Y.S. Palpara Mahavidyalaya

Programme Specific Outcome

BACHELOR OF SCIENCE (HONOURS)

MAJOR IN CHEMISTRY

4 year Undergraduate Programme

Under CCFUP and NEP 2020 system

Upon successful completion of this course,

1. Fundamental Knowledge: Students should have a strong foundation in the fundamental concepts of chemistry, including principles of inorganic, organic, and physical chemistry.
2. Laboratory Skills: Students should be proficient in laboratory techniques and safety procedures, including the ability to design and conduct experiments, analyze data, and draw conclusions.
3. Problem-Solving Skills: Graduates should be able to apply chemical principles to solve complex problems in various contexts, such as environmental, industrial, and medicinal chemistry.
4. Critical Thinking: Students should develop critical thinking skills, including the ability to evaluate scientific literature, assess the validity of experimental results, and make informed decisions based on evidence.
5. Communication Skills: Graduates should be able to effectively communicate scientific concepts and research findings through written reports and oral presentations.
6. Ethical and Professional Conduct: Students should understand and adhere to ethical standards in scientific research and demonstrate professionalism in their interactions with peers and colleagues.
7. Interdisciplinary Knowledge: Graduates should recognize the interdisciplinary nature of chemistry and its connections to other fields of science and technology.
8. Research Skills: For those pursuing research-oriented careers, the program may include the development of research skills, including experimental design, data analysis, and publication of research findings.
9. Environmental and Social Responsibility: Students may be expected to understand the environmental and societal implications of chemical processes and products and contribute to sustainable practices.

SEMESTER I
Course outcome
4 year Undergraduate Programme

Under CCFUP and NEP 2020 system

Major-1: ORGANIC CHEMISTRY-I

MJ1T: ORGANIC CHEMISTRY-I

Course contents:

A. Basics of Organic Chemistry

Bonding and Physical Properties

1. Valence Bond Theory: To know the concept of hybridisation, shapes of molecules, resonance (including hyperconjugation) and calculation of formal charges and double bond equivalent (DBE); orbital pictures of bonding (sp^3 , sp^3 , sp: C-C, C-N & C-O systems and *s-cis*and *s-trans* geometry for suitable cases).

2. Electronic displacements: To know inductive effect, field effect, mesomeric effect, resonance energy; bond polarization and bond polarizability; electromeric effect; steric effect, steric inhibition of resonance.

3. MO theory: To get qualitative idea about molecular orbitals, bonding and antibonding interactions, idea about σ, σ^*, π, π^*, n – MOs; basic idea about Frontier MOs (FMO); concept of HOMO, LUMO and SOMO; interpretation of chemical reactivity in terms of FMO interactions; sketch and energy levels of π MOs of i) acyclic p orbital system (C=C, conjugated diene, triene, allyl and pentadienyl systems) ii) cyclic p orbital system (neutral systems: [4], [6]- annulenes; charged systems: 3-,4-,5-membered ring systems); Hückel's rules for aromaticity up to [10]-annulene (including mononuclear heterocyclic compounds up to 6-memberedring); concept of antiaromaticity and homoaromaticity; non-aromatic molecules; Frost diagram; elementary idea about α and β; measurement of delocalization energies in terms of $\beta$for buta-1,3-diene, cyclobutadiene, hexa-1,3,5-triene and benzene.

4. Physical properties: To study the influence of hybridization on bond properties: bond dissociation energy (BDE) and bond energy; bond distances, bond angles; concept of bond angle strain (Baeyer's strain theory); melting point/boiling point and solubility of common organic compounds in terms of covalent & non-covalent intermolecular forces; polarity of molecules and dipole moments; relative stabilities of isomeric hydrocarbons in terms of heat of hydrogenation, heatof combustion and heat of formation.

B. General Treatment of Reaction Mechanism I

1. *Mechanistic classification:* To know ionic, radical and pericyclic (definition and example);

To study various Reaction types like addition, elimination and substitution reactions (definition and example); nature of bond cleavage and bond formation: homolytic and heterolytic bond fission, homogenic and

To study heterogenic bond formation; curly arrow rules in representation of mechanistic steps; reagenttype: electrophiles and nucleophiles (elementary idea); electrophilicity and

nucleophilicity in terms of FMO approach.

2. *Reactive intermediates: To learn about* carbocations (carbenium and carbonium ions), carbanions, carbon radicals, carbenes: generation and stability, structure using orbital picture and electrophilic/nucleophilicbehavior of reactive intermediates (elementary idea).

C. Stereochemistry I

1. *Bonding geometries of carbon compounds and representation of molecules:* To study tetrahedral nature of carbon and concept of asymmetry; Fischer, sawhorse, flying-wedge and Newman projection formulae and their inter translations.

2. *Concept of chirality and symmetry:* To study symmetry elements and point groups ($C_{\alpha v}$, C_{nh}, C_{nv}, C_n, $D_{\alpha h}$, D_{nh}, D_{nd}, D_n, S_n (C_s, C_i); molecular chirality and centre of chirality; asymmetric and dissymmetric molecules; enantiomers and diastereomers; concept of epimers; concept of stereogenicity, chirotopicity and pseudoasymmetry; chiral centres and number of stereoisomerism: systems involving 1/2/3-chiral centre(s) (AA, AB, ABA and ABC types).

3. *Relative and absolute configuration:* To study D/L and *R/S* descriptors; *erythro/threo*and *meso*nomenclature of compounds; *syn/anti* nomenclatures for aldols; *E*/*Z* descriptors for C=C, conjugated diene, triene, C=N and N=N systems; combination of *R/S*- and *E/ Z*-isomerisms.

4. *Optical activity of chiral compounds:* To study optical rotation, specific rotation and molar rotation; racemic compounds, racemisation (through cationic, anionic, radical intermediates and through reversible formation of stable achiral intermediates); resolution of acids, bases and alcohols via diastereomeric salt formation; optical purity and enantiomeric excess;invertomerism of chiral trialkylamines.

MJ1P: ORGANIC CHEMISTRY LAB- I

1. Separation: To study separation based upon solubility, by using common laboratory reagents like water (cold, hot), dil. HCl, dil. NaOH, dil. $NaHCO_3$, *etc*., of components of a binary solid mixture; purification of **any one** of the separated components by crystallization and determination of its melting point. The composition of the mixture may be of the following types: Benzoic acid/*p*-Toluidine; *p*-Nitrobenzoic acid/*p*-Aminobenzoic acid; *p*-Nitrotolune/*p*-Anisidine; *etc*.

2. Determination of boiling point: To study the boiling point of common organic liquid compounds e.g., ethanol, cyclohexane, chloroform, ethyl methyl ketone, cyclohexanone, acetylacetone, anisole, crotonaldehyde, mesityl oxide, *etc*. [Boiling point of the chosen organic compounds should preferably be less than 160 °C]

3. Identification of a Pure Organic Compound: To study the identification procedure of the following compounds.

Solid compounds: oxalic acid, tartaric acid, citric acid, succinic acid, resorcinol, urea, glucose, cane sugar, benzoic acid and salicylic acid

Liquid Compounds: formic acid, acetic acid, methyl alcohol, ethyl alcohol, acetone, aniline,

dimethylaniline, benzaldehyde, chloroform and nitrobenzene

SEC 1: Chemistry of Cosmetics & Perfumes

SEC1P: Chemistry of Cosmetics & Perfumes

Course Outline:

Part-A:

i) Preparation of talcum powder.
ii) Preparation of shampoo.
iii) Preparation of enamels.
iv) Preparation of hair remover.
v) Preparation of face cream.
vi) Preparation of nail polish and nail polish remover.
vii) Preparation of Lipstick.

Part-B: Field visit and submission of the Report

Chemistry (MINOR)

4 year Undergraduate Programme

Minor-1: ATOMIC STRUCTURE, ACIDS AND BASES, REDOX REACTIONS, & STATES OF MATTER.

MI-1T: ATOMIC STRUCTURE, ACIDS AND BASES, REDOX REACTIONS, & STATES OF MATTER.

Course contents:

Section A: Inorganic Chemistry-I

Atomic Structure

To study Bohr theory for hydrogen atom (simple mathematical treatment), atomic spectra of hydrogen and Bohr model, Sommerfeld model, quantum numbers and their significance, Pauli exclusion principle, Hund rule, electronic configuration of many-electron atoms, *Aufbau* principle and its limitations.

Acids and bases

To study Bronsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system

concept. Hard and soft acids and bases (HSAB concept), applications of HSAB process.

Redox reactions

To learn how to balance redox reactions, oxidation number and ion-electron methods. Elementary idea on standard redox potentials with sign conventions, Nernst equation (without derivation), formal potential, oxidimetry and reductimetry.

Section B: Physical Chemistry-I

Kinetic Theory of Gases and Real gases

1. To learn the concept of pressure and temperature; Collision of gas molecules; Collision diameter; Collision number and mean free path; Frequency of binary collisions (similar and different molecules); Rate of effusion

2. To learn the nature of distribution of velocities, Maxwell distribution of speed and kinetic energy; Average velocity, root mean square velocity and most probable velocity; Principle of equipartition of energy and its application to calculate the classical limit of molar heatcapacity of gases

3. To learn the deviation of gases from ideal behavior; compressibility factor; Boyle temperature; Andrew and Amagat plots; van der Waals equation and its features; its derivation and application in explaining real gas behaviour; Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states

Liquids

To learn the definition of Surface tension, its dimension and principle of its determination using stalagmometer; Viscosity of a liquid and principle of determination of coefficient of viscosityusing Ostwald viscometer; Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only)

Solids

To learn the various forms of solids, crystal systems, unit cells, Bravais lattice types, Symmetry elements; Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices; Miller indices of different planes and interplanar distance, Bragg's law; Structures of NaCl, KCl andCsCl (qualitative treatment only); Defects in crystals; Glasses and liquid crystals.

MI-1P: Practical

Course Outline:

Section A: Inorganic Chemistry –LAB

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.

3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe(II) ions by titrating it with $K_2Cr_2O_7$using redox indicator.
5. Estimation of Cu(II) ions iodometrically using $Na_2S_2O_3$.

Section B: Physical Chemistry-LAB

(I) Surface tension measurement (use of organic solvents excluded)
   a) Determination of the surface tension of a liquid or a dilute solution using a Stalagmometer
   b) Study of the variation of surface tension of a detergent solution with concentration
(II) Viscosity measurement (use of organic solvents excluded)
   a) Determination of the relative and absolute viscosity of a liquid or dilute solution using anOstwald's viscometer
   b) Study of the variation of viscosity of an aqueous solution with concentration of solute

SEMESTER II

4 year Undergraduate Programme

Course outcome
Under CCFUP and NEP 2020 system

Major-2: INORGANIC CHEMISTRY-I

MJ2T: INORGANIC CHEMISTRY-I

Course contents:

Extra nuclear Structure of atom

To study Bohr's theory, its limitations and atomic spectrum of hydrogen atom; Sommerfeld's Theory. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of *wave function*. Quantum numbers and their significance. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals. Pauli's Exclusion Principle, Hund's rules and multiplicity, Exchange energy, Aufbau principle and its limitations, Ground state Term symbols of atoms and ions for atomic number up to 30.

Chemical periodicity

To study modern IUPAC Periodic table, Effective nuclear charge, screening effects and penetration, Slater's rules, atomic radii, ionic radii (Pauling's univalent), covalent radii, lanthanide contraction. Ionization potential, electron affinity and electronegativity (Pauling's, Mulliken's and Allred-Rochow's scales) and factors influencing these properties,

group electronegativities. Group trends and periodic trends in these properties in respect of s-, p-and d-block elements. Secondary periodicity, Relativistic Effect, Inert pair effect.

Acid-Base reactions

To learn the basic concepts of Acid-Base theory, Arrhenius concept, theory of solvent system (in H_2O, NH_3, $SO_2$and HF),Bronsted-Lowry's concept, relative strength of acids, Pauling's rules. Lux-Flood concept, Lewis concept, group characteristics of Lewis acids, solvent levelling and differentiating effects. Thermodynamic acidity parameters, Drago-Wayland equation. Superacids, Gas phase acidity and proton affinity; HSAB principle. Acid-baseequilibria in aqueous solution (Proton transfer equilibria in water), pH, buffer. Acid-base neutralisation curves; indicator, choice of indicators.

Redox Reactions and precipitation reactions

To learn Ion-electron method of balancing equation of redox reaction, Elementary idea on standard redox potentials with sign conventions, Nernst equation (without derivation). Influence of complex formation, precipitation and change of pH on redox potentials; formal potential. Feasibility of a redox titration, redox potential at the equivalence point, redox indicators. Redox potential diagram (Latimer and Frost diagrams) of common elements and their applications. Disproportionation and comproportionation reactions (typical examples)

To study solubility product principle, common ion effect and their applications to the precipitation andseparation of common metallic ions as hydroxides, sulfides, phosphates, carbonates, sulfates and halides.

MJ 2P INORGANIC CHEMISTRY LAB-I

The students will learn the following practicals.

Acid and Base Titrations:

1. Estimation of carbonate and hydroxide present together in mixture
2. Estimation of carbonate and bicarbonate present together in a mixture.
3. Estimation of free alkali present in different soaps/detergents.

Oxidation-Reduction Titrimetric

1. Estimation of Fe(II) using standardized $KMnO_4$ solution
2. Estimation of oxalic acid and sodium oxalate in a given mixture
3. Estimation of Fe(II) and Fe(III) in a given mixture using $K_2Cr_2O_7$ solution.
4. Estimation of Fe(III) and Mn(II) in a mixture using standardized $KMnO_4$ solution.
5. Estimation of Fe(III) and Cu(II) in a mixture using $K_2Cr_2O_7$.
6. Estimation of Fe(III) and Cr(III) in a mixture using $K_2Cr_2O_7$.

SEC 2: Medicinal & Pharmaceutical Chemistry

SEC 2P: Medicinal and Pharmaceutical Chemistry

The students will learn the following practicals.

Part-A: Extraction

i) Extraction of eucalyptus leaf ingredient
ii) Extraction of eugenol from clove
iii) Extraction of nicotine from tobacco.
iv) Curumine from turmeric
v) Extraction of caffeine from tea/coffee

Part-B: A project: Collection and brief introduction of at least 10 herbal plants

Chemistry (MINOR)

4 year Undergraduate Programme

Minor-2: GENERAL ORGANIC CHEMISTRY, ALIPHATIC HYDROCARBONS &CHEMICAL KINETICS

MI-2T: GENERAL ORGANIC CHEMISTRY, ALIPHATIC HYDROCARBONS &CHEMICAL KINETICS

Course contents:

Section A: Organic Chemistry-I

Fundamentals of Organic Chemistry

To study electronic displacements, inductive effect, resonance and hyperconjugation; cleavage of bonds: homolytic and heterolytic; structure of organic molecules on the basis of VBT; nucleophiles electrophiles; reactive intermediates: carbocations, carbanions and free radicals.

Stereochemistry

To study different types of isomerism; geometrical and optical isomerism; concept of chirality and optical activity (up to two carbon atoms); asymmetric carbon atom; elements of symmetry (plane and centre); interconversion of Fischer and Newman representations; enantiomerism and diastereomerism, meso compounds; threo and erythro, D and L, cis and trans nomenclature; CIP Rules: R/S (upto 2 chiral carbon atoms) and E/Z nomenclature.

Nucleophilic Substitution and Elimination Reactions

To study nucleophilic substitutions: SN1 and SN2 reactions; eliminations: E1 and E2 reactions (elementary mechanistic aspects); Saytzeff and Hofmann eliminations; elimination vs substitution.

Aliphatic Hydrocarbons

To study functional group approach for the following reactions (preparations & reactions) to be studied in context to their structures.

Alkanes (up to 5 Carbons): To study preparation, catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: mechanism for free radical substitution: halogenation.

Alkenes (up to 5 Carbons): To study preparation, elimination reactions, dehydration of alcohols and dehydrohalogenation of alkyl halides; cis alkenes (partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alkaline $KMnO_4$) and trans-addition (bromine) with mechanism, addition of HX [Markownikoff's (with mechanism) and anti-Markownikoff's addition], hydration, ozonolysis, oxymercuration-demercuration and hydroboration-oxidation reaction.

Alkynes (up to 5 Carbons): To study preparation, acetylene from CaC_2 and conversion into higher alkynes, by dehalogenation of tetra halides and dehydrohalogenation of vicinal dihalides.

To study reactions, formation of metal acetylides, addition of bromine and alkaline KMnO4, ozonolysis and oxidation with hot alkaline $KMnO_4$.

Section B: Physical Chemistry

Chemical Kinetics

To study rate law, Order and molecularity, Extent of reaction; rate constants; Rates of First, second and nth order reactions and their Differential and integrated forms (with derivation); Pseudo first order reactions; Determination of order of a reaction by half-life and differential method; Opposing reactions, consecutive reactions and parallel reactions Temperature dependence of rate constant; Arrhenius equation, energy of activation; Collisiontheory; Lindemann theory of unimolecular reaction; outline of Transition State theory (classical treatment)

MI-2P: Practical

MI2P: Organic Chemistry- LAB

To study the qualitative Analysis of Single Solid Organic Compounds

1. Detection of special elements (N, Cl, and S) in organic compounds.
2. Solubility and Classification (solvents: H_2O, dil. HCl, dil. NaOH)
3. Detection of functional groups: Aromatic-NO_2, Aromatic -NH_2, -COOH,carbonyl (no distinction of –CHO and >C=O needed), -OH (phenolic) in solid organic compounds.

Physical Chemistry-LAB

To study the kinetics of the following reactions

1. Initial rate method: Iodide-persulphate reaction
2. Integrated rate method
   (i) Acid hydrolysis of methyl acetate with hydrochloric acid
   (ii) Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate
   (iii) Decomposition of H_2O_2