(Autonomous)

SYLLABUS

Bachelor of Science (B.Sc.)

(Three Year Under Graduate Programme)

CHEMISTRY

Syllabus & Examination Scheme (NEP 2020)

I - II Semester 2025-26

(Autonomous)

BACHELOR OF SCIENCE

Chemistry Semester I

EXAMINATION SCHEME

Paper code	Paper Title		Credit	EoSE*	in Hrs.
		Marks		Theory	Practical
BCHE101	Chemical bonding, Chemistry of s - block & p - block elements, , Mathematical concepts, States of matter and Nuclear Chemistry	100	4	3	-
BCHEP 151	Chemistry Lab I	50	2	-	4
Total		150	6		

^{*} EoSE = End of Semester Examination

S. No.	PAPER	EoSE	CIA	TOTAL
1.	Theory	70%	30%	100
2.	Practical	60%	40%	100

Note:

• It will be necessary for a candidate to pass in theory part as well as practical part of a subject separately.

(Autonomous)

B.Sc. Semester I

1 credit- 25 marks 4 credit- 100 marks Question paper: 70 marks Internal Assessment: 30 marks

Objectives:

The aim of this course is to provide students with a theoretical understanding of the basic constituents of matter, atoms, ions and molecules in terms of their electronic structure and chemical bonding of these are to be explained by applying basic quantum chemistry. The objective of this course is to explain the basic concepts of mathematics and to explain the structural differences and transformations between states of matter. In addition, the laboratory course is designed to provide students with practical experience in basic qualitative analytical techniques, the use of laboratory techniques, and the determination of physical properties of matter.

Course Outcomes:

By the end of this course, students will have a clear understanding of various concepts related to atomic and molecular structure, chemical bonding, mathematical concepts, and states of matter. Students will also have practical experience in calibration of glassware, qualitative analysis of radicals, identification of functional groups in organic compounds, determination of various physical properties of substances, crystallization and preparation of standard solutions of different concentrations

Marks distribution in question paper:

The question paper (EoSE – End of Semester Examination) will consist of two parts: Part A and Part B

Part-A- 14 marks

Part-A will be compulsory having 10 very short answer type questions (with a limit of 20 words) of two marks each and candidate can attempt any 7 questions.

Part-B- 56 marks

Part-B of the question paper shall be divided into 4 units comprising of question no 2 to question no.5. There will be one question from each unit with internal choice. Each question will carry 14 marks.

(Autonomous)

Chemical bonding, Chemistry of s -block & p - block elements, , Mathematical concepts, States of matter and Nuclear Chemistry

Unit-I

Ionic Solids: Ionic structures, Radius ratio rule and its effect and coordination number, Limitations of radius ratio rule, Lattice defects, Semiconductors, Lattice energy and Born-Haber cycle, Solvation energy and solubility of ionic solids, Polarizing power and polarisability of ions, Fajan's rule.

Metallic bond: Free electron theory, Valence bond theory and Band theory.

Weak Interactions: Hydrogen bonding, Van der Waals forces.

Periodicity of s and p-block elements:

Effective nuclear charge, Shielding or screening effect, Slater rules, Variation of effective nuclear charge in periodic table. Atomic radii (Van der Waals), Ionic and crystal radii, Covalent radii (octahedral and tetrahedral). Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. Electron gain enthalpy, Trends of electron gain enthalpy. Electronegativity, Pauling's/Mulliken's/Allred-Rochow's and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, Partial charge, Hybridization, Group electronegativity. Sanderson's electron density ratio.

s-Block Elements: Comparative study of properties of alkali and alkaline earth metals, Diagonal relationships, Salient features of hydrides, Solvation and complexation tendencies including their functions in biosystems, An introduction to alkyls and aryls.

Unit-II

Covalent Bond: Valence bond theory and its limitations, Directional characteristics and shapes of simple inorganic molecules and ions. Valence shell electron pair repulsion (VSEPR) theory to NH_3 , H_3O^+ , SF_4 , CIF_3 , ICl_2 , H_2O .

Molecular Orbital Theory: Homonuclear and heteronuclear (*CO* and *NO*) diatomic molecules. Multicenter bonding in electron deficient molecules, Bond strength and bond energy, Percentage ionic character from dipole moment and electronegativity difference.

Periodicity in properties of p-block elements with special reference to atomic and ionic radii, Ionization energy, Electron-affinity, Electronegativity, Diagonal relationship, Catenation.

Some Important Compounds of p-block Elements: Hydrides of boron, Diborane and higher boranes, Borazine, Borohydrides, Fullerenes, Carbides, Fluorocarbons, Silicates (structural principle), Tetrasulphur tetranitride, Basic properties of halogens, Interhalogens and polyhalides

Unit-III

Mathematical Concepts: Logarithmic relations, Curve sketching, Linear graphs and calculations of slopes, Differentiation of functions like: kx, e^x , x^n , $sin\ x$ and $log\ x$. maxima and minima, Partial differentiation and Euler's reciprocity relations, Integration of some useful/relevant functions. Permutations and combinations, Factorials, Probability, Matrices and Determinant.

Liquid State: Intermolecular forces, Structure of liquids (a qualitative description). Structural differences between solids, liquids and gases. Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of somatic, nematic and cholesteric phases. Thermography and seven segment cells.

Solid State: Definition of space lattice, Unit cell.

Laws of crystallography- (i) Law of constancy of interfacial angles (ii) Law of rationality of indices (iii) Law of symmetry. Symmetry elements in crystals.

Basic concept of X-ray diffraction by crystals. Derivation of Bragg's equation. Determination of crystal structure of *NaCl* and *CsCl* (Laue's method and powder method.), Band theory of solids, Defects in solids.

(Autonomous)

Unit-IV

Gaseous States: Postulates of kinetic theory of gases, Deviation from ideal behavior, Van der Waals equation of state.

Critical Phenomenon: PV isotherms of real gases, Continuity of states, the isotherms of Van der Waals equation, Relationship between critical constants and Van der Waals constants, the law of corresponding states, Reduced equation of state.

Molecular Velocities: Root mean square, average and most probable velocities. Qualitative discussion of the Maxwell's distribution of molecular velocities, Collision number, Mean free path and collision diameter. Liquification of gases (based on Joule-Thomson effect.)

Nuclear Chemistry: Fundamental particles of nucleus (nucleons), concept of nuclides and its representation, Isotopes, Isobars and Isotones (with specific examples), forces operating between nucleons (n-n, p-p & n-p), Qualitative idea of stability of nucleus (n/p ratio).

Radiochemistry: Natural and artificial radioactivity, Radioactive disintegration series, Radioactive displacement law, Radioactivity decay rates, Half-life and average life, Nuclear binding energy, Mass defect and calculation of defect and binding energy, Nuclear reactions, Spallation, Nuclear fission and fusion. Brief discussion on atom bomb, Nuclear reactor and Hydrogen atom.

- 1. Concise Inorganic Chemistry by J.D. Lee, Wiley.
- 2. Inorganic Chemistry by Catherine E. Housecraft and Alan G. Sharpe, Pearson.
- 3. Selected Topics in Inorganic Chemistry by Wahid U. Malik, G. D. Tuli and R. D. Madan, S. Chand, New Delhi.
- 4. Advanced Inorganic Chemistry: Volume I & II by Satya Prakash, G. D. Tuli, S. K. Basu and R. D. Madan, S. Chand, New Delhi.
- 5. Inorganic Solids Introduction to Concepts in Solid-state Structural Chemistry by D. M. Adams, John Wiley, London.
- 6. Principles of Inorganic Chemistry by Puri, Sharma & Kalia, Vishal Publishing Co. Essentials of Nuclear Chemistry by H.J. Arnikar, New Age International Publishers.
- 7. Chemical Kinetics by Keith J. Laidler, Pearson Education.
- 8. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma & M. S. Pathania, Vishal Publishing Co.
- 9. Advanced Physical Chemistry by Gurdeep Raj, Goel Publishing House.
- 10. Physical Chemistry by W. Atkins, Oxford University Press.
- 11. Physical Chemistry by R. J. Silby and R. A. Alberty, John Wiley & Sons.
- 12. Physical Chemistry by G.M. Barrow, Tata McGraw-Hill.
- 13 A Textbook of Physical Chemistry: (Volume I) by K. L. Kapoor, Macmillan India Ltd.

(Autonomous)

Chemistry Lab I

1 credit- 25 marks 2credit- 50 marks

External Assessment: 30 marks Internal Assessment: 20 marks

Inorganic Chemistry 7 marks

1. Volumetric Analysis

- a) Estimation of hardness of water by EDTA.
- b) Estimation of ferrous/ferric ions by dichromate/permanganate method.
- c) Estimation of copper using thiosulphate by iodometric method.
- d) Determination of quantity of acetic acid in commercial vinegar using standard NaOH solution.
- e) Determination of alkali content in antacid tablet using standard HCl solution.
- f) Estimation of calcium content in chalk as calcium oxalate by permanganometery.

Organic Chemistry 5 marks

2. A. Laboratory Techniques

- a) Determination of melting point (naphthalene, benzoic acid, urea etc.); boiling point (methanol, ethanol, cyclohexane, etc.); mixed melting point (urea- cinnamic acid) using Thiele's tube.
- b) Crystallization of phthalic acid and benzoic acid from hot water, acetanilide from boiling water, naphthalene from ethanol. Sublimation of naphthalene, camphor etc.

B. Qualitative Analysis

Identification of functional groups (unsaturation, phenolic, alcoholic, carboxylic, carbonyl, ester, carbohydrate, amine, amide, nitro, etc.) in simple organic compounds (solids or liquids) through element detection (N, S and halogens).

Physical Chemistry 8 marks

3. Viscosity and Surface Tension:

- a) To determine the viscosity/surface tension of a pure liquid (alcohol etc.) at room temperature. (Using the Ostwald Viscometer/Stalagmometer, respectively.).
- b) To determine the percentage composition of a given binary mixture (acetone and ethyl methyl ketone) by surface tension method.
- c) To determine the percentage composition of a given binary mixture (non-interacting systems) by viscosity method.
- d) To determine the viscosity of amyl alcohol in water at different concentrations (change in viscosity due to intermolecular interactions and calculate the excess viscosity of these solutions.)

4. Viva voce 5 marks

5. Practical Record 5 marks

(Autonomous)

- 1. Vogel's Qualitative Inorganic Analysis, A. I. Vogel, Prentice Hall.
- 2. Vogel's Quantitative Inorganic Analysis Including Elementary Instrumental Analysis, ELBS.
- 3. Vogel's Textbook of Quantitative Chemical Analysis, A. I. Vogel, Pearson Education Ltd.
- 4. Advanced Practical Organic Chemistry by N. K. Vishnoi, Vikas Publishing House Pvt Ltd.
- 5.Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, V. K Ahluwalia. Universities Press, Hyderabad.
- 6.Laboratory Techniques in Organic Chemistry by V. K Ahluwalia, I K International, N
- 7. Advanced Practical Organic Chemistry J. B Yadav, Goel Publishing House.
- 8. Practical Physical Chemistry, by B. D Khosla, S. Chand & Company.

(Autonomous)

BACHELOR OF SCIENCE

Chemistry Semester II

EXAMINATION SCHEME

Paper code	- I	Maximum Marks	Credit	EoSE* in Hrs.	
		Marks		Theory	Practical
BCHE201	Reaction mechanism, Aromatic and Aliphatic hydrocarbons, Stereochemistry, Aromaticity and Alkyl & Aryl halides	100	4	3	-
BCHEP 251	Chemistry Lab II	50	2	-	4
Total		150	6		

^{*} EoSE = End of Semester Examination

S. No.	PAPER	EoSE	CIA	TOTAL
1.	Theory	70%	30%	100
2.	Practical	60%	40%	100

Note:

• It will necessary be for a candidate to pass in theory part as well as practical part of a subject separately.

(Autonomous)

B.Sc. Semester II

1 credit- 25 marks 4 credit- 100 marks Question paper: 70 marks Internal Assessment: 30 marks

Objectives:

The objective of this course is to provide students with a theoretical understanding of the types of organic reactions and their mechanisms, generation and stability of various intermediates, determination of rection mechanism, stereochemistry of organic compounds with an understanding of the enantiomers, diastereomers, D-L and R-S nomenclature. The aim of this course is to explain the structure and reactivity of aromatic hydrocarbons, and to explain the order and molecularity of the reactions, the rate law and order of reactions determination. In addition, the laboratory course is designed to provide students with practical experience in basic quantitative analytical techniques including volumetric analysis, qualitative analytical techniques, and the determination of kinetic parameters of reactions.

Course Outcomes:

By the end of this course, students will have a clear understanding of drawing logical and detailed reaction mechanisms for various fundamental reactions of aliphatic and aromatic hydrocarbons, methods of determining the reaction mechanisms, classifying the molecules as chiral or achiral, determining the D-L and R-S nomenclature of stereoisomers and identifying the formation of racemic mixture or optically active compounds during the reactions. Students will also have an understanding about order and molecularity of reactions, rate law and methods determining order and kinetic parameters of reactions. Students will also have practical experience in quantitative analytical techniques including volumetric analysis, identification of organic compounds by determination of functional groups, determination of order and rate constant of various reactions.

Marks distribution in question paper:

The question paper (EoSE - End of Semester Examination) will consist of two parts A and B

Part A- 14 marks

Part-A will be compulsory having 10 very short answer type questions(with a limit of 20 words) of two marks each and candidate can attempt any 7 questions.

Part B- 56 marks

Part-B of the question paper shall be divided into 4 units comprising question no 2 to question no.5.

There will be one question from each unit with internal choice. Each question will carry 14 marks.

(Autonomous)

Reaction mechanism, Aromatic, Aliphatic hydrocarbons, Stereochemistry, Aromaticity, Alkyl & Aryl halides and Chemical kinetics

Unit-I

Fundamentals of Organic Chemistry: Classification and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties of organic compounds. Electronic Displacements: Inductive, Electromeric, Resonance and Mesomeric effects, Hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic bond fission with suitable examples. Curly arrow rules, Formal charges; Electrophiles and Nucleophiles; Nucleophilicity and basicity.

Mechanism of Organic Reactions: Reaction intermediates: Types, shapes and relative stability; Carbocations, Carbanions, Free radicals, Carbenes, Nitrenes and Benzyne (Arynes). Types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions. Markovnikov rule, Anti- Markovnikov rule, Saytzeff's rule and Hofmann elimination. Energy considerations. Methods of determination of reaction mechanism (product analysis, intermediates, isotope effects, kinetic and stereochemical studies).

Aliphatic Hydrocarbon: Alkanes and Cycloalkanes; Free radical halogenation of alkanes; mechanism, orientation, reactivity and selectivity. Cycloalkanes - nomenclature, methods of formation, chemical re- actions. Baeyer's strain theory and its limitations. Theory of strain less rings.

Alkenes; Relative stabilities of alkenes. Chemical reactions of alkenes - hydroboration-oxidation, oxymercuration-reduction, epoxidation, ozonolysis and oxidation with $KMnO_4$, Polymerization of alkenes, Substitution at the allylic and vinylic positions of alkenes.

Unit-II

Stereochemistry of Organic Compounds: Concept of isomerism, Types of isomerism, Difference between configuration and conformation, Flying wedge and Fischer projection formulae.

Optical Isomerism: Elements of symmetry, Molecular chirality, Enantiomers, Stereogenic centre, Optical activity. Properties of enantiomers, Chiral and achiral molecules with two stereogenic centres. Diastereomers, Threo and Erythro isomers, Meso compounds. Resolution of enantiomers. Inversion, Retention and racemization (with examples).

Relative and absolute configuration, Sequence rules, D-L and R-S systems of nomenclature.

Geometrical Isomerism: Determination of configuration of geometric isomers; cis-trans and E-Z systems of nomenclature. Geometrical isomerism in oximes and alicyclic compounds.

Conformational Isomerism: Newman projection and Sawhorse formulae, Conformational analysis of ethane, *n*-butane and cyclohexane.

Cycloalkenes, Dienes and Alkynes: Classification and nomenclature of isolated, conjugated and cumulated dienes. Structure of allenes and butadiene. Methods of formation, properties and chemical reactions - 1,2- and 1,4- additions, Diels-Alder reaction and polymerization reactions.

Structure and bonding of alkynes, Synthetic methods, Chemical reactions - acidity of alkynes, Mechanism of electrophilic and nucleophilic addition reactions: hydroboration-oxidation, metal-ammonia reduction, oxidation and polymerization.

(Autonomous)

Unit-III

Arenes and Aromaticity: Nomenclature of benzene derivatives: The aromatic nucleus, aryl group, and side chain, Structure of benzene: molecular formula and Kekule structure, Stability and carbon-carbon bond lengths of benzene, Resonance structure, MO diagram.

Aromaticity: Huckel's rule, aromatic ions-three to eight membered.

Aromatic electrophilic substitution: General pattern of the mechanism, role of sigma and pi complexes,

Mechanism of nitration, halogenation, sulphonation, mercuration, chloromethylation and Friedel crafts reactions, Energy profile diagrams, Activating and deactivating substituents, Directive influence, orientation and ortho/para ratio. Side chain reactions of benzene derivatives, Birch reduction.

Alkyl Halides: Synthetic methods of alkyl halides, Chemical reactions, Mechanisms of nucleophilic substitution reactions of alkyl halides, SN2 and SN1 reactions with energy profile diagrams.

Polyhalogen compounds: Chloroform, Carbon tetrachloride

Aryl Halides: Methods of formation of aryl halides, Nuclear and side chain reactions, The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions, Relative reactivities of alkyl, vinyl, allyl and aryl halides.

Unit-IV

Chemical Kinetics: Chemical kinetics and its scope, Rate of a reaction, Factors influencing the rate of a reaction: concentration, temperature, pressure, solvent, light, catalyst. Concentration dependence of rates, Mathematical characteristics of simple chemical reactions - zero order, first order, second order and pseudo-order; Half-life and mean-life. Determination of the order of reaction - differential method, Method of integration, Method of half-life period and isolation method. Radioactive decay as a first order phenomenon.

Experimental Methods of Chemical Kinetics: Conductometric, Potentiometric, Optical methods: polarimetry and spectrophotometric method. Theories of chemical kinetics. Effect of temperature on rate of reaction, Arrhenius equation, Concept of activation energy.

Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects.

Chemistry of Noble Gases: Chemical properties of the noble gases, Chemistry of Xenon, Structure and bonding in Xenon compounds.

(Autonomous)

- 1. Concise Inorganic Chemistry by J.D. Lee, Wiley.
- 2. Inorganic Chemistry: Principles of Structure and Reactivity by Ellen A. Keiter, James
- E. Huheey and Richard L. Keiter, Pearson.
- 3. Organic Chemistry by S. S. Gupta, Oxford University Press.
- 4.Organic Reaction Mechanisms by V. K. Ahluwalia and Rakesh Kumar Parashar, Narosa Publishing House, New Delhi.
- 5.Organic Chemistry Reactions and Reagents: Covering Complete Theoretical Organic Chemistry by O. P Agarwal, Goel Publishing House, Meerut.
- 6.Organic Chemistry by R. T. Morrison and R. N. Boyed, Prentice Hall.
- 7. Organic Chemistry by I. L. Finar (Vol. I & II), ELBS.
- 8. Advanced Organic Chemistry by A. Bahl and B. S. Bahl, S. Chand.
- 9. Modera Organic Chemistry by M.K. Jain and S. C. Sharma, Vishal Publishing Co.
- 10.March's Advanced Organic Chemistry: Reactions,
- 11.Mechanisms and Structure by J. March and M. B. Smith, Wiley.Mechanism in Organic Chemistry by Peter Sykes, Pearson Education.
- 12. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania, Vishal Publishing Co.
- 13. Advanced Physical Chemistry by Gurdeep Raj, Goel Publishing House.
- 14.A Textbook of Physical Chemistry by K. L. Kapoor (Volume 5), Macmillan India Ltd.
- 15. Chemical Kinetics and Reaction Dynamics by Santosh K. Upadhyay, Springer (Anamaya Publishers, New Delhi, India).

(Autonomous)

Chemistry Lab II

1 credit- 25 marks 2credit- 50 marks

External Assessment: 30 marks Internal Assessment: 20 marks

Inorganic Chemistry

7 marks

1. Qualitative Analysis

Separation and identification of six radicals (three cations and three anions) in the given inorganic mixture including special combinations of anions.

Organic Chemistry 5 marks

- 2. (a) Synthesis of semi carbazones of any one of the following compounds: acetone, ethyl
 - (b) Synthesis of 2,4-dinitrophenylhyrazones of any aldehyde /ketone.
 - (c) Synthesis of Coumarin through salicylaldehyde.

methyl ketone, cyclohexanone, benzaldehyde.

(d) Synthesis of 3,5- dinitro benzoic acid using benzoic acid and nitrating reagent

OF

- (a) Chromatography separation of the active ingredients of plants (spinach etc.), flowers and juices by Paper/Thin layer chromatography (TLC).
- (b) Separation and identification of the monosaccharides in the given mixture by Paper/Thin layer chromatography (TLC) and reporting the R_f values.
- (c) Separation of a mixture of two amino acids by ascending and horizontal paper chromatography.

Physical Chemistry 8 marks

3 Chemical Kinetics:

- (a) To determine the specific reaction rate of the hydrolysis of methyl acetate/ethyl acetate catalyzed by hydrogen ions at room temperature.
- (b) To study the effect of acid strength on the hydrolysis of an ester.
- (c) To compare the strengths of HCl and H₂SO₄ by studying the kinetics of hydrolysis of ethyl acetate.
- (d) To study the oxidation of iodide ions by H₂O₂ as an iodine clock reaction.
- (e) To study the decomposition of H_2O_2 catalyzed by iodide ions.
- (f) To study the kinetics of reaction between acetone and iodine in presence of an acids.

4. Viva voce 5 marks

5. Practical Record 5 marks

(Autonomous)

- 1. Vogel's Qualitative Inorganic Analysis, A. I. Vogel Prentice Hall.
- 2. Vogel's Quantitative Inorganic Analysis Including Elementary Instrumental Analysis, ELBS.
- 3. Vogel's Textbook of Quantitative Chemical Analysis, A. I. Vogel, Pearson Education Ltd.
- 4. Advanced Practical Organic Chemistry by N. K. Vishnoi, Vikas Publishing House Pvt Ltd.
- 5. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, V. K Ahluwalia. Universities Press, Hyderabad.
- 6. Laboratory Techniques in Organic Chemistry by V. K Ahluwalia, I K International, N
- 7. Advanced Practical Organic Chemistry J. B Yadav, Goel Publishing House.
- 8. Practical Physical Chemistry, by B. D Khosla, S. Chand & Company.
- 9. Advanced Practical Organic Chemistry by Amit Arora, Discovery Publishing House, New Delhi.

(Autonomous)

(Autonomous)