SEMESTER I
PHYSICAL AND ORGANIC CHEMISTRY-I
THEORY

Program: B.Sc. **Max. Hours: 60**
Course Code: U20/CHE/DSC/101 **Hours per week: 4**
Course Type: DSC-1 **Max. Marks: 100**
No. of Credits: 4

COURSE OBJECTIVES:

- To help the students acquire knowledge on the basic principles of Quantum mechanics, and colloidal solution.
- To understand the nature and properties of different states of matter.
- To learn the structures of basic organic molecules, the types of reactions they undergo and their stereochemistry.
- To learn the methods of preparation and reactivity of hydrocarbons with mechanisms.

COURSE OUTCOMES:

CO 1: Understand and explain the structure of an atom using quantum mechanics.

CO 2: Acquire knowledge about colloids and adsorption and their applications.

CO 3: Understand the properties of gases, liquid crystals and crystalline solids.

CO 4: Acquire a fundamental understanding of the relationships between molecular structure and reaction mechanisms.

CO 5: Interpret the concept of aromaticity and familiarize with the various types of aliphatic and aromatic reactions.

PHYSICAL CHEMISTRY

MODULE 1: ELEMENTARY QUANTUM MECHANICS AND COLLOIDS (15 Hrs)

ATOMIC STRUCTURE AND ELEMENTARY QUANTUM MECHANICS (9 Hrs)

Limitations of Classical Mechanics, Black body radiation, Rayleigh Jeans Law, Planck's radiation law, photoelectric effect, Compton effects, De Broglie's hypothesis, Heisenberg's uncertainty principle, sinusoidal wave equation, Hamiltonian operator, Schrodinger equation in Cartesian and spherical polar coordinates (no derivation) Physical significance of terms involved, equation applied to H-atom. Atomic Orbitals, Radial and angular wave functions, Shape of atomic orbitals (Quantitative treatment) based on angular wave functions). Probability distribution curves - Quantum numbers and their importance.

COLLOIDS & SURFACE CHEMISTRY (6 Hrs)

Definition of colloids. Classification of colloids. Solids in liquids (sols): preparations and properties – Kinetic, Optical and Electrical stability of colloids. Protective action. Hardy–Schultz law, Gold number. Liquids in liquids (emulsions): Types of emulsions, preparation and emulsifier. Liquids in solids(gels): Classification, preparations and properties, General applications of colloids. Adsorption: Types of adsorption. Factors influencing adsorption. Freundlich adsorption isotherm. Langmuir theory of unilayer adsorption isotherm. Applications.

MODULE 2: STATES OF MATTER (15 Hrs)

GASEOUS STATE (7Hrs)

Deviation of real gases from ideal behavior, Vander Waal's equation of state. Critical phenomena: PV-isotherms of real gases, continuity of state, Andrew's isotherms of carbon dioxide. The Vander Waals equation and the critical state, Derivation of relationship between critical constant and Vander Waals constants. Experimental determination of critical constants. The law of corresponding states, reduced equation of state. Joule -Thomson effect and inversion temperature of a gas. Liquefaction of gases: (i) Linde's method based on Joule-Thomson effect. (ii) Claude's method based on adiabatic expansion of a gas.

LIQUID STATE (3 Hrs)

Inter molecular forces, structure of liquids (qualitative description). Structural differences between solids, liquids and gases. Liquid crystals, the mesomorphic state: Classification of liquid crystals into Smectic and Nematic, differences between liquid crystal and solid/liquid. Application of liquid crystals as LCD devices.

SOLID STATE **(5 Hrs)**

Laws of crystallography (i) Law of Constancy of interfacial angles (ii) law of symmetry, symmetry elements in crystals. (iii) Law of rationality of indices. Definition of space lattice, unit cell. Bravais lattices and seven crystals systems. X-ray diffraction of crystals: Deviation of Bragg's equation, determination of structure of NaCl (Bragg's method and powder method). Defects in crystals: Stoichiometric and non-Stoichiometric defects. Band theory of semiconductors: Extrinsic and Intrinsic Semiconductors, n-type and p-type and their applications in photo voltaic cells.

ORGANIC CHEMISTRY

MODULE 3: STRUCTURAL THEORY AND STEREOCHEMISTRY **(15 Hrs)**

STRUCTURAL THEORY OF ORGANIC MOLECULES **(7 Hrs)**

Cleavage of bonds (homolysis and heterolysis), Electrophiles, Nucleophiles (including neutral molecules like H_2O, BF_3, NH_3 and $AlCl_3$). Reactive intermediates: carbocations, carbanions and free radicals.

Electronic Displacements

Inductive effect. Application of inductive effect to a) Basicity of amines b) Acidity of Carboxylic acids and c) Stability of carbocations.
Resonance or Mesomeric effect. Application to a) Acidity of phenol and (b) acidity of carboxylic acids.
Hyperconjugation and its application to stability of carbocations, Free radicals and alkenes.

Types of organic reactions (mechanism not required)
Addition – Electrophilic, nucleophilic and free radical. Substitution – Electrophilic, nucleophilic and free radical. Elimination and Rearrangement Reactions – examples.

SYMMETRY OF MOLECULES **(2 Hrs)**

Symmetry operations and symmetry elements in molecules. Definition of Axis of symmetry types of C_n, Plane of symmetry (σ_h, σ_v, σ_d) Center of symmetry and improper rotational axis of symmetry (S_n). Explanation with examples.

STEREO CHEMISTRY OF CARBON COMPOUNDS **(6Hrs)**

Conformations with respect to ethane, butane and cyclohexane. Molecular representation: Wedge Formula, Newmann, Sawhorse and Fischer representations. Optical isomerism: optical activity, optical rotation and specific rotation, Concept of chirality. Examples: Glyceraldhyde, Lactic acid, Alanine. Molecules with similar chiral carbons (Tartaric acid), Enantiomers and Meso compounds. Molecules with dissimilar chiral carbons (2,3 – Dibromopentane). Diastereomerism. Configuration: Relative (D and L) and Absolute configuration, CIP Rules: R/S Racemic mixture

racemization and resolution techniques (chemical method only) Geometrical isomerism with reference to alkenes and cycloalkanes: cis – trans and E/Z configuration.

MODULE 4: ALIPHATIC & AROMATIC HYDROCARBONS (15 Hrs)

ALIPHATIC HYDROCARBONS (8 Hrs)

Alkanes – Methods of preparation: Corey-House reaction, Wurtz reaction, from Grignard reagent, Kolbe synthesis. Chemical reactivity - inert nature, free radical substitution, Halogenation example- reactivity, selectivity and orientation.

Alkenes – Preparation of alkenes (with mechanism) (a) by dehydration of alcohols (b) dehydrohalogenation of alkyl halides (c) by dehalogenation of 1,2 dihalides, Zaitsev's rule. Properties: Addition of Hydrogen – heat of hydrogenation and stability of alkenes. trans-addition of halogen and its mechanism. Addition of HX, Markonikov's rule, addition of H_2O, HOX, H_2SO_4 with mechanism and addition of HBr in the presence of peroxide (anti – Markonikov's addition). Oxidation (cis – additions) – hydroxylation by $KMnO_4$, OsO_4, trans addition- peracids (via epoxidation), hydroboration, ozonolysis – location of double bond. Dienes – Types of dienes, reactions of conjugated dienes – 1,2 and 1,4 addition of HBr to 1,3 – butadiene and Diels – Alder reaction.

Alkynes – Preparation by dehydrohalogenation of vicinal dihalides, dehalogenation of tetrahalides. Physical Properties: Acidity of terminal alkynes (formation of metal acetylides) preparation of higher alkynes, Chemical reactivity – electrophilic addition of X_2, HX, H_2O (tautomerism), Oxidation (formation of enediol, 1,2 diones and carboxylic acids) and reduction (Metal-ammonia reduction, catalytic hydrogenation).

AROMATIC HYDROCARBONS (7 Hrs)

Concept of aromaticity –definition, Huckel's rule – application to Benzenoids and Non – Benzenoids (cyclopropenyl cation, cyclopentadienyl anion and tropylium cation). Preapartions: From acetylene, phenols, benzene carboxylic acids and sulphonic acids Reactions - General mechanism of electrophilic substitution, mechanism of nitration, sulphonation and halogenation, Friedel Craft's alkylation and acylation. Orientation of aromatic substitution - Definition of ortho, para, and meta directing groups. Ring activating and deactivating groups with examples. Orientation – (i) activating groups: Amino, methoxy and alkyl groups. (ii) Deactivating groups - carboxy, nitro, nitrile, carbonyl and sulphonic acid & halo groups.

Text Books:

1. Puri, B.R., Sharma L.R., and Pathania, M.S. (2003). *Elements of Physical Chemistry.* Jalandhar, Delhi: Vishal Publishing Co.

2. Bahl, A., &Tuli. (2009). *Essentials of physical chemistry: A textbook for B. Sc. classes as per UGC model syllabus* (Rev. multicoloured.). New Delhi: S. Chand.

3. Bahl, A. and Bahl, B.S. (2011). *A Textbook of Organic Chemistry.* Ram Nagar, New Delhi: S. Chand and Company.

4. Jain, M.K., and Sharma, S.C. (2011). *Modern Organic Chemistry.* Jalandhar, Delhi: Vishal Publishing Co.

5. Sharma, Y.R. (2012). *A Text Book of Complete Organic Chemistry*. Bangalore: Kalyani Publishers.

Reference Books:

1. S.oni, P. (1979). *A textbook of physical chemistry* (11th ed.). New York: Academic Press.
2. Prutton, C., & Maron, S. (1965). *Principles of physical chemistry* (4th ed.). New York: Macmillan
3. Morrison R.T., Boyd, R.N., and Bhattacharjee S.K. (2011). *Organic Chemistry.* Delhi, Chennai, Chandigarh: Pearson.
4. Ferguson, L. (1966). *The Modern Structural theory of Organic Chemistry*. New Delhi: Prentice-Hall of India Pvt.
5. Solomons, T., & Fryhle, C. (2008). *Organic chemistry* (9th ed.). Hoboken, NJ: John Wiley.

PHYSICAL AND ORGANIC CHEMISTRY-I

MODEL QUESTION PAPER
THEORY

Course Code: U20/CHE/DSC/101 **Max. Marks: 60**
Credits: 4 **Max. Time: 2Hrs**

SECTION - A

I Answer the following **4X10=40 M**

1. Write the Schrodinger wave equation and explain the significance of ψ and ψ^2 and give shapes of p and d atomic orbitals. (CO 1) 10M

OR

2. a) What are colloids? How are they classified?(CO 2) 5M
   b) Derive expression for Langmuir adsorption isotherm.(CO 2) 5M
3. a) Explain Critical phenomenon and derive relationship between Vander waals constants and critical constants.(CO 3) 6M
   b) Differentiate between Smectic, Nematic liquid crystals and give their application (CO 3) 4M

OR

4. a) Explain Andrew Isotherm of CO_2 at different temperatures(CO 3) 5M
   b) Derive Bragg's equation (CO 3) 5M
5. a) What is Mesomeric effect? How does it explain the acidity of phenols? (CO 4) 5M
   b) Give the order of basicity of the following amines by applying the concept of Inductive effect CH_3NH_2, $(CH_3)_2NH$, $(CH_3)_3N$ (CO 4) 5M

OR

6. a) Justify that the chair form of cyclohexane is the most stable conformation.(CO 4) 6M
   b) Define proper axis of symmetry. Illustrate with 2 examples. (CO 4) 4M
7. a) What is Markovnikov's rule? Explain with a suitable example. (CO 4) 4M
   b) Give any three methods of preparation of alkenes. (CO 4) 6M

OR

8. a) Give the mechanism of Nitration on Benzene. (CO 5) 5M
   b) Write a note on directive influence of methyl group. (CO 5) 5M

SECTION - B

II .Answer any <u>FOUR</u> **4x5=20 M**

9. State and explain Heisenberg's uncertainty principle. Calculate the uncertainty in the position of a particle when the uncertainty in the momentum is 0.01 gm.cm/ sec. (h= 6.625×10^{-27} erg.sec). (CO 1)
10. Define Hardy Schulze rule and Gold number. (CO 2)
11. What are Extrinsic and Intrinsic Semiconductors and give their applications. (CO 3)
12. Explain the terms electrophile and nucleophile with 2 examples each. (CO 4)
13. How can you interpret aromatic character in a molecule? (CO 5)
14. What are Dienes? Explain Diel's Alder Reaction? (CO 5)