Summarize Conformations of n-butane, Eclipsed and Staggered form 5. Explain Baeyer's strain theory and its limitations 6. Judge D & L, R & S nomenclature of organic compounds. 7. Identify and write E & Z nomenclature in geometrical isomers. 8. Explain different types of organic reactions with their examples.		
2.1	**Stereochemistry** Isomerism: Optical activity, chiral and achiral molecules, representation of three-dimensional molecules- tetrahedral model, Flying-Wedge	**[10 L]**

	representation, Fisher Projection, sawhorse (perspective) formula, Newman projection, Interconversions of Projection and Perspective formula, Conformations of n-butane, Eclipsed and Staggered form, Baeyer's strain theory and its limitations. Ring strain in small rings (Cyclopropane and cyclobutane), configurational isomerism, Optical isomerism of tartaric acid, enantiomers, diastereomers (Threo & Erythro), meso compounds, resolution of enantiomers, inversion retention and racemization; Geometrical isomerism: Alkene derivative & oximes, E & Z system of nomenclature; Relative and absolute configuration, sequence rules, D & L and R & S system of nomenclature	
2.2	**Types of reactions:** Substitution, Addition, Elimination and Rearrangement with suitable examples.	**[5 L]**
Module 3	**Heterocyclic compounds and hydrocarbons**	**[15 L]**

Learning Objective

- To study fundamentals and chemical reactions of heterocyclic compounds and hydrocarbons.

Learning Outcomes:

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

1. Recall and write structure, synthesis and chemical reactions of few heterocyclic compounds.
2. Recall and write structure, synthesis and chemical reactions of aromatic hydrocarbons. (benzene).
3. Explain Sulfonation, Nitration, Halogenation and Alkylation reaction.
4. Describe activating and deactivating substituent (i/o/m/p effect)

3.1	**Heterocyclic compounds** Nomenclature, aromaticity and synthesis, properties, and resonance structures of Pyridine, Pyrrole, Furan, Thiophene	**[5 L]**
3.2	**Polynuclear hydrocarbon** Classification, aromaticity and synthesis or industrial preparation, properties, uses and resonance structures of Naphthalene, Anthracene and Phenanthrene	**[5 L]**

3.3	**Aromatic hydrocarbons** Method of preparation and chemical reactions of benzene: sulphonation, nitration, halogenation and alkylation, activating and deactivating substituents, orientation, ortho/para ratio, ipso effect.	**[5 L]**

List of Major Textbooks:

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

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.	√	√	√			√		√	

SEMESTER I

Minor Course - I

COURSE TITLE: Chemistry Minor Paper I

COURSE CODE: CH-MN-101 **[CREDITS - 02]**

Course learning outcome		
At the end of this course, Students will be able to 1. Write the classification of organic compounds, their general properties and methods of purification. 2. Write the IUPAC names of simple organic compounds. 3. Describe and differentiate isomerism and its types. 4. Define and identify the orders of reactions and basic terms of chemical kinetics. 5. Identify factors affecting rate of reactions. 6. Define kinetics of catalytic reactions. 7. Describe and compare theories of chemical bonding. 8. Classify the types of hybridization. 9. Apply the theories of chemical bonding for predicting the geometric structures of molecules. 10. Calculate bond order of different molecules.		
Module 1	**Basic Organic Chemistry I**	**[15 L]**
Learning Objective: • To familiarize the student with the fundamental concepts of organic and inorganic chemistry.		
Learning Outcomes: At the end of this module the learner will be able to 1. Write the classification of organic compounds, their general properties and methods of purification. 2. Write the IUPAC names of simple organic compounds. 3. Describe and differentiate isomerism and its types.		
1.1	**Organic Chemistry – Some Basic Principles and Techniques** General introduction, methods of purification, qualitative and quantitative analysis, classification and IUPAC nomenclature of organic compounds.	**[8 L]**

1.2	**Isomerism** Isomerism Types, Structural Isomerism: Chain, Positional, functional, metamerism, Tautomerism, Stereoisomerism, optical isomerism, representation of three-dimensional molecules- tetrahedral model, Flying-Wedge representation, Fisher Projection, sawhorse (perspective) formula, Newman projection, Interconversions of Projection and Perspective formula.	**[7 L]**
Module 2	**General Chemistry I**	**[15 L]**
Learning Objective: • To make the students aware about some study basic properties of inorganic chemistry e.g. chemical kinetics and chemical bonding.		
Learning Outcomes: At the end of this module the learner will be able to 1. Define and identify the orders of reactions and basic terms of chemical kinetics. 2. Identify factors affecting rate of reactions; define kinetics of catalytic reactions. 3. Describe and compare theories of chemical bonding; classify the types of hybridization. 4. Apply the theories of chemical bonding for predicting the geometric structures of molecules. 5. Calculate bond order of different molecules.		
2.2	**Chemical Kinetics:** Chemical kinetics and its scope, rate of reaction, factors affecting rate of reaction: temperature, concentration, pressure, solvent, light and catalyst, Molecularity of reaction, Classification of chemical reaction, Order of reaction with illustration (first order, second order, third order, zero order, pseudo first order) reaction, second order (a = b), half-life and mean life, Numerical Problems.	**[7 L]**
2.1	**Chemical Bonding:** Definition of chemical bonds, Types of bonds – ionic, covalent, coordinate, metallic bonds. Valence Bond Theory, Concept of hybridization. Types of hybridization involving s, p, & d orbitals, VSEPR theory with examples, Basics of MO theory, MO – bonding, non-bonding, anti-bonding, MO diagram of O_2, N_2, CO and NO; Bond order.	**[8 L]**

List of Major Textbooks:

1. A textbook of Organic Chemistry by Arun Bahl and B. S. Bahl, S. Chand & Company Pvt. Ltd.
2. Organic chemistry Vol. I and Vol. II by I.L. Finar (Longman group).
3. Organic chemistry by R. T. Morrison and Boyd Prentice Hall India.
4. Organic chemistry Vol.I and Vol.II by B. K. Sharma, & S. K. Sharma Goel Pub. House, Merut.
5. Concise Inorganic Chemistry by J. D. Lee, 5/E, Oxford University Press, Indian Eds.
6. Basic Inorganic Chemistry by F. A. Cotton and G. Wilkinson, Wiley publication.
7. Inorganic Chemistry by Shriver & Atkins, 4/E, Oxford University Press, Indian Eds.
8. General and Inorganic Chemistry: Volume I by R. P. Sarkar, New Central Book Agency; 3rdRevised edition (1 July 2011), India.
9. Inorganic Chemistry: Principles of Structure and Reactivity by J. E. Huheey, E.A. Keiter, R.L. Keiter, Pearson; 4th edition (1997).
10. Inorganic Chemistry by Shriver, Atkins and Langford, Pubs: W H Freeman & Co (1994).
11. Essence of chemical kinetics by Dr. Harichandra A. Parbat and Dr. Damodar V. Prabhu, Sara Publication, 1st edition, (2022).

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.			√				√		

SEMESTER I
Multidiscipline Course - I

COURSE TITLE: General Chemistry I

COURSE CODE: CH-MDC-101 **[CREDITS - 02]**

Course learning outcome		
At the end of this course, Students will be able to 1. Define basic physical properties, outline the fundamental concepts of atomic structure; calculate quantum numbers and effective nuclear charge; interpret atomic spectrum and depict different orbitals in atoms. 2. Describe the periodic table; state the principal resemblances of elements within each main group of the periodic table; compare the trends in the properties of the elements in the periodic table. 3. Define and calculate different units of concentration of solution. 4. Define the significance of nanoscience and technology, including understanding nanostructures and their properties in various applications. 5. Discuss and analyze challenges and anticipate future prospects in nanotechnology		
Module 1	**Basics of Inorganic Chemistry**	**[15 L]**
Learning Objective • To perceive basics of periodic properties, chemical bonding. • To learn basics of periodic properties		
Learning Outcomes: At the end of this course, Students will be able to 1. Define basic physical properties, outline the fundamental concepts of atomic structure; calculate quantum numbers and effective nuclear charge; interpret atomic spectrum and depict different orbitals in atoms. 2. Describe the periodic table; state the principal resemblances of elements within each main group of the periodic table; compare the trends in the properties of the elements in the periodic table.		
1.1	**Atomic Structure:** Rutherford atomic model, Bohr's theory and it's limitations, atomic spectrum of hydrogen atom, de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Quantum numbers and their significance, Shapes of s, p, d and f orbitals, Aufbau principle, Hund's rule, Pauli exclusion principle, Effective nuclear charge (Slater Rule).	**[8 L]**

1.2	**Periodic properties:** Long form of periodic table, Classification of elements, general properties of period and group elements; variation of orbital energy with atomic number, Discussion of the general properties of the elements along the period and group, Pauling's scale of electronegativity, Diagonal relationship.	**[7 L]**
Module 2	**Chemical calculation and Introduction to Nanoscience**	**[15 L]**
Learning Objective • To learn calculations of different concentration units of solution • To understand the foundational principles of nanoscience and technology, including nanostructures, properties, and classification. • To learn the applications, challenges, and future prospects of nanomaterials, with a focus on innovation and technological advancements.		
Learning Outcomes: At the end of this course, Students will be able to 1. Define and calculate different units of concentration of solution. 2. Define the significance of nanoscience and technology, including understanding nanostructures and their properties in various applications. 3. Discuss and analyse challenges and anticipate future prospects in nanotechnology		
2.1	**Chemical calculation:** Mole concept, Gram atomic weight, Gram molecular weight, Equivalent weight, Methods of expressing concentration of solutions: Molarity, Formality, Normality, Molality, mole fraction, % w/w, % w/v, %v/v, interconversion of units of concentration. Numerical Titrations: calculation of preparation of standard solution, Problems.	**[8 L]**
2.2	**Introduction to Nanoscience and technology**: Definition of Nanoscience and technology, History and scope, Nano-size and properties, Overview of nanostructures and nano-materials, classification, (cluster, colloid, nanoparticles, and nanostructures - Spheroid, Wire, Rod, Tube, and Quantum Dot), Application of nanomaterials, Nature: The best nanotechnologist, Challenges and future prospects.	**[7 L]**

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).
7. C. N. R. Rao, A. Muller, A. K. Cheetam, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Willey-VCH Verlag, Germany, 2005.
8. G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Appications, Imperial College Press, London, 2004
9. R. W. Kelsall, I. W. Hameley, M. Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, England, 2005
10. Charles P. Poole and Frank J Owens, Introduction to nano technology, Wiley Interscience, 2003. 5. Pradeep, T., A text of book of nanoscience and nanotechnology, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012.
11. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis Sixth Edition, Pearson, 2009.
12. 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.	√	√	√			√	√	√	
4.	√	√	√				√	√	
5.	√	√	√			√	√	√	

SEMESTER I

Skill Enhancement Course - I

COURSE TITLE: Chemistry Lab Operations and Safety Measures

COURSE CODE: CH-SEC-101 **[CREDIT - 01]**

Course learning outcome		
At the end of this course, Students will be able to 1. Illustrate the handling of glassware and chemicals. 2. Depict the methods of storage and disposal of chemicals and glassware. 3. Recall and apply the hazardous nature of chemicals. 4. Identify the appropriate chemical and fire safety hazard and its associated risks, depict the various protective equipment, emergency procedure and first aid.		
Learning Objective		
• To equip students with the knowledge of handling of glassware and chemicals. • To make students aware of methods of storage and disposal of chemicals and glassware and their hazardous nature. • To make students aware about safety hazards, safety procedure, and emergency actions.		
Module 1	**Introduction to lab operations**	**[15 L]**
Learning Objective: • To equip students with the knowledge of handling of glassware and chemicals. • To make students aware of methods of storage and disposal of chemicals and glassware and their hazardous nature. • To make students aware about safety hazards, safety procedure, and emergency actions.		
1.1	General guidelines, Handling of glassware, Handling of equipment, Equipment protection, Handling of chemicals, Receipt and labelling of chemicals, Precautions in handling, Chemical spills, Storage and Disposal of chemicals and glassware, Mercury and Biohazardous clean up and disposal procedure.	**[8 L]**
1.2	Safety rules, Hygiene, Knowledge about personal safety, Use of personal equipment, Respiratory protective equipment, Electrical safety, Fire extinguisher, Laboratory injuries and treatment, Accident management.	**[7 L]**

List of Major Textbooks:

1. Hazards in Chemical Laboratory - G. D. Muir.
2. Research Methodology –C. R. Kothari, New Age International Publishers, New Delhi (2004).
3. Manufacture, Storage and Import of Hazardous Chemicals Rules -1989.
4. Laboratory safety for chemistry students – R. H. Hill, D. C. Finster, Wiley (2016).

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 I

Major Course - I

COURSE TITLE: Chemistry Laboratory – Major (Paper1 & Paper-2)

COURSE CODE: CHP-MJ-101(Practical) **[CREDITS - 02]**

Course learning outcome		
At the end of this course, Students will be able to 1. Demonstrate practical knowledge of qualitative analysis of inorganic salts. 2. Perform standardization and various preparation of standard solutions.		
Learning Objective • To equip students with the knowledge of inorganic qualitative approach of salts. • To make students understand the methods of preparation of standard solutions and quantitative approach.		
A	**Inorganic qualitative analysis**	
	CHLORIDES: Cu^{+2}, Fe^{+3}, Mn^{+2}, Co^{+2}, Ni^{+2}, Ba^{+2}, Sr^{+2}, Na^{+}, K^{+}, NH_4^{+} **BROMIDES** : Sr^{+2}, Na^{+}, K^{+}, NH_4^{+} **IODIDE** : K^{+} **NITRATE** : Pb^{+2}, Co^{+2}, Ni^{+2}, Ba^{+2}, Sr^{+2}, Na^{+}, K^{+}, NH_4^{+} **SULPHIDE** : Zn^{+2}, Sb^{+3} **SULPHATE** : Cu^{+2}, Al^{+3}, Fe^{+2}, Zn^{+2}, Mn^{+2}, Co^{+2}, Ni^{+2}, Mg^{+2}, Na^{+}, K^{+}, NH_4^{+} **CARBONATE**: Cu^{+2}, Mn^{+2}, Co^{+2}, Ni^{+2}, Zn^{+2}, Ca^{+2}, Ba^{+2}, Sr^{+2}, Mg^{+2}, Na^{+}, K^{+}, NH_4^{+} **PHOSPHATE**: Cu^{+2}, Al^{+3}, Fe^{+3}, Zn^{+2}, Mn^{+2}, Ba^{+2}, Sr^{+2}, Mg^{+2}, Na^{+}, K^{+}, NH_4^{+} **OXIDE** : As^{+3}, Sb^{+3}, Zn^{+2} **CHROMATE**: Na^{+}, K^{+} **N.B. Candidate should perform the analysis of at least 12 compounds.**	
B	**Preparation of standard solution (by students) of following**	
	1. 0.1N succinic acid against NaOH 2. 0.1N KHP against NaOH/KOH 3. 0.01N $Na_2S_2O_3$ against I_2 solution 4. 0.1N $H_2C_2O_4.2H_2O$ against $KMnO_4$ solution 5. 0.1N $K_2Cr_2O_7$ against $FeSO_4.7H_2O$ or $FeSO_4,(NH_4)_2SO_4.10H_2O$ solution **N.B. Candidate should perform at least 3 standard solution preparation.**	

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 I

Minor Course - I

COURSE TITLE: Chemistry Laboratory – Minor

COURSE CODE: CHP-MN-101(Practical) **[CREDITS - 02]**

Course learning outcome		
At the end of this course, Students will be able to 1. Demonstrate practical knowledge of qualitative analysis of organic substance. 2. Perform various analytical methods of volumetric analysis especially acid-base and redox titration.		
Learning Objective: • To equip students with the knowledge of organic substances and it's spotting. • To make students understand the methods of volumetric exercises and quantitative approach.		
A	**Organic Qualitative Analysis**	
	Acid: Benzoic acid, Phthalic acid and Succinic acid **Phenol:**α-Naphthol, β-Naphthol, Resorcinol **Base:** Aniline, p-toluidine **Neutral:** **Ketone:** Acetone, Acetophenone **Ester:** Methyl acetate, Methyl salicylate **Carbohydrate:** Glucose, Fructose **Hydrocarbon:** Naphthalene **Halogenated Hydrocarbon:** Carbon tetrachloride, Chloro benzene, **Nitro compound:** Nitro benzene, m-dinitro benzene **Amide:** Urea **Anilide:** Acetanilide **N.B. Candidate should perform the analysis of at least 08 compounds**	
B	**Volumetric exercise**	
	HNO_3 NaOH $H_2C_2O_4{\cdot}2H_2O$ H_2SO_4 $NaHCO_3$ HNO_3 $KMnO_4$ $H_2C_2O_4{\cdot}2H_2O$ KOH / NaOH $KMnO_4$ $FeSO_4{\cdot}7H_2O$ $K_2Cr_2O_7$	

	$H_2C_2O_4 \cdot 2H_2O$ $KMnO_4$ $FeSO_4 \cdot 7H_2O$ **N.B. Candidate should perform at least 4 volumetric exercises.**	

List of Major Textbooks:

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

Mapping of CLOs and PSOs:

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

SEMESTER I

Multidisciplinary Course - I

COURSE TITLE: Chemistry Laboratory – Multidisciplinary Course

COURSE CODE: CHP-MDC-101(Practical) **[CREDITS - 02]**

Course learning outcome		
At the end of this course, Students will be able to 1. Demonstrate practical knowledge of qualitative analysis of inorganic salts. 2. Perform standardization and various preparation of standard solutions.		
Learning Objective		
Learning Objective: • To equip students with the knowledge of inorganic qualitative approach of salts. • To make students understand the methods of preparation of standard solutions.		
A	**Inorganic qualitative analysis**	
	CHLORIDES: Cu^{+2}, Fe^{+3}, Mn^{+2}, Co^{+2}, Ni^{+2}, Ba^{+2}, Sr^{+2}, Na^{+}, K^{+}, NH_4^{+} **BROMIDES** : Sr^{+2}, Na^{+}, K^{+}, NH_4^{+} **IODIDE** : K^{+} **NITRATE** : Pb^{+2}, Co^{+2}, Ni^{+2}, Ba^{+2}, Sr^{+2}, Na^{+}, K^{+}, NH_4^{+} **SULPHATE** : Cu^{+2}, Al^{+3}, Fe^{+2}, Zn^{+2}, Mn^{+2}, Co^{+2}, Ni^{+2}, Mg^{+2}, Na^{+}, K^{+}, NH_4^{+} **CARBONATE (only water soluble)**: Cu^{+2}, Mn^{+2}, Co^{+2}, Ni^{+2}, Zn^{+2}, Ca^{+2}, Ba^{+2}, Sr^{+2}, Mg^{+2}, Na^{+}, K^{+}, NH_4^{+} **PHOSPHATE (only water soluble)**: Cu^{+2}, Al^{+3}, Fe^{+3}, Zn^{+2}, Mn^{+2}, Ba^{+2}, Sr^{+2}, Mg^{+2}, Na^{+}, K^{+}, NH_4^{+} **N.B. Candidate should perform the analysis of at least 8 compounds.**	
B	**Preparation of solution (by students) of following**	
	0.1N succinic acid, 0.1N KHP, 0.01N $Na_2S_2O_3$, 0.1N $H_2C_2O_4\,2H_2O$, 0.1N$K_2Cr_2O_7$ **N.B. Candidate should perform at least 3 solution preparation.**	

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 I

Skill Enhancement Course - I

COURSE TITLE: Chemistry Lab Operations and Safety Measures

COURSE CODE: CHP-SEC-101 (Practical)**[CREDIT - 01]**

Course learning outcome		
At the end of this course, Students will be able to 1. Illustrate the handling of glasswares such as burette and pipette and weighing machine. 2. Illustrate the preparation of standard solutions, common soaps and detergent. 3. Demonstrate and handling of fire-extinguisher.		
Learning Objective		
• To equip students with the knowledge of handling of glasswares and chemicals. • To make students understand the methods of preparation of standard solutions, soaps and detergents.		
1.1	1. Demonstration and handling of fire-extinguisher. 2. Calibration and handling of burette and pipette. 3. Handling, precautions and calibration of weighing machine. 4. Storage and disposal of chemicals: demonstration and handling. 5. Preparation technique of standard solutions. 6. Laboratory preparation of standard soap. 7. Laboratory preparation of liquid soap. 8. Laboratory preparation of detergent. (**Minimum 7 Practicals to be performed**)	

List of Major Textbooks:

1. Hazards in Chemical Laboratory - G. D. Muir.
2. Research Methodology –C. R. Kothari, New Age International Publishers, New Delhi (2004).
3. Manufacture, Storage and Import of Hazardous Chemicals Rules -1989.
4. Laboratory safety for chemistry students – R. H. Hill, D. C. Finster, Wiley (2016).

Mapping of CLOs and PSOs:

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