S. S. Jain Subodh P.G. College, Jaipur

(Autonomous)

Bachelor of Science (Chemistry)

B.Sc. Chemistry

(Three/Four Year Under Graduate Programme)

Syllabus & Examination Scheme (NEP 2020)

I -II Semester

2025-26

S. S. Jain Subodh P.G. College, Jaipur

(Autonomous)

BACHELOR OF SCIENCE (Chemistry)

Semester I

EXAMINATION SCHEME

Paper code	Paper Title	Maximum Marks	Credit	EoSE* in Hrs.	
				Theory	Practical
BCHEH101	Chemical bonding and Chemistry of representative and transition Elements	100	4	3	-
BCHEH102	States of matter, Chemical kinetics, Thermodynamics and Thermochemistry	100	4	3	-
BCHEHP 151	Chemistry Lab I	50	2	-	4
BCHEHP 152	Chemistry Lab II	50	2	-	4
Total		300	12	-	-

* **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.

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B.Sc. (Chemistry) Semester I

1 credit- 25 marks
4 credit- 100 marks
External Assessment: 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, and to explain periodicity in the physical and chemical properties of s-block, p-block and d-block elements and also to explain chemistry of their compounds. The objective of this course is also to explain the basic concepts of thermodynamics in addition to heat capacity, Joule's law, different types of enthalpies and bond enthalpies and their applications, and to explain the structural differences and transformations between states of matter and structural determination of solids. In addition, the laboratory courses are designed to provide students with practical experience in basic qualitative analytical techniques related to radicals, quantitative analytical techniques related to volumetric analysis, and the determination of physical properties of matter, pKa of an acid and kinetic parameter for various reactions.

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, periodicity in the physical and chemical properties of s, p and d block elements and chemistry of their compounds. Students will also have practical experience in calibration of glassware, qualitative analysis of radicals, quantitative analytical techniques including volumetric analysis, determination of various physical properties of substances, crystallization and preparation of standard solutions of different concentrations and 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 2-5.

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

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Paper I: Chemical Bonding and Chemistry of Representative and Transition Elements

Unit-I

Ionic Bond: General characteristics, types of ions, size effects, Radius ratio and coordination number, Lattice energy, Born-Landé equation with derivation, Madelung constant, Born-Haber cycle and its application, energy. Polarizing power, Polarizability, Fajan's rules, Solvation energy, Solubility of ionic compounds. Defects in solids, Frankel and Schottky defects, non-stoichiometric compounds.

Metallic bond: Qualitative idea of free electron theory, valence bond theory and band theory, Semiconductors and insulators, Conduction in solids, Electrical and magnetic properties of solids, Introduction to superconductors and super-conductivity.

Unit-II

Covalent bond: General characteristics, Valence bond theory and its limitations. Directional characteristics of covalent bond, Resonance and resonance energy, Hybridization involving s, p and d-orbitals.

Valence Shell Electron Pair Repulsion (VSEPR) Theory to NH_3, H_2O, H_3O^+, SF_4, ClF_3, ICl^-_2 Shapes of simple inorganic molecules and ions. Dipole moment, percentage ionic-character from dipole moment and electronegativity difference.

Molecular Orbital Theory: Detailed description of linear combination of atomic orbitals (LCAO), MOT of Homonuclear and heteronuclear diatomic molecules (CO, NO) and their ions, Comparison of valence bond and molecular orbital approaches, Multicenter bonding in electron deficient molecules, bond strength and bond energy.

Weak Interactions: Hydrogen bond, theories of hydrogen bonding. Weak intermolecular forces of attraction, Vander Waals forces.

Unit-III

s-Block Elements: Comparative study, diagonal relationship, salient features of hydrides, solvation and complexation tendencies including their functions in biosystems, an introduction to alkyls and aryls.

p-Block Elements: Comparative study of the p-block elements and group trends: electronic configuration, Physical and chemical properties, Diagonal relationship, Atomic and ionic radii, Ionization enthalpy, Electron gain enthalpy, Electronegativity and oxidation states, Oxidation state diagrams on the basis of redox potentials, Inert pair effect, Catenation.

Compounds of p-Block Elements: Hydrides of boron; diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates, silicones, oxygen fluorides, peracids of sulphur, tetrasulphur tetranitride, basic properties of halogens, interhalogen compounds and polyhalides.

Chemistry of Noble Gases: Position in the periodic table, discovery, isolation, important compounds of noble gases with special references to xenon compounds: Synthesis, bonding and their stereochemistry.

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Unit-IV

Chemistry of d-Block elements: Chemistry of the elements of first transition series; Electronic configuration and comparative study with respect to atomic and ionic radii, oxidation states and ionization enthalpy. Redox potentials, oxidation state diagrams on the basis of redox potentials, binary compounds and complexes illustrating relative stability of their oxidation states, coordination number and geometry, metallic nature, magnetic properties, catalytic activity, colour and spectral properties of transition metal ions.

Chemistry of the elements of second and third transition series; Electronic configuration, general characteristics, comparative treatment with their 3d-analogues in respect of ionic radii, oxidation states, magnetic behaviour, spectral properties and stereochemistry.

Suggested Books and References:

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. Organic Chemistry by R.T Morrison. & R. N Boyed, Prentice Hall.
5. Organic Chemistry by S. S. Gupta, Oxford University Press.
6. Organic Reaction Mechanisms by V. K. Ahluwalia, Narosa Publishing House, New Delhi.
7. Organic Chemistry – Reactions and Reagents: Covering Complete Theoretical Organic Chemistry by O. P. Agarwal, Goel Publishing House, Meerut.
8. Organic Chemistry (Vol. I & II) by I. L Finar, ELBS.
9. Advanced Organic Chemistry by A Bahl. & B. S Bahl, S. Chand.
10. Organic Chemistry by C. N Pillai, Oxford University Press.
11. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure by J March, & M. B Smith, Wiley.
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. Physical Chemistry by W. Atkins, Oxford University Press.
15. Physical Chemistry by R. J. Silby and R. A. Alberty, John Wiley & Sons.
16. Physical Chemistry by G.M. Barrow, Tata McGraw-Hill.
17. A Textbook of Physical Chemistry (Volume 1) by K. L. Kapoor, Macmillan India Ltd.
18. Instrumental Methods of Chemical analysis by Gurdeep R. Chatwal & Sham K. Anand, Himalaya Publishing House.
19. Instrumental Methods of Chemical Analysis by V.K. Ahluwalia, Springer.
20. Instrumental Methods of Chemical analysis by B. K. Sharma, Goel Publishing House, Meerut.
21. Analytical Chemistry by Gary D. Christian, Purnendu K. Dasgupta & Kevin A. Schug, Wiley.
22. Fundamentals of Analytical Chemistry by F. James Holler, Stanley R Crouch, Donald M. West & Douglas A. Skoog, Cengage Learning India Pvt. Ltd.

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Paper II: States of matter, Chemical kinetics, Thermodynamics and Thermochemistry

Unit I

Ideal gases: Kinetic Theory of Gases, Concept of molar mass and molar volume. Determination of molar mass of a gas and volatile substances. The barometric distribution laws. Maxwell distribution law of molecular velocities. The Maxwell energy distribution. The Maxwell Boltzmann distribution law and its experimental verification, Derivation of average, root mean square velocities and most probable velocities. Collision properties: Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules.

Real gases: Deviations of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waal's equations and its implications. PV isotherms of van der Waals gas equation. Critical phenomenon and critical constants. Reduced equation of state and law of corresponding states.

Unit II

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: Thermal expansion and compressibility, Heat of vaporization. Determination of vapour pressure and heat of vaporization. Disorder in liquid state and structure of liquid water. Intermolecular forces. Cohesion of liquids. Eyring theory of liquids, seven segment cell.

Solid state: Crystalline and amorphous states. Isotropy and anisotropy. Definition of space lattice and 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. Weiss and Miller indices. 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.). Defects in solids.

Unit III

Chemical Kinetics: Chemical kinetics and its scope, Rate of reaction; Instant rate, Specific rate, factors influencing the rate of a reaction: concentration, temperature, pressure, solvent, light, catalyst, Rate constant and their units. Rate laws in terms of the advancement of a reaction. Experimental methods of the determination of rate laws, Order, molecularity and stoichiometry of a reaction. Methods of determination of order of reaction.

Derivation of integrated rate equations- zero order, first order, second order and third order. Graphical applications of these equations for the determinations of rate constant.

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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.

Temperature dependence of reaction rates; Arrhenius equation, Energy of activation. Collision theory of reaction rates. Complex reactions and their nature. Derivation of rate equation for the opposing or reversible reactions ($A + B \leftrightarrow C$), parallel reactions and consecutive reactions ($A \rightarrow B \rightarrow C$), characteristics of consecutive reactions.

Unit IV

Thermodynamics: Definitions of thermodynamic terms: system, surroundings, thermodynamic process. Concept of work and heat, Internal energy, Enthalpy. State and path functions and their exact and inexact differential, Calculation of work for reversible and irreversible expansion and compression of gases under isothermal and adiabatic conditions. Zeroth law of thermodynamics, first law of thermodynamics. Heat capacity at constant pressure (C_p) and constant volume (C_v) and their thermodynamic relationship. Application of first law of thermodynamics.

Thermochemistry: Standard states, Heat of reaction at constant pressure and constant volume and their thermodynamic relationship, Enthalpy of formation and enthalpy of combustion and its applications. Changes in enthalpy at constant temperature and pressure. Hess's Law. Heat of reaction at constant pressure and volume. Variation of heat of reaction with temperature. Bond enthalpies and bond energies, Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data.

Suggested Books and References:

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.
7. Organic Chemistry by R. T. Morrison & R. N. Boyed, Prentice Hall.
8. Stereochemistry of Organic Compounds by V. K. Ahluwalia, Springer.
9. Stereochemistry conformation and Mechanism by P.S. Kalsi, New Age International Publishers.
10. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania, Vishal Publishing Co.
11. Advanced Physical Chemistry by Gurdeep Raj, Goel Publishing House.
12. Physical Chemistry by W. Atkins, Oxford University Press.
13. Physical Chemistry by R. J. Silby and R. A. Alberty, John Wiley & Sons.
14. Physical Chemistry by G.M. Barrow, Tata McGraw-Hill.
15. A Textbook of Physical Chemistry (Volume 1) by K. L. Kapoor, Macmillan India Ltd.

16. A Text Book of Physical Chemistry by A. S. Negi and S. C. Anand, New Age International Publishers.
17. Elements of Physical Chemistry, P. Atkins and J. De Paula, Oxford.
18. Instrumental Methods of Chemical analysis by Gurdeep R. Chatwal & Sham K. Anand, Himalaya Publishing House.
19. Instrumental Methods of Chemical Analysis by V.K. Ahluwalia, Springer.
20. Instrumental Methods of Chemical analysis by B. K. Sharma, Goel Publishing House, Meerut.
21. Analytical Chemistry by Gary D. Christian, Purnendu K. Dasgupta & Kevin A. Schug, Wiley.
22. Fundamentals of Analytical Chemistry by F. James Holler, Stanley R Crouch, Donald M. West & Douglas A. Skoog, Cengage Learning India

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Chemistry Lab I

1credit - 25 marks
2 credit - 50 marks
ExternalAssessment:.30marks
Internal Assessment: 20 marks

Inorganic Chemistry

A. Qualitative analysis: 10 marks

Analysis of the given inorganic mixture containing **six** radicals (three acidic and three basic) including interfering acid radicals – fluoride (F^-), borate (BO_3^{3-}), oxalate ($C_2O_4^{2-}$), and phosphate (PO_4^{3-}), excluding insoluble.

B. Quantitative analysis: Volumetric analysis 10 marks

1. Estimation of Ca^{2+} & Mg^{2+} using EDTA solution.
2. Estimation of Cu (II) ions iodometrically, using sodium thiosulphate solution.
3. Determination of total hardness of water.
4. Determination of number of molecules of water of crystallization in oxalic acid crystals.
5. Estimation of sodium carbonate and bicarbonate in mixed solution.
6. Estimation of sodium carbonate and sodium hydroxide in a mixed solution.
7. Estimation of Ferrous and Ferric sulphates in a mixed solution.

Viva voce 5 marks

Practical Record 5 marks

Suggested Books and References:

1. Vogel's textbook of quantitative chemical analysis by Arthur Israel Vogel, Harlow: Prentice Hall.
2. Vogel's Qualitative Inorganic Analysis by A. I. Vogel, Prentice Hall.
3. Vogel's Qualitative Inorganic Analysis, 7/e by G. Svehla, Pearson Education.
4. Vogel's textbook of quantitative inorganic analysis: including elementary instrumental analysis by Arthur Israel Vogel, Longman Scientific & Technical.
5. Vogel's Quantitative Inorganic Analysis Including Elementary Instrumental Analysis, ELBS.
6. Vogel's Textbook of Quantitative Chemical Analysis by G. H. Jeffery, J. Bassett, J. Mendham and R B Denney, Longman Scientific & Technical.
7. Advance Practical Inorganic Chemistry by Gurdeep Raj, Goel Publishing House.

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Chemistry Lab II

1 credit- 25 marks
2 credit- 50 marks
External Assessment: 30 marks
Internal Assessment: 20 marks

Physical Chemistry

A. Solubility and Distribution Law:

1. To study the solubility curve of salts such as potassium nitrate, etc.
2. To study the solubility curve of phenol in water and hence study the effect of separate addition of substances such as naphthalene, potassium chloride and acetic acid.
3. Determine the molecular complexity of benzoic acid in benzene by Distribution Law.

B. pH metry:

1. Preparation of buffer solutions of different pH; (i) sodium acetate-acetic acid and (ii) ammonium chloride-ammonium hydroxide.
2. Study the effect on pH of the solutions of acetic acid, sodium acetate and their mixture by adding $HCl/NaOH$.
3. Determination of pH of different buffer solutions and evaluate the pK_a of an acid by Handerson equation.

C. Viscosity/surface tension measurements:

1. Determine the relative viscosity of a liquid by using viscometer.
2. Determination of viscosity of aqueous solutions of (i) ethanol and (ii) sugar at room temperature.
3. Study the variation of viscosity of sucrose solution with the concentration of solute.
4. Determine the relative surface tension of a liquid by using stalagmometer.
5. Study the variation of surface tension of detergent solutions with concentration.

D. Thermochemistry:

1. Determine the heat capacity of the calorimeter and enthalpy of neutralization of an acid and base.
2. Study of the solubility of benzoic acid in water and determination of ΔH.
3. Determine the enthalpy of reaction and verify Hess's law.

Any two of the above exercises under different headings, 2×10=20 marks.

Viva voce **5 marks**

Practical Record **5 marks**

Suggested Books and References:

1. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publishing House.
2. Practical Physical Chemistry by B. D. Khosla, S. Chand & Company.
3. Senior Practical Physical Chemistry by B. D. Khosla, V. C. Garg and A. Gulati, R. Chand & Co.: New Delhi.
4. Experiments in Physical Chemistry 8th Ed. by C. W. Garland, J. W. Nibler and D. P. Shoemaker, McGraw-Hill: New York.
5. Experimental Physical Chemistry 3rd Ed.by A. M. Halpern by G. C. McBane, W.H. Freeman & Co.: New York.

Suggested E-resources:

All the above suggested books are available as e- books.

Online Lecture Notes and Course Materials:

All prescribed courses are available in the form of e-books, Adobe Acrobat documents (PDF), web pages etc.

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BACHELOR OF SCIENCE (Chemistry)

Semester II

EXAMINATION SCHEME

Paper code	Paper Title	Maximum Marks	Credit	EoSE* in Hrs.	
				Theory	Practical
BCHEH201	Reaction mechanism, Stereochemistry, Hydrocarbons, Aliphatic and aromatic halides	100	4	3	-
BCHEH202	Principles and Methods of Analytical Techniques	100	4	3	-
BCHEHP 251	Chemistry Lab I	50	2	-	4
BCHEHP 251	Chemistry Lab II	50	2	-	4
Total		300	12	-	-

* **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 .

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B.Sc.(Chemistry) Semester II

1 credit- 25 marks
4 credit- 100 marks
External Assessment: 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 enantionrers, diastereomers, D/L and R/S nomenclature. The aim of this course is to explain the structure and reactivity of aliphatic and aromatic hydrocarbons, alkyl and aryl halides, and to explain principles and methods of different analytical techniques viz. quantitative analysis including volumetric and gravimetric analysis, solvent extraction, distillation. In addition, the laboratory course is designed to provide students with practical experience in basic quantitative analytical techniques including volumetric and gravimetric analysis, qualitative analytical techniques, and the laboratory techniques.

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 principles and methods of analytical techniques. Students will also have practical experience in quantitative analytical techniques including volumetric and gravimetric analysis, identification of organic compounds by determination of functional groups, thin layer and paper chromatography.

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 2-5.
There will be one question from each unit with internal choice. Each question will carry 14 marks.

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PAPER-I :-Reaction mechanism, Stereochemistry, Hydrocarbons, Aliphatic and Aromatic halides

Unit-I

Structure and Bonding: Hybridization, inductive effect, hyperconjugation, resonance, Van der Waals interactions, inclusion compounds, clathrates, charge transfer complexes, hydrogen bonding.

Mechanism of Organic Reactions: Homolytic and heterolytic bond breaking, electrophiles and nucleophiles, types of organic reactions, energy considerations, transition state, reactive intermediates-carbocations, carbanions, free radicals, carbenes, arynes and nitrenes. Methods of determination of reaction mechanism.

Alkanes: Nomenclature of branched and unbranched alkanes. Classification of carbon atoms in alkanes. Isomerism in alkanes, methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey House reaction and decarboxylation of carboxylic acids) physical properties and chemical reactions of alkanes. Halogenation of alkanes; mechanism, orientation, reactivity and selectivity.

Unit-II

Stereochemistry of Organic Compounds: Concept of isomerism. Types of isomerism.

Optical Isomerism: Elements of symmetry, molecular chirality, enantiomers, chiral and achiral molecules with two stereogenic centres, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization, Asymmetric synthesis. Relative and absolute configuration, Fischer projection and flying wedge formula. sequence rule, D, L and R, S systems of nomenclature.

Geometric isomerism: Determination of configuration of geometrical isomers, E, Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds.

Conformational isomerism: Conformational analysis of ethane and n-butane. Newman projection and Sawhorse formula. Difference between configuration and conformation.

Unit-III

Cycloalkanes: Nomenclature, methods of formation, chemical reactions. Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane). Theory of strain less rings. Cyclopropane ring: banana bonds.

Alkenes: Nomenclature of alkenes, methods of formation, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. The Saytzeff 's rule, Hofmann elimination, physical properties and relative stabilities of alkenes. Chemical reactions of alkenes, Mechanisms involved in hydrogenation, electrophilic and free radical addition reactions. Markovnikov's rule, hydroboration-oxidation, oxymercuration- demercuration, epoxidation, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$, polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes. Industrial applications of ethylene and propene.

Cycloalkenes: Methods of formation, conformations and chemical reactions.

Dienes: Nomenclature and classification, isolated, conjugated and cumulated dienes, Structure of allenes and butadiene, methods of formation, polymerization, Chemical reaction-1,2 and 1,4 additions. Diels-Alder reaction.

Alkynes: Nomenclature, structure and bonding, Methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, hydroboration-oxidation, metal ammonia reduction, oxidation and polymerization.

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Unit-IV

Arenes and Aromaticity: Nomenclature of benzene derivatives. Aromatic nucleus, aryl group and side chain. Structure of benzene: molecular formula and Kekule structure. Stability and carbon-carbon bond lengths of benzene, resonating structures, MO picture.

Aromaticity: The Hückel's rule and its applications. Energy level, molecular orbital diagram; ethene, 1,3 butadiene, benzene. Aromatic electrophilic substitution (SEAr): General pattern of the mechanism, role of sigma and π-complexes, mechanism of nitration, halogenation, sulphonation, and Friedel-Crafts reaction. Effect of substituent groups (inductive, mesomeric and hyperconjugative effect), activating and deactivating groups, directive influence of groups, determination of orientation to disubstituted derivatives; ortho/para ratio, Birch Reduction. Method of formation and chemical reactions of benzene, alkyl benzenes and biphenyl.

Alkyl and Aryl Halides: Nomenclature and classification of alkyl halides, methods of formation, chemical reactions. Mechanisms of nucleophilic substitution, reactions of alkyl halides SN2 and SN1 reactions with energy profile diagrams. Methods of formation of aryl halides, nuclear and side chain reactions. The addition-elimination and elimination-addition mechanisms of nucleophilic aromatic substitution reactions. Relative reactivities of alkyl halides v/s vinyl, allyl and aryl halides. Preparation and properties of vinyl, allyl and benzyl halides. Synthesis and uses of DDT and BHC.

Suggested Books and References:

1. Concise Inorganic Chemistry by J.D. Lee, Wiley, India.
2. Inorganic Chemistry by Catherine E. Housecroft, & Alan G Sharpe, Pearson Education Ltd.
3. Principles of Inorganic Chemistry by Puri, Sharma & Kalia, Vishal Publishing Co.
4. Concepts and Models of Inorganic Chemistry, B.E. Douglas, D. McDaniel, & J. Alexander, Wiley.
5. Selected Topics in Inorganic Chemistry by Wahid U. Malik, G. D. Tuli and R. D. Madan, S. Chand, New Delhi.
6. Advanced Inorganic Chemistry (Volume I) by Satya Prakash, S. Chand, New Delhi.
7. Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson, & P.L Gaus, Willey.
8. Principles of Inorganic Chemistry by Brian W. Pfennig, Wiley.
9. Organic Chemistry by I. L. Finar, Pearson.
10. Organic Chemistry by R.T. Morrison, R.N. Boyd & S.K. Bhattacharjee, Pearson.
11. Chemical Kinetics by Keith J. Laidler, Pearson Education.
12. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma & M. S. Pathania, Vishal Publishing Co.
13. Advanced Physical Chemistry by Gurdeep Raj, Goel Publishing House.
14. Physical Chemistry by W. Atkins, Oxford University Press.
15. Physical Chemistry by R. J. Silby and R. A. Alberty, John Wiley & Sons.
16. Physical Chemistry by G.M. Barrow, Tata McGraw-Hill.
17. A Textbook of Physical Chemistry: (Volume V) by K. L. Kapoor, Macmillan India Ltd.
18. Instrumental Methods of Chemical analysis by Gurdeep R. Chatwal & Sham K. Anand, Himalaya Publishing House.
19. Instrumental Methods of Chemical Analysis by V.K. Ahluwalia, Springer.
20. Instrumental Methods of Chemical analysis by B. K. Sharma, Goel Publishing House, Meerut.
21. Analytical Chemistry by Gary D. Christian, Purnendu K. Dasgupta & Kevin A. Schug, Wiley.
22. Fundamentals of Analytical Chemistry by F. James Holler, Stanley R Crouch, Donald M. West & Douglas A. Skoog, Cengage Learning India Pvt. Ltd.

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PAPER -II: - Principles and Methods of Analytical Techniques

Unit-I

Gravimetric analysis: Principle of Gravimetric analysis, precipitation methods, super saturation and precipitate formation, the purity of the precipitate, coprecipitation, post-precipitation, conditions of precipitation, precipitation from homogeneous solution, washing of the precipitate. Drying and ignition of the precipitate, masking and demasking agents.

Unit-II

Solvent extraction: Principles and process of solvent extraction, the distribution law and the partition coefficient, liquid-liquid extraction, factors favouring solvent extraction, choice of solvent for solvent extraction, stripping, solid liquid extraction, organic reagents used in solvent extraction. Organic reagents in quantitative inorganic analysis. Application of the organic reagents-DMG, Cupferron, 8 hydroxyquinoline, cupron, salicylaldehyde oxime, l-nitroso-2- naphthol, 4-bromomandelic acid, nitron, tannic acid, arsonic acids, pyridine, anthranilic acid, pyrogallol and ethylenediamine.

Unit-III

Data analysis and comparison of results: Completion of gravimetric results, compilation of results, reliability of results-accuracy and precision, cleaning and calibration of glassware, standard deviation, t, q and f tests, correction, significant figures, errors in analysis.

Volumetric analysis: Principle and applications of redox titrations, iodometry and iodimetry. Theory of complexation titrations. Methods of end point detection, EDTA as Titrant, types of EDTA titration of mixtures, metal indicators.

Unit-IV

Distillation: Distillation methods of organic solvents; steam, fractional, vacuum and molecular distillations, manometers, monostates distillation. Analysis of oils and fats, saponification value, iodine value, RM value, acid value.

Quantitative estimation of functional groups; alcoholic phenolic, carboxylic acids and unsaturated groups (olefinic & acetylenic).

Polarimetry: Basic principle, instrumentation, experimental techniques, determination of specific rotation and concentration of the substances, applications of polarimetry. An elementary idea of Refractometry, Interferometry; circular dichroism and optical rotatory dispersion.

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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. Organic Chemistry by I. L. Finar, Pearson
5. Organic Chemistry by R.T. Morrison, R.N. Boyd & S.K. Bhattacharjee, Pearson.
6. Reaction Mechanism in Organic Chemistry by S. M. Mukherji & S. P. Singh, TRINITY Press
7. Physical Chemistry by R. J. Silbey, R. A. Alberty & M. G. Bawendi, John Wiley & Sons.
8. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania, Vishal Publishing Co.
9. An Introduction to Chemical Thermodynamics by R. P. Rastogi & R. R. Mishra, Vikas House.
Publishing
10. A Text Book of Physical Chemistry: A. S. Negi and S. C. Anand, New Age International Publishers.
11. Advanced Physical Chemistry by Gurdeep Raj, Goel Publishing House.
12. Instrumental Methods of Chemical analysis by Gurdeep R. Chatwal & Sham K. Anand, Himalaya Publishing House.
13. Instrumental Methods of Chemical Analysis by V.K. Ahluwalia, Springer.
14. Instrumental Methods of Chemical analysis by B. K. Sharma, Goel Publishing House, Meerut.
15. Analytical Chemistry by Gary D. Christian, Purnendu K. Dasgupta & Kevin A. Schug, Wiley.
16. Fundamentals of Analytical Chemistry by F. James Holler, Stanley R Crouch, Donald M. West & Douglas A. Skoog, Cengage Learning India Pvt. Ltd.
17. Analytical Chemistry: Theory and Practice 3rd edition by R.M. Verma, CBS.
18. Principles and Practice of Analytical Chemistry 5Th Edition by F.W. Fifield & D. Kealey, Wiley India.
19. Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler & Stanley R. Crouch, Cengage Learning.
20. Analytical Chemistry I by Ulf Ritgen, Springer.

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(Autonomous)

B.Sc. (Chemistry) Semester II

Chemistry Lab I

1 credit- 25 marks
2 credit- 50 marks
External Assessment: 30 marks
Internal Assessment: 20 marks

Organic Chemistry:

A. Organic compound Identification:

1. Identification of organic compounds through functional groups analysis, determination of melting point/boiling point, specific test and preparation of a suitable derivative.

B. Laboratory Techniques:

1. Purification of organic solid compounds by crystallization using water/alcohol/acetone solvents.

2. Separation of two miscible liquids by fractional distillation.

3. Determination of melting point and mixed melting point of two unknown organic compounds.

C. Organic Preparations:

1. Preparation of acetanilide from aniline.

2. Preparation of an azo-dye.

Any two of the above exercises under different headings, 2 × 10 = 20 marks.

Viva voce **5 marks**

Practical Record **5 marks**

Suggested Books and References:

1. Ahluwalia, V. K. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, Universities Press, Hyderabad.
2. Ahluwalia, V. K. Laboratory Techniques in Organic Chemistry, I K International, New Delhi.
3. Arora Amit Advanced Practical Organic Chemistry, Discovery Publishing House, New Delhi.
4. Furniss, Brian S., Hannaford, Antony J. et al, Vogel's Textbook of Practical Organic Chemistry, Pearson.

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Chemistry Lab II

1 credit- 25 marks
2 credit- 50 marks
External Assessment: 30 marks
Internal Assessment: 20 marks

Gravimetric Analysis

a) Estimation of Cu as CuSCN.
b) Estimation of Ni as Ni (dimethylglyoxime)

Laboratory Techniques

A. Thin Layer Chromatography: Determination of Rf values and identification of organic compounds.
a) Separation of green leaf pigments (spinach leaves may be used).
b) Preparation and separation of 2,4-dinitrophenylhydrazones of acetone, 2-butanone, hexan-2-one and
hexan-3-one using toluene and light petroleum (40 − 60) solvent system.
c) Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5: 1.5)

B. Paper Chromatography (Ascending and Circular): Determination of Rf values and identification of
organic compounds.
a) Separation of mixture of phenylalanine and glycine. Alanine and aspartic acid, leucine and glutamic
acid. Spray reagent – ninhydrin.
b) Separation of a mixture of D, L – alanine, glycine and L-Leucine using n-butanol: acetic acid: water
(4:1:5), Spray reagent-ninhydrin.
c) Separation of monosaccharides from a mixture of D- galactose and D-Fructose Using n-butanol:
acetone: water (4:5:1) Spray reagent -aniline hydrogen phthalate.

Any two of the above exercises under different headings, $2 \times 10 = 20$ marks.

Viva voce **5 marks**

Practical Record **5 marks**

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Suggested Books and References:

1. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis by V. K. Ahluwalia, Universities Press, Hyderabad.
2. Laboratory Techniques in Organic Chemistry by V. K. Ahluwalia, I K International, New Delhi.
3. Advanced Practical Organic Chemistry by Amit Arora, Discovery Publishing House, New Delhi.
4. Vogel's Textbook of Practical Organic Chemistry Furniss, S.Brian, Hannaford, J. Antony et al,, Pearson.