

B.Sc. Physical Science (Multidisciplinary)
Subject- Chemistry
(To be Effective from Session 2026-27)

Core Course (Multidisciplinary)

COURSE DETAILS:

Course Title	Chemistry-I
Semester	Semester-I
Course Code	260/CHHP/CC/101
Course ID	CC-A1
Level of Course	100-199
Total Credits	04 (Lecture: 03, Tutorial: 0, Practical: 01)
Total Marks	100
Marks Distribution	Theory External: 50 Theory Internal: 25 Practical External: 20 Practical Internal: 05

COURSE CURRICULUM DELIVERY WEEKLY DISTRIBUTION:

Total Hours per Week: 5	
Lectures (L) Hours per Week: 3	Practical (P) Hours per Week: 2

COURSE OBJECTIVES

- To develop a fundamental understanding of atomic structure, quantum numbers, electronic configuration, and periodic properties of elements.
- To explain the principles of chemical bonding, including valence bond theory, hybridization, VSEPR theory, and molecular orbital theory.
- To introduce the basic concepts of organic chemistry, including classification, nomenclature, electronic effects, and reaction intermediates.
- To develop an understanding of stereochemistry and conformational analysis, including isomerism, chirality, and molecular configurations.
- To provide knowledge of chemical kinetics, including rate laws, order of reactions, and the effect of temperature on reaction rates.

COURSE OUTCOMES

- Apply quantum mechanical concepts and periodic trends to explain electronic configurations, effective nuclear charge, and properties of elements.
- Analyze molecular structure and bonding using valence bond theory, hybridization, VSEPR, and molecular orbital theory, and predict molecular geometry and properties.



- Classify and name organic compounds, and interpret the role of electronic effects and reaction intermediates in determining reactivity and stability.
- Analyze stereochemical features of organic molecules, including optical and geometrical isomerism, and evaluate conformational stability of different molecular systems.
- Apply principles of chemical kinetics to determine rate laws, order of reactions, half-life, and evaluate the effect of temperature using the Arrhenius equation.

DETAILED CONTENT OF COURSE:

Theory Syllabus: Total Contact Hours: 45

Unit	Topics	Contact Hours
I	Atomic Structure & Periodic Properties Quantum numbers, Aufbau and Pauli exclusion principles, Hund's rules of maximum multiplicity, Periodic classification of elements into s, p d & f block elements and electronic configuration, screening effect, effective nuclear charge and Slater's rules, discussion and trends of the following properties of representative elements (s & p block): atomic and ionic radii, ionization enthalpy, electron gain enthalpy and electronegativity (Pauling's/ Mulliken's/ Allred Rachow's scale).	11
II	Chemical Bonding - Part I Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions (BeF_2 , BF_3 , CH_4 , PF_5 , SF_6 , IF_7 , SO_4^{2-} , and ClO_4^-). Valence shell electron pair repulsion (VSEPR) theory to NH_3 , H_2O , SF_4 , ClF_3 , H_2O , SnCl_2 , ClO_3^- and ICl_2^- . Molecular orbital theory of homonuclear and heteronuclear diatomic molecules (N_2 , O_2 , C_2 , CO , and NO), bond order, bond length and bond energy.	11
III	Basic Concepts in Organic Chemistry Classification and Nomenclature of organic compounds. Electronic Displacements: Inductive, electrometric, resonance and mesomeric effects, hyperconjugation and their comparison & applications. Reaction intermediates: Carbocations, Carbanions, Free radicals, Carbenes, arynes and nitrenes (Types, shape, structure, Mechanistic study and relative stability) Stereochemistry and Conformational Analysis Isomerism: Types of isomerism, Optical isomerism: elements of symmetry, Optical Activity, Molecular chirality/asymmetry, Enantiomers, Diastereoisomers, Meso compounds, Racemic mixture and resolution. Relative and absolute configuration: D/L designation, Geometric isomerism: Cis-Trans and E & Z nomenclature, Conformational isomerism: Conformational analysis of ethane and n-butane; chair, boat, half chair and twist boat conformations of cyclohexane (interconversions and energy level diagram).	12

IV Chemical Kinetics	11
Rate of reaction, rate equation, factors influencing the rate of a reaction – concentration, temperature, pressure, solvent, light, catalyst, Order of a reaction, integrated rate expression for zero order, first order, second and third order reaction. Half-life period of reaction, Methods of determination of order of reaction, Difference between molecularity and order of reaction, Effect of temperature on the rate of reaction – Arrhenius equation	

V	Practicals:	30
1. Titrimetric Analysis: (i) Calibration and use of apparatus (ii) Preparation of solutions of different Molarity/Normality. 2. Paper chromatographic separation of Cu^{2+} and Cd^{2+} ions. 3. To study the process of sublimation of camphor and phthalic acid. 4. To prepare a pure sample p-Bromoacetanilide from acetanilide. 5. To estimate Zn^{2+} and Mg^{2+} ions using standardized EDTA solution by Complexometric titrations. 6. Determination of surface tension of a liquid using the drop number method. 7. Determination of surface tension of a liquid using the drop weight method. 8. Determination of the viscosity of a liquid using Ostwald's viscometer.		

COURSE EVALUATION METHODS

Theory Exams: Total Marks: 75 (External: 50 + Internal: 25)

Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks

Practical Exam: Total Marks: 25 (External: 20 + Internal: 05)

Internal Assessment: 05 Marks	• Class Participation: 05 Marks
External Assessment: 20 Marks (03 Hours)	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

Instructions for End-Term Theory Exam:

The Examiner is requested to set nine questions in total, selecting two questions from each section. Question-1 will be a compulsory question consisting short answer type questions covering all the units of the syllabus. All questions should carry equal marks.

RECOMMENDED BOOKS

1. Atkins, P., & de Paula, J. (2018). *Physical chemistry* (11th ed.). Oxford University Press.
2. Lee, J. D. (2010). *Concise inorganic chemistry* (5th ed.). Wiley India.
3. Huheey, J. E., Keiter, E. A., & Keiter, R. L. (2006). *Inorganic chemistry: Principles of structure and reactivity* (4th ed.). Pearson Education.
4. Morrison, R. T., & Boyd, R. N. (2011). *Organic chemistry* (7th ed.). Pearson Education.
5. Solomons, T. W. G., Fryhle, C. B., & Snyder, S. A. (2016). *Organic chemistry* (12th ed.). Wiley.
6. Clayden, J., Greeves, N., & Warren, S. (2012). *Organic chemistry* (2nd ed.). Oxford University Press.
7. Puri, B. R., Sharma, L. R., & Pathania, M. S. (2017). *Principles of physical chemistry* (47th ed.). Vishal Publishing Co.
8. Laidler, K. J. (1987). *Chemical kinetics* (3rd ed.). Harper & Row.
9. McQuarrie, D. A., & Simon, J. D. (1997). *Physical chemistry: A molecular approach*. University Science Books.
10. Vogel, A. I., Jeffery, G. H., Bassett, J., Mendham, J., & Denney, R. C. (1989). *Vogel's textbook of quantitative chemical analysis* (5th ed.). Longman.
11. Yadav, J. B. (2013). *Advanced practical physical chemistry*. Krishna Prakashan Media.
12. Rao, C. N. R., & Agarwala, U. C. (1988). *Experiments in physical chemistry*. Wiley Eastern.
13. Kumari, R., & Anand, A. (2018). *Physical chemistry laboratory manual: An interdisciplinary approach*. I.K. International Publishing House.



Subject- Chemistry
(To be Effective from Session 2026-27)

Core Course (Multidisciplinary) *B. Sc. Physical Science (Multidisciplinary)*

COURSE DETAILS:

Course Title	Chemistry-II	
Semester	Semester-II	
Course Code	260/CHEP/CC/201	
Course ID	CC-A2	
Level of Course	100-199	
Total Credits	04 (Lecture: 03, Tutorial: 0, Practical: 01)	
Total Marks	100	
Marks Distribution	Theory External: 50 Practical External: 20	Theory Internal: 25 Practical Internal: 05

COURSE CURRICULUM DELIVERY WEEKLY DISTRIBUTION:

Total Hours per Week: 5		
Lectures (L.) Hours per Week: 3	Practical (P) Hours per Week: 2	

COURSE OBJECTIVES

- To develop an understanding of advanced chemical bonding concepts, including metallic bonding, intermolecular forces, and ionic bonding with polarization effects.
- To introduce the preparation, properties, and reaction mechanisms of hydrocarbons (alkanes, alkenes, and alkynes).
- To explain the kinetic theory of gases and the behavior of ideal and real gases, along with the physical properties of liquids.
- To provide fundamental knowledge of solid-state chemistry, including crystal structures, X-ray diffraction, and defects in solids.
- To develop practical skills in organic synthesis, qualitative analysis, and quantitative volumetric analysis using standard laboratory techniques.

COURSE OUTCOMES

- Analyze different types of chemical bonding, including metallic bonding, intermolecular forces, and ionic bonding, and explain polarization effects using Fajan's rules.
- Apply concepts of organic chemistry to explain the preparation, mechanisms, and reactivity of alkanes, alkenes, and alkynes.
- Apply kinetic theory to evaluate gaseous behavior and analyze physical properties of liquids such as surface tension and viscosity under varying conditions.

- Interpret crystal structures and solid-state properties using concepts of unit cells, X-ray diffraction, lattice energy, and crystal defects.
- Perform laboratory experiments involving organic synthesis, detection of elements, and redox titrations, and analyze results to determine composition and purity of chemical substances.

DETAILED CONTENT OF COURSE:

Theory Syllabus: Total Contact Hours: 45

Unit	Topics	Contact Hours
I	Chemical Bonding: II Metallic Bonding: conductors, semiconductors, and insulators; Weak forces: Van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, instantaneous dipole-induced dipole interactions, hydrogen bonding. Ionic Bonding: Lattice energy, Born-Haber cycle, solvation energy, and ionic radii Covalent character in ionic compounds, polarizing power and polarizability, Fajan's rules and consequences of polarization.	11
II	Hydrocarbons: Alkanes: General introduction alkanes, general methods of preparation: Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids, Reactivity and Mechanisms: Free radical substitutions, halogenation: relative reactivity and selectivity. Alkenes: Synthesis, Saytzeff and Hoffmann elimination, Reactions of alkenes: Electrophilic additions their mechanisms (Markownikov/ Anti Markownikov addition), mechanism of oxymercuration-demercuration, hydroboration- oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti- hydroxylation (oxidation). Alkynes: General methods of preparation, reactions of alkynes: acidity, electrophilic and nucleophilic additions.	12
III	Gaseous and Liquid State Kinetic molecular model of a gas; collision frequency; collision diameter; mean free path and viscosity of gases; Maxwell-Boltzmann distribution: molecular velocities, law of equipartition of energy, molecular basis of heat capacities; Ideal gases, and deviations from ideal gas behaviour, van der Waals equation of state, critical state, law of corresponding states. Physical properties of Liquid, vapour pressure, surface tension and viscosity and their applications; effect of concentration of solutes on surface tension and viscosity; effect of temperature on viscosity and surface tension of liquid	11

IV	Solid State Unit Cells, Miller indices, crystal systems and Bravais Lattices, elementary applications of vectors to crystal systems; X-ray diffraction, Bragg's Law, Structure of NaCl, CsCl, and KCl ; Close packing in metals and metal compounds, semiconductors, insulators; Defects in crystals, stoichiometric defects; Non stoichiometric defects; lattice energy; isomorphism.	11
V	Practical's: - Preparation of Iodoform from Acetone. - Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements). - Preparation of Dibenzalacetone from acetone and benzaldehyde. - To prepare 2,4-DNP derivative of Benzophenone/Acetophenone. - To determine the percentage purity of the given sample of Mohr's salt, 22 gm of which are dissolved per litre of the given solution. Provided N/20 Potassium permanganate solution. - To determine the percentage of the Ferrous ions in a given sample of Mohr's salt, 20 gm of which are dissolved per litre of the given solution. Provided N/20 Potassium permanganate solution. - To determine the number of molecules of water of crystallization in the given sample of Oxalic Acid. Provided N/20 Potassium permanganate solution. - To determine the percentage of Fe (II) ions in the given sample of Mohr's salt by titrating it with $K_2Cr_2O_7$ using (diphenylamine/ <i>N</i>-phenyl anthranilic acid) as indicator. - To determine the value of x in the given sample of Mohr's salt, 19.5 gm of which have been dissolved per litre of the water, by titrating it with N/20 $K_2Cr_2O_7$	30

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4. Huheey, J. E., Keiter, E. A., & Keiter, R. L. (2006). *Inorganic chemistry: Principles of structure and reactivity* (4th ed.). Pearson Education.
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7. Puri, B. R., Sharma, L. R., & Pathania, M. S. (2017). *Principles of physical chemistry* (47th ed.). Vishal Publishing Co.
8. Bahl, B. S., Tuli, G. D., & Bahl, A. (2016). *Essentials of physical chemistry*. S. Chand Publishing.
9. Madan, R. L. (2014). *Physical chemistry*. S. Chand Publishing.
10. Gurdeep, R. (2014). *Advanced physical chemistry*. Pragati Prakashan.
11. Singh, J. (2013). *Organic chemistry*. Pragati Prakashan.
12. Finar, I. L. (2011). *Organic chemistry* (Vols. 1–2). Pearson Education.
13. Vogel, A. I., Jeffery, G. H., Bassett, J., Mendham, J., & Denney, R. C. (1989). *Vogel's textbook of quantitative chemical analysis* (5th ed.). Longman.
14. Yadav, J. B. (2013). *Advanced practical physical chemistry*. Krishna Prakashan Media.
15. Rao, C. N. R., & Agarwala, U. C. (1988). *Experiments in physical chemistry*. Wiley Eastern.