DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry (Minor)
Organic Chemistry 1

Semester I **Paper – 2 (P2)** **Credits 4**

Course outcome

Upon successful completion of this course, the student will be able to

CO-1 Understand different organic compounds with respect to the functional group and thus capable to name the organic compounds as per IUPAC nomenclature.

CO-2 Understand the basics of chemical reactions i.e. Substrate and Reagent, types of Reagents, Electrophilic and Nucleophilic Homolytic and heterolytic fission. Electron mobility, Inductive effect etc.

CO-3 Recognize and draw constitutional isomers, stereoisomers, including enantiomers and diasteromers, racemic mixture and meso compounds.

CO-4. Understand fundamental principles of organic chemistry and predict outcomes and derive mechanism of various types of organic reactions.

CO-5 Understand various types of reactive intermediates and factors affecting their stability

CO-6 Understand the nomenclature, synthesis, isomerism and physical properties of alkanes and cycloalkanes.

CO-7 Understand the concept of Aromaticity of benzenoids & non-benzenoids, the preparation, reactivity & structure of aromatic compounds.
CO-8 Learn the preprations, reactivity & stereochemistry of SN1 &SN2 reactions of Halogen compounds.

Unit I

I. Structure and bonding: bond lengths, bond angles, bond energy, localised and delocalized π bonds, resonance, inductive and field effects, steric effect, tautomerism, inclusion compounds, clathrates, charge transfer complexes, van der Waals interaction, hyperconjugation, aromaticity.

II. Mechanism of Organic Reactions: Curved arrow notation, drawing electron movements with arrows, half headed and double-headed arrows, Reactive intermediates-generation, structure, stability and reactions of carbocation, carbanion, free radicals and carbenes, Arynes, Nitrenes.

III. Types of organic reactions-addition, elimination, substitution, rearrangement, condensation, methods of determination of reaction mechanism (product analysis, intermediates, isotopic effects, kinetic and stereochemical studies). Energy considerations.

Unit II

IV. Stereoisomerism

Optical isomerism: Elements of symmetry, molecular chirality, optical activity, stereogenic centres, enantiomers, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers,

inversion, retention and racemization. Relative and absolute configurations. Sequence rules. D, L and R, S nomenclature.

Geometrical isomerism: determination of configuration of geometric isomers. E, Z system, geometrical isomerism in oximes and alicyclic compounds. Conformational isomerism-Conformational analysis of ethane and n-butane and cyclohexane, axial and equatorial bonds, Saw-horse and flying wedge formulae, Fischer and Newman projections formulae. Difference between conformation and configuration.

Unit – III

V. Alkanes And Cycloalkanes: Methods of formation with special reference to Wurtz, Kolbe, Corey-House reactions and decarboxylation. Physical properties and chemical reactions. Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity.

Cycloalkanes: Nomenclature, methods of preparation. Baeyer's strain theory and its limitations. Ring strain in (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring and banana bond.

VI. Alkenes, Cycloalkenes, Dienes: methods of formation. Mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides. Regio-selectivity in alcohol-dehydration. Saytzeff's rule, Hofmann elimination. Physical properties and relative stabilities of alkenes. Chemical reactions of alkenes- Mechanisms involved in hydrogenation, electrophilic and free-radical additions. Markownikoff’s rule. Hydroboration-oxidation, oxymercuration-reduction, epoxidation, ozonolysis, hydrations, hydroxylation and oxidation with $KMnO_4$, polymerization of alkenes. Substitutions at allylic and vinylic positions of alkenes.

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

VII. Alkynes: Structure and bonding in alkynes. Methods of formation, chemical reactions and acidity of alkynes. Mechanism of electrophilic and mucleophilic addition reactions, hydroboration-oxidation, reductions and oxidation reactions.

Unit IV

VIII. Arenes and Aromaticity: Nomenclature of benzene derivatives. Structure of benzene: molecular formula and Kekule structure. Stability and carbon carbon bond length of benzene, resonance structure, MO picture.

IX. Aromatic electrophilic substitution- general pattern of the mechanism, Arrhenium ion intermediate. Mechanism of nitration, halogenation, sulfonation, mercuration and Friedel-Crafts reaction. Energy profile diagrams. Activation and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction.

X. Alkyl and Aryl Halides: Methods of formation, chemical reactions. Mechanism of nucleophilic substitution reactions of alkyl halides, SN2 and SN1 reactions with energy profile diagrams, Aryl halides - Methods of

formation, nuclear and side chain reactions. Mechanisms of nucleophilic aromatic substitutions.

Text Books (Theory Courses):

(a) Organic Chemistry, Vol. I, I.L. Finar, Pearson Education.
(b) Organic Chemistry, M.K. Jain, Shoban Lal& Co.
(c) Pradeep's Organic Chemistry, S.N. Dhawan, Pradeep Publication.

Reference Books:

(a) Organic Chemistry, Morrison and Boyd, Prentice Hall.
(b) Organic Chemistry, L.G. Wade Jr. Prentice Hall.
(c) Fundamentals of Organic Chemistry Solomons, John Wiley.
(d) Organic Chemistry, Vol. I, II, III S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International)
(e) Organic Chemistry, F.A. Carey, McGraw-Hill Inc.
(f) Introduction to Organic Chemistry, Streitwiesser, Hathcock and Kosover, Macmillan.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry (Minor)
Physical Chemistry 1

Semester II **Paper 3 (P3)** **Credits 4**

Course outcome

CO-1- Students would gain knowledge regarding the basic of computers and mathematical concepts of log, permutation and combination, differential and integration of some relevant functions.

CO-2- Student would gain understanding of gaseous state, critical phenomenon, liquid state, solid state, colloidal state and liquid crystals.

CO-3- It would help students recognize the importance of chemical kinetics and catalysis.

Unit I

I. Mathematical Concepts: Logarithmic relations, curves scratching, equation of straight line and slopes, tracing of curves, differentiation of simple functions like x, ex, xn, sinx, logx; maxima and minima, partial differentiation. Integration of some useful/relevant functions; Permutations and Combinations. Factorials, Probability.

II. Computers: General introduction to computers, different components of a computer. Hardware and Software, input-output devices, binary numbers and its arithmetic; introduction to computer languages, Programming and operating systems.

Unit II

III. Gaseous State: Deviation of gases from ideal behaviour, van der Waals equation of State.

IV. Critical phenomenon: PV isotherms of real gases, continuity of states, the isotherms of van der Waals equations, relationship between critical constants and van der Waals constants, the law of corresponding states, reduced equation of states.

V. Molecular Velocities: Qualitative discussion of the Maxwell's distribution of molecular velocities, collision numbers, mean free path and collision diameter. Liquification of gases (based on Joule Thomson effect).

VI. Liquid State: A qualitative description of intermolecular forces, structure of liquids,structural differences between solids, liquids and gases.

VII. Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic, smectic and cholestric liquid crystals. Thermography and seven segment cell.

Unit III

VIII. Solid State: Definition of unit cell and space lattice.

IX. Laws of crystallography:

a. Law of constancy of interfacial angles

b. Law of rationality of indices

c. Symmetry elements in crystals and law of symmetry.

X. Diffraction-X-ray diffraction by crystals. Derivation of Bragg's equation. Laue's method and powder method, determination of crystal structure of NaCl, KCl and CsCl

XI. Colloidal State: Solids in liquids (sols): properties- Kinetic, optical and electrical; stability of colloids, protective action, Hardy-Schulz law, gold number.

XII. Liquids in liquids (emulsions): types of emulsions, preparation. Emulsifier.

XIII. Liquids in solids (gels): classification, preparation and properties, inhibition, general applications of colloids.

Unit IV

XIV. Chemical Kinetics:

a. Molecularity and order of reaction, concentration dependence of rates, integrated rate expression for- zero order, first order, second order, pseudo order reactions, half-life.

b. Determination of the order of reaction: Differential method, method of integration, half-life method and isolation method.

c. Brief outlines of experimental methods of studying chemical kinetics: conductometric, potentiometric, optical methods, polarimetry and spectrophotometery.

d. Theories of chemical kinetics: Arrhenius theory of reaction rate, effect of temperature on rate of reaction, concept of activation energy. Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis).Thermodynamics aspect of transition state theory.

XV. Catalysis: Catalysis, classification of catalysis, characteristics of catalysed reactions,

Text Books (Theory Courses):

a. Physical Chemistry, Puri Sharma & Pathania.
b. Pradeep Physical Chemistry, Khetrapal, Pradeep Publication.
c. Computers and Common Sense, R. Hunt and Shelly, Prentice Hall.

Reference Books:

a. Physical Chemistry. G.M. Barrow. International Student Edition, McGrawHill
b. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd.
c. The Elements of Physical Chemistry, P.W. Atkins, Oxford.
d. Physical Chemistry Through problems, S.K. Dogra and S. Dogra, Wiley Eastern Ltd.
e. Basic Programming with Application, V.K. Jain, Tata McGraw Hill.
f. Physical Chemistry, Glasstone

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry (Minor)
Physical Chemistry 2

Semester III **Paper 5 (P5)** **Credits 4**

Course outcome

CO-1- After the completion of the semester, student will acquire knowledge of first law and second law of thermodynamics, thermochemistry, entropy enthalpy etc.

CO-2- It will also make them familiar with conductance, equivalent conductance, Kohlrausch's law, Ostwald dilution law, Deby-Huckel Onsagar equation, e.m.f. of cell, types of cell, liquid junction potential, pH and pka, Henderson- Hazel equation etc.

Unit I

I. Thermodynamics-1

a. Definition of thermodynamic terms: System, surroundings etc. Types of systems, intensive and extensive properties. State and path functions and their differentials. Thermodynamic process. Concept of heat and work.

b. First Law of Thermodynamics: Statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law - Joule-Thomson coefficient and inversion temperature. Calculation of w,q, dU&dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.

II. Thermochemistry: Standard state, standard enthalpy of formation - Hess's Law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization. Bond dissociation energy,effect of temperature on enthalpy of reaction, Kirchhoff s equation.

Unit II

III. Thermodynamics - II

a. Second law of thermodynamics: statements of second law of thermodynamics, Carnot's cycle and its efficiency, Carnot's theorem. Thermodynamic scale of temperature, Le Chatelier's principle, reaction isotherm and reaction isochore, Clapeyron-Clausius equation and its applications

b. Concept of entropy: Entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, criteria of spontaneity and equilibrium change in ideal gases and mixing of gases.

IV. Gibbs and Helmholtz free energy functions and their definitions

Unit III

V. Electrochemistry -1:

a. Electrical transport - Conduction in metals and in electrolyte solutions, specific conductance, equivalent conductance, experimental determination of equivalent conductance and specific conductance, variation of equivalent and specific conductance with dilution. Kohlrausch's law, weak and strong electrolyte, Arrhenius theory of electrolyte dissociation and its limitations. Ostwald's dilution law its uses and limitations. Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only). Transport number, definition and its determination by Hittorfs method and moving boundary method.

VI. Applications of conductivity measurements: Determination of degree of dissociation, determination of Ka of acids, determination of solubility product of a sparingly soluble salt, conductometric titrations.

Unit IV

VII. Electrochemistry - II:

a. Types of reversible electrodes- Gas-metal ion, metal-ion, metal-insoluble salt-anion and redox electrodes. Electrode reactions, single electrode potential, standard electrode potential. Reference electrode: standard hydrogen electrode and calomel electrode, Nernst equation, derivation of cell E.M.F., electrochemical series and its significance.

b. Electrolytic and Galvanic cells- Reversible and irreversible cells, conventional representation of electrochemical cells.

c. EMF of a cell and its measurements- Calculation of cell EMF. Calculation of thermodynamic quantities of cell reactions (ΔG, ΔH and K)

d. Concentration cell with and without transport, liquid junction potential, application of concentration cells, valency of ions, solubility product and activity coefficient, potentiometric titrations.

VIII. Definition of pH and pKa, determination of pH using quinhydrone and glass electrodes by potentiometric methods. Buffers - Mechanism of buffer action, Henderson-Hazel equation. Hydrolysis of salts.

Books Suggested (Theory Courses)

a. Physical Chemistry. G.M. Barrow. International Student Edition, McGraw Hill.

b. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd.

c. The Elements of Physical Chemistry, P.W. Atkins, Oxford.

d. Physical Chemistry Through problems, S.K. Dogra and S. Dogra, Wiley Eastern Ltd.

e. Graduate physical Chemistry, Volume I-III By L.R. Sharma and M.S. Pathania

f. Principles of Physical Chemistry by B.R. Puri, L.P Sharma and M.S. Pathania, Vishal publication, Jallandhar.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry (Minor)
Inorganic Chemistry 2

Semester IV **Paper 7 (P 7)** **Credits 4**

Course outcome

CO-1 Chemistry of transition and inner-transition elements. These insights are important as they help in the rational selection of the cations of these elements for tailor-made syntheses of newer complexes

CO-2 Concepts of coordination chemistry and their applications

CO-3 Importance of different acid-base concepts which forms the basis of rational ligand designing and coordination complex formation for specific bio-inorganic, materials and optoelectronic applications.

CO-4 Importance and different chemical aspects of non-aqueous solvents which now-a-days are gaining importance in varied targeted syntheses of drugs and materials for technological applications

UNIT I

I. Chemistry of Elements of First Transition Series: Characteristic properties of d-block elements. Binary compounds (hydrides, carbides and oxides) of the elements of the first transition series and complexes with respect to relative stability of their oxidation states, coordination number and geometry.

II. Chemistry of Elements of Second and Third Transition series: General characteristics, comparative treatment of Zr/Hf, Nb/Ta , Mo/W in respect of ionic radii, oxidation states, magnetic behavior, spectral properties and stereochemistry.

Unit - II

III. Coordination Compounds double salts: Werner's coordination theory and its experimental verification, Sidwick's concept of effective atomic number, EAN concept, Polydentate ligands or chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes, Inner and outer orbital complexes, Limitations of VBT.

UNIT III

IV. Chemistry of Lanthanide Elements: Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, cerie ammonium sulphate and its analytical uses.

V. Chemistry of Actinides: Electronic conformation, oxidation states and magnetic properties, chemistry of separation of Np, Pu and Am from U.

Unit IV

VI. Oxidation and Reduction: Electrode potential, electrochemical series and its applications. Principles involved in the extraction of the elements.

VII. Acids and Bases : Arrhenius, Bronsted-Lowry, the Lux-Flood, solvent system and Lewis concept of acids and bases.

VIII. Non-aqueous Solvents: Physical properties of a solvent, types of solvents and their general characteristics, Reactions in non-aqueous solvents with reference to liquid NH_3 and liquid SO_2.

Text Books (Theory Courses):

a. Concise Inorganic Chemistry, J.D. Lee, Blackwell Science Ltd.
b. Inorganic Chemistry, Puri, Sharma, Kalia and Kaushal.
c. Pradeep's Inorganic Chemistry, K.K. Bhasin, Pradeep Publication.
d. Chemistry for degree students, R. L. Madan

Reference Books:

a. Inorganic Chemistry, J.E. Huheey, Ellen A. Keiter, Richard L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd.
b. Inorganic Chemistry, D.E. Shriver, P W. Atkins and C.H.L. Langford, Oxford.
c. Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson and P.L. Gaus, Wiley.
d. Concepts of Models of Inorganic Chemistry, B. Douglas, D. Mc Daniel and J Alexander, John Wiley.
e. Inorganic Chemistry, W.W. Porterfield, Addison - Wesley.
f. Inorganic Chemistry, A.G. Sharpe, ELBS
g. Inorganic Chemistry, G.L. Meissler and D.A. Tarr, Prentice-Hall.