ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION

Model Syllabus for 4-Year UG Honours in B.Sc. (Chemistry) as Major in consonance with Curriculum framework w.e.f. AY 2025-26

COURSE STRUCTURE (for Semester I to VI)

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
I	I	1	General Chemistry	3	3
			Qualitative Analysis of Simple Salt	2	1
		2	Inorganic Chemistry	3	3
			Inorganic Preparations	2	1
	II	3	Organic Chemistry – I (Structural Theory & Hydrocarbons)	3	3
			Organic Preparations	2	1
		4	Physical Chemistry – I (States of Matter, Phase rule & Surface Chemistry)	3	3
			Physical Chemistry – I Practical	2	1
II	III	5	Organic Chemistry – II (Halogenated Hydrocarbons and Oxygen Containing Functional Groups)	3	3
			Organic Qualitative Analysis	2	1
		6	Physical Chemistry – II (Solutions and Electrochemistry)	3	3
			Physical Chemistry – II Practical	2	1
		7	Coordination Chemistry	3	3
			Preparation of Coordination Compounds	2	1
	IV	8	Organic Chemistry-III (Nitrogen Containing Organic Compounds &Biomolecules)	3	3
			Organic Chemistry-III Practical	2	1
		9	Physical Chemistry – III (Ionic equilibrium and Thermodynamics)	3	3

		10	Applied and Physical Chemistry	3	3
			Applied and Physical Chemistry Practical	2	1
III	V	11	Organic Spectroscopy	3	3
			Organic Spectral Problems	2	1
		12 A	Analytical Methods in Chemistry	3	3
			Analytical Methods in Chemistry Practical	2	1
			OR		
		12 B	Synthetic Organic Chemistry	3	3
			Synthetic Organic Chemistry Practical	2	1
		13 A	Separation techniques and Chromatography	3	3
			Separation techniques and Chromatographic Techniques	2	1
			OR		
		13 B	Industrial Chemistry - Polymers	3	3
			Industrial Chemistry - Polymers Practical	2	1
	VI	14 A	Green Chemistry and Nanotechnology	3	3
			Green Chemistry and Nanotechnology - Practical	2	1
			OR		
		14 B	Industrial Chemistry-Fertilizers and Surface Coatings	3	3
			Industrial Chemistry-Fertilizers and Surface Coatings Practical	2	1
		15 A	Environment and Industrial Chemicals	3	3
			Environment and Industrial Chemicals Practical	2	1
			OR		
		15 B	Food Chemistry	3	3
			Food Chemistry Practical	2	1

SEMESTER-III

COURSE 5: ORGANIC CHEMISTRY-II

Theory **Credits: 3** **3 hrs/week**

I. LEARNING OBJECTIVES:

1. To understand the structure, reactivity, and mechanisms of halogenated organic compounds, alcohols and phenols.
2. To analyze the mechanisms of key reactions involving aldehydes and ketones.
3. To discuss the properties and synthetic applications of carboxylic acids.
4. To explore the importance and utility of active methylene compounds in organic synthesis.

II. COURSE OUTCOMES:

At the end of the course, the student will be able to

1. Describe and compare SN1 and SN2 mechanisms in halogen compounds
2. Illustrate the methods of preparation and reactions of alcohols and phenols including rearrangements.
3. Predict products and explain mechanisms of carbonyl compound reactions.
4. Demonstrate the preparation and properties of carboxylic acid with mechanisms.
5. Apply synthetic strategies using acetoacetic and malonic esters for target molecule synthesis

III. SYLLABUS:

UNIT-1: HALOGENATED HYDROCARBONS (9 h)

Alkyl halides: Nucleophilic substitution reactions – SN1 and SN2 mechanisms with energy profile diagrams, Comparison of SN1 and SN2 reactions.

Aryl halides: Nucleophilic aromatic substitution, relative reactivity of alkyl, allyl, vinyl, benzyl and aryl halides towards nucleophilic substitution reactions.

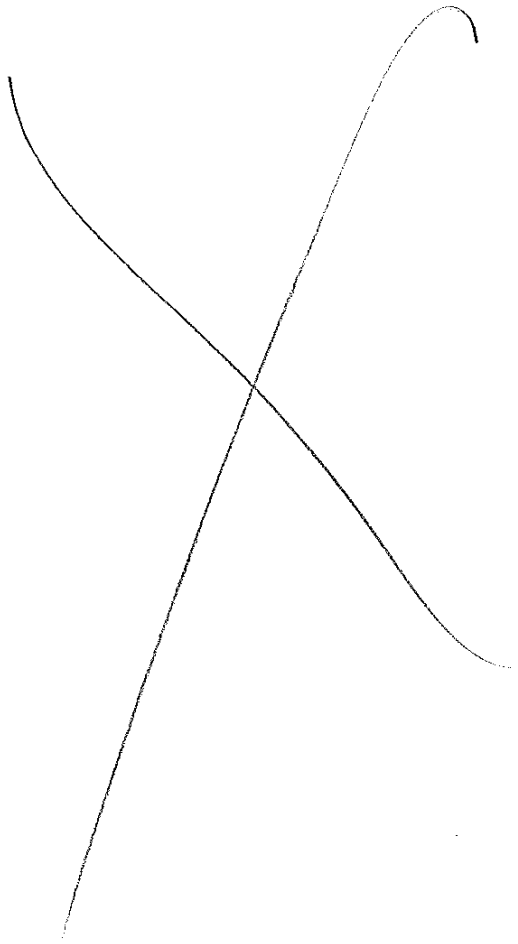
UNIT-2: ALCOHOLS AND PHENOLS (9 h)

Alcohols: Preparation of 1°, 2°, 3°-alcohols from Grignard's reagent, Chemical properties: substitution of –OH by using PCl_5, PCl_3, $SOCl_2$ and HX / $ZnCl_2$, Oxidation of alcohols with PCC and PDC, Pinacol-Pinacolone rearrangement with mechanism.

Phenols: Preparation from diazonium salt, Reimer-Tiemann and Kolbe–Schmidt reaction with mechanism.

UNIT-3: CARBONYL COMPOUNDS (9 h)

Preparation from acid chlorides, Nucleophilic addition reactions with HCN, and alcohols, addition-elimination reactions with hydroxylamine, hydrazine, phenyl hydrazine, 2,4-DNP, semi-carbazide, Oxidation with $KMnO_4$, Clemmensen reduction, Wolf–Kishner reduction.



Reaction & Mechanism- Aldol condensation, Cannizzaro reaction, Perkin reaction, Benzoin condensation.

UNIT-4: CARBOXYLIC ACIDS **(9 h)**

Preparation of carboxylic acids from Grignard reagent, Reactions of carboxylic acids involving -H, -OH and-COOH groups: formation of salts, esters, acid chlorides, amides and anhydrides. Hunsdiecker reaction, Schmidt reaction, Arndt-Eistert synthesis, Hell-Volhard-Zelinsky reaction, Mechanism of acidic hydrolysis of esters.

UNIT- 5: ACTIVE METHYLENE COMPOUNDS **(9 h)**

Acetoacetic ester (AAE): Keto-enol tautomerism, preparation of Acetoacetic ester by Claisen condensation with mechanism, synthetic applications of AAE in the preparation of mono carboxylic acids, dicarboxylic acids, α, β-unsaturated acids and heterocyclic compounds.

Malonic ester: Preparation and synthetic applications of Malonic ester.

IV. REFERENCES:

1. R.N. Morrison, R.N. Boyd, Organic Chemistry, Pearson Education, 7th edition, 2010.
2. Peter Sykes, Guidebook to Mechanism in Organic Chemistry, 6th edition, 1985.
3. S.P. Singh, O. Prakash, Reaction mechanism in organic chemistry, Laxmi Publications, 2017.
4. P.Y. Bruice, Organic Chemistry, 8th Edition, Pearson, 2017.
5. V.K. Ahluwalia, P. Bhagat, R. Aggarwal, R. Chandra, Intermediate for Organic Synthesis, I.K. International. 2005.
6. T.W.G. Solomons, C.B. Fryhle, S.A. Snyder, Organic Chemistry, 12th Edition, Wiley, 2016.

V. PROPOSED ACTIVITIES:

1. Concept Mapping- Compare SN1 & SN2 mechanisms with energy diagrams.
2. Lab-based Demonstration-Tests for alcohols and phenols.
3. Problem Solving / Reaction Mapping- Interconversion exercises between carboxylic acid derivatives.
4. Group Discussion: How esters are used in perfumes, solvents, and food industries.

VI. CO-CURRICULAR ACTIVITIES AND ASSESSMENT METHODS:

1. Continuous Internal Evaluation (CIA): Monitoring the progress of student's learning.
2. Class Tests, Worksheets, Quizzes, Industrial/Field visits, Student seminars, Poster and PPT presentations, Peer learning, Project-based learning, Assignments, Debates, Group Discussions: Enhances critical thinking skills.
3. Semester End Examination (SEE): Critical indicator of student's learning and teaching methods adopted by teachers throughout the semester.

SEMESTER-III

COURSE 5: ORGANIC QUALITATIVE ANALYSIS

Practical **Credits: 1** **2 hrs/week**

I. LEARNING OBJECTIVES:

1. To identify functional groups in unknown organic compounds using systematic analysis.
2. To determine the physical constants of organic compounds accurately.
3. To prepare suitable solid derivatives to confirm the presence of functional groups.
4. To apply laboratory safety protocols and precise techniques during analysis.

II. COURSE OUTCOMES:

At the end of the course, the student will be able to

1. Proper use of glassware, equipment and chemicals in the laboratory.
2. Systematically analyze unknown organic compounds to identify functional groups.
3. Determine melting point or boiling point of organic compounds to assess purity.
4. Prepare derivatives for confirmation of functional groups.

III. SYLLABUS:

Systematic Qualitative Analysis of an organic compounds for functional group identification including the determination of melting point and boiling point with suitable derivatives: ***Alcohols, Phenols, Aldehydes, Ketones, Carboxylic acids, Aromatic primary amines, amides and simple sugars.***

IV. REFERENCES:

1. F.G. Mann, B.C. Saunders, Practical Organic Chemistry, Pearson Education, 2009.
2. B.S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, Pearson, 2012.
3. V.K. Ahluwalia, R. Aggarwal, (2004), Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press, 2004
4. V.K. Ahluwalia, S. Dhingra, (2004), Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press, 2004.

V. CO-CURRICULAR ACTIVITIES AND ASSESSMENT METHODS:

1. Internal Practical Assessment
2. Lab Record Evaluation
3. Final Practical Examination
4. Oral/Viva Voce

SEMESTER-III

COURSE 6: PHYSICAL CHEMISTRY-II

Theory	Credits: 3	3 hrs/week

I. LEARNING OBJECTIVES:

1. Understand the principles governing the behaviour of solutions.
2. Apply colligative properties to determine molecular weights and solution behaviours.
3. Describe and differentiate between thermal and photochemical reactions, Fluorescence, Phosphorescence, with mechanistic insights.
4. Explain and apply concepts of ionic conductance and perform conductometric titrations.
5. Analyze electrochemical cells, EMF, electrode potentials, and perform potentiometric titrations.

II. COURSE OUTCOMES:

At the end of the course the student will be able to

1. Understand Azeotropes, Raoult's law and Nernst distribution law.
2. Calculate colligative properties and molecular masses of solutes using various experimental methods.
3. Explain laws of photochemistry and mechanisms of photochemical reactions with qualitative concepts of fluorescence and phosphorescence.
4. Evaluate conductance behavior of electrolytes and perform conductometric titrations.
5. Illustrate working principles of electrochemical cells and perform potentiometric titrations.

III. SYLLABUS:

UNIT-1: SOLUTIONS **(9 h)**

Classification - miscible, partially miscible and Immiscible, Raoult's Law, Azeotropes, HCl-H_2O system and ethanol-water system, Partially miscible liquids: phenol- water system, Critical solution temperature (CST), Effect of impurity on consolute temperature, Nernst distribution law, Calculation of the partition coefficient, Applications of Nernst distribution law.

UNIT- 2: COLLIGATIVE PROPERTIES **(9 h)**

Relative lowering of vapour Pressure, Elevation in boiling point, Depression in freezing point and Osmotic pressure. Determination of molecular mass of non-volatile solute by Ostwald- Walker method, Cottrell's method, Rast method and Berkeley-Hartley method.

UNIT - 3: PHOTOCHEMISTRY **(9 h)**

Difference between thermal and photochemical processes, Laws of photochemistry: Grothus-Draper's law and Stark-Einstein's law of photochemical equivalence, Quantum Yield, Photochemical reaction mechanism: Hydrogen-Chlorine and Hydrogen-Bromine reaction. Qualitative description of Fluorescence, Phosphorescence, Jablonski diagram, Chemiluminescence, and Photosensitization.

UNIT - 4: ELECTROCHEMISTRY-I (9 h)

Strong and weak electrolytes, Conductance, Specific conductance, Equivalent conductance and Molar conductance - effect of dilution. Cell constant. Kohlrausch's law and its applications. Application of conductivity measurements-conductometric titrations. Transport number and determination of transport number by Hittorf's method. Debye-Huckel - Onsager's equation for strong electrolytes (derivation excluded).

UNIT- 5: ELECTROCHEMISTRY-II (9 h)

Electrochemical Cells, Types of electrodes with examples: Metal- metal ion, Gas electrode, Inert electrode, Redox electrode, Metal-metal insoluble salt - salt anion. Single electrode potential, Standard electrode potential, Determination of EMF of a cell, Nernst equation, Potentiometric titrations.

IV. REFERENCES:

1. P.W. Atkins, J.de. Paula, Atkin's Physical Chemistry Ed., 10th Edition, Oxford University Press, 2014.
2. G.W. Castellan, Physical Chemistry, 4th Edition, Narosa., 2004.
3. K.L. Kapoor, A Textbook of Physical Chemistry, 3rd Edition, McGraw-Hill Education, 2015.
4. B.R. Puri, L.R. Sharma, M.S. Pathania, *Principles of Physical Chemistry,* Vishal Publishing, 2020.
5. P. Bahadur, **Concepts of** *Physical Chemistry,* G.R. Bathla Publications, *2018.*

V. PROPOSED ACTIVITIES:

1. Experiment: Plot miscibility curves and CST.
2. Comparative worksheet: Thermal and photochemical reactions, Fluorescence and Phosphorescence.
3. Group Work: Determination of EMF and Conductivity.

VI. CO-CURRICULAR ACTIVITIES AND ASSESSMENT METHODS:

1. Continuous Internal Evaluation (CIA): Monitoring the progress of student's learning.
2. Class Tests, Worksheets, Quizzes, Industrial/Field visits, Student seminars, Poster and PPT presentations, Peer learning, Project-based learning, Assignments, Debates, Group Discussions: Enhances critical thinking skills.
3. Semester End Examination (SEE): Critical indicator of student's learning and teaching methods adopted by teachers throughout the semester.

SEMESTER-III

COURSE 6: PHYSICAL CHEMISTRY-II PRACTICAL

Practical | **Credits: 1** | **2 hrs/week**

I. LEARNING OBJECTIVES:

1. Determine critical solution temperature (CST) and study the effect of electrolytes.
2. Use conductometry to determine the concentrations of strong and weak acids.
3. Apply potentiometric methods for accurate titration of acid-base systems.
4. Develop precision, accuracy, and skill in handling electrochemical instruments.

II. COURSE OUTCOMES:

At the end of the course the student will be able to

1. Determine the CST of a partially miscible liquid system and interpret the effect of impurities.
2. Conduct and interpret conductometric and potentiometric titrations of strong and weak acids with a strong base.
3. Use and calibrate electrochemical instruments accurately in titrations.

III. SYLLABUS:

1. Determination of Critical Solution Temperature (CST) for Phenol-water system.
2. Study the effect of electrolyte on Critical Solution Temperature.
3. Conductometric titration- Determination of the concentration of HCl solution using standard NaOH solution.
4. Conductometric titration - Determination of the concentration of CH_3COOH solution using standard NaOH solution.
5. Potentiometric titration - Determination of the concentration of HCl using standard NaOH solution.

IV. REFERENCES:

1. B.D. Khosla, V.C. Garg, A. Gulati, Senior Practical Physical Chemistry, R. Chand & Co, New Delhi, 2015.
2. K.L. Kapoor, A Textbook of Physical Chemistry, McGraw-Hill Education, 2019.
3. C.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th Edition, McGraw-Hill, New York, 2003.

V. CO-CURRICULAR ACTIVITIES AND ASSESSMENT METHODS:

1. Internal Practical Assessment
2. Lab Record Evaluation
3. Final Practical Examination
4. Oral/Viva Voce

SEMESTER-III

COURSE 7: COORDINATION CHEMISTRY

Theory | **Credits: 3** | **3 hrs/week**

I. LEARNING OBJECTIVES:

1. Understand the nomenclature, structure and isomerism of coordination compounds.
2. Apply VBT and CFT to explain bonding, geometry, magnetism, and reactivity in coordination complexes.
3. Analyze the stability of metal complexes using kinetic and thermodynamic principles.
4. Interpret the properties of organometallic compounds, especially metal carbonyls, using MO theory and the 18-electron rule.
5. Explore the roles of metal ions in biological systems and understand their physiological and toxicological effects.

II. COURSE OUTCOMES:

At the end of the course, the student will be able to:

1. Classify ligands and write IUPAC names of coordination compounds.
2. Explain VBT and CFT concepts to predict structures of complexes.
3. Analyze substitution mechanisms and assess kinetic/thermodynamic stability of complexes.
4. Describe bonding, electron count and synergic bonding in metal carbonyls.
5. Examine the biological roles and toxicity of metal ions and apply chelation in medicine.

III. SYLLABUS:

UNIT-1: COORDINATION CHEMISTRY-I (9 h)

Types of Ligands-IUPAC nomenclature of Coordination compounds, structural and stereo isomerism in complexes with coordination numbers 4 and 6. Valence Bond Theory (VBT): Postulates- magnetic properties- Inner and outer orbital complexes - Limitations of VBT.

UNIT-2: COORDINATION CHEMISTRY-II (9 h)

Crystal Field Theory: Postulates of CFT, Splitting in Octahedral, tetrahedral, tetragonal and square planar fields. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Factors affecting the crystal field splitting energy, Spectrochemical series.

UNIT-3: INORGANIC REACTION MECHANISM AND STABILITY OF COMPLEXES (9 h)

Inorganic Reaction Mechanism: Labile and inert complexes, Substitution reactions in square planar complexes, Trans-effect and its applications, Cisplatin as an anti-cancer drug.

Stability of metal complexes: Thermodynamic stability and kinetic stability, factors affecting the stability of metal complexes, chelate effect, determination of composition of complex by Job's method.

UNIT- 4: ORGANOMETALLIC COMPOUNDS-METAL CARBONYLS (9 h)

Definition and classification of organometallic compounds based on bond type. **Metal carbonyls:** General methods of preparation of metal carbonyls of 3d series,18-electron rule, electron count of mononuclear and polynuclear carbonyls. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT, π-acceptor behaviour of CO, synergic effect.

UNIT- 5: BIOINORGANIC CHEMISTRY (9 h)

Metal ions present in biological systems, classification of elements according to their action in biological systems. Na / K- pump, carbonic anhydrase and carboxypeptidase. Toxicity of metal ions (Hg, Pb, Cd and As) and reasons for toxicity, Use of chelating agents in medicine. Haemoglobin - transfer of oxygen, Myoglobin-Storage and transfer of iron.

IV. REFERENCES:

1. P.W. Atkins, T.L. Overton, J.P. Rourke, M.T. Weller, F.A. Armstrong, Shriver and Atkins Inorganic Chemistry, 5th Edition, Oxford University Press, 2010.
2. G.L. Miessler, P.J. Fischer, D.A. Tarr, Inorganic Chemistry, 5th Edition, Pearson, 2014.
3. J.E. Huheey, E.A. Keiter, R.L. Keiter, O.K. Medhi, Inorganic Chemistry- Principles of Structure and Reactivity, Pearson Education, 2009.
4. B.W. Pfennig, Principles of Inorganic Chemistry. John Wiley & Sons, 2015.
5. F.A. Cotton & G. Wilkinson, Advanced Inorganic Chemistry Wiley-VCH, 1999.
6. J.D. Lee, **Concise Inorganic Chemistry**, Oxford University Press, 2008.

V. PROPOSED ACTIVITIES:

1. Worksheet on writing IUPAC names and isomer structures of complex compounds.
2. Electron-count assignments of metal carbonyls.
3. Chart: Role of metal ions in enzymes and metal toxicity.
4. Group project: Use of chelating agents in medicine

VI. CO-CURRICULAR ACTIVITIES AND ASSESSMENT METHODS:

1. Continuous Internal Evaluation (CIA): Monitoring the progress of student's learning
2. Class Tests, Worksheets, Quizzes, Industrial/Field visits, Student seminars, Poster and PPT presentations, Peer learning, Project-based learning, Assignments, Debates, Group Discussions: Enhances critical thinking skills.
3. Semester End Examination (SEE): Critical indicator of student's learning and teaching methods adopted by teachers throughout the semester.

SEMESTER-III

COURSE 7: PREPARATION OF COORDINATION COMPOUNDS

Practical **Credits: 1** **2 hrs/week**

I. LEARNING OBJECTIVES:

1. To develop safe laboratory practices and chemical handling procedures.
2. To synthesize and isolate coordination compounds.
3. To determine the composition of a metal-ligand complex in solution.

II. COURSE OUTCOMES:

At the end of the course, the student will be able to:

1. Synthesize and purify coordination compounds.
2. Understand coordination numbers, geometries, and ligand types.
3. Demonstrate methods of complex preparation and analysis.
4. Apply Job's method to determine stoichiometric ratios of complexes.

III. SYLLABUS:

1. Preparation of Tetraamminecopper (II) sulphate.
2. Preparation of Potassium tri(oxalato)ferrate(III).
3. Preparation of hexaamminecobalt(III) chloride.
4. Acetylacetonate complexes of Cu^{2+}/Fe^{+3}.
5. Determination of the stoichiometry of a metal-ligand complex by the Jobs method.

IV. REFERENCES:

1. James E. Huheey, Inorganic Chemistry: Principles of Structure and Reactivity, Harper Collins College Publishers, 1993.
2. Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition, Pearson Education, 2000.
3. R. Gopalan, P.S. Subramanian, Elements of Analytical Chemistry, Sultan Chand & Sons, 3rd Edition, 2003.
4. G. Svehla, Vogel's Qualitative Inorganic Analysis, 7th Edition, Prentice Hall, 1996.

V. CO-CURRICULAR ACTIVITIES AND ASSESSMENT METHODS:

1. Internal Practical Assessment
2. Lab Record Evaluation
3. Final Practical Examination
4. Oral/Viva Voce

SEMESTER-IV

COURSE 8: ORGANIC CHEMISTRY-III

Theory **Credits: 3** **3 hrs/week**

I. LEARNING OBJECTIVES:

1. To understand classification, synthesis, and reactions of amines and nitro hydrocarbons.
2. To interpret the chemistry and reactivity of heterocyclic compounds and their aromaticity.
3. To understand structural details and interconversions of carbohydrates.
4. To classify amino acids and explain their synthesis, structure, and properties.

II. COURSE OUTCOMES:

At the end of the course, the student will be able to

1. Describe the synthesis and chemical behaviour of amines and nitro hydrocarbons.
2. Understand the synthetic applications of diazonium salts.
3. Illustrate aromaticity and reactivity patterns in five- and six-membered heterocycles.
4. Explain the structural features, stereochemistry, and reactivity of carbohydrates.
5. Classify and synthesize amino acids and explain their biochemical behaviour.

III. SYLLABUS:

UNIT-1: AMINES **(9 h)**

Classification and Basicity of amines, Preparation- Gabriel synthesis and reduction of amides. Distinction between Primary, secondary and tertiary amines using Hinsberg's method. Hoffmann's exhaustive methylation with mechanism, Hoffmann and Cope elimination with mechanism.

Diazonium Salts: Preparation and synthetic applications of diazonium salts. Preparation of azo dyes.

UNIT-2: NITRO HYDROCARBONS **(9 h)**

Classification, Tautomerism of nitroalkanes leading to acid and keto form, Preparation of Nitroalkanes-from alkyl halides, oxidation of amines and oximes, Reactivity - halogenation, nitration, reaction with HONO, Nef reaction and Mannich reaction.

UNIT-3: HETEROCYCLIC COMPOUNDS **(9 h)**

Classification and nomenclature of heterocyclic compounds with one hetero atom,

Pyrrole, Furan, and Thiophene: Aromatic character, Preparation from 1,4-dicarbonyl compounds (Paul-Knorr synthesis). Electrophilic substitution reactions-Halogenation, Nitration, Sulphonation, Acylation and Formylation, Diels-Alder reaction in furan.

Pyridine: Basicity, Aromaticity, Synthesis from acetylene, Chichibabin Reaction.

UNIT-4: CARBOHYDRATES (9 h)

Structural elucidation of glucose and fructose, epimers and anomers, mutarotation, Haworth projections and conformational structures of glucose and fructose, Interconversions of aldoses and ketoses: Killiani-Fischer synthesis, Ruff degradation.

UNIT- 5: AMINO ACIDS (9 h)

Definition and classification of amino acids into alpha, beta, and gamma amino acids. Natural and essential amino acids - definition and examples, classification of alpha amino acids into acidic, basic and neutral amino acids with examples. Synthesis of amino acids-Strecker's synthesis and Gabriel-Phthalimide synthesis. Zwitter ion structure, Iso-electric point, Peptide bond.

IV. REFERENCES:

1. R.N. Morrison, R.N. Boyd, Organic Chemistry, Pearson Education, 7th edition, 2010.
2. P.Y. Bruice, Organic Chemistry, 8th Edition, Pearson, 2017.
3. V.K. Ahluwalia, P. Bhagat, R. Aggarwal, R. Chandra, Intermediate for Organic Synthesis, I.K. International. 2005.
4. F.A. Carey and R.J. Sundberg, Advanced Organic Chemistry, Springer, 2008.
5. T.L. Gilchrist, Heterocyclic Chemistry, Pearson Education,1997.
6. I.L. Finar, Organic Chemistry, Vols. 1 & 2, Pearson Education, 2002.
7. O.P. Agarwal, Chemistry of Organic Natural Products, Vols. 1&2, Goel Pubs, 2015.

V. PROPOSED ACTIVITIES:

1. Group debate on tautomerism and worksheets on named reactions.
2. Create Haworth projection models using paper/polystyrene.
3. Worksheet on epimer/anomer identification.

VI. CO-CURRICULAR ACTIVITIES AND ASSESSMENT METHODS:

1. Continuous Internal Evaluation (CIA): Monitoring the progress of student's learning.
2. Class Tests, Worksheets, Quizzes, Industrial/Field visits, Student seminars, Poster and PPT presentations, Peer learning, Project-based learning, Assignments, Debates, Group Discussions: Enhances critical thinking skills.
3. Semester End Examination (SEE): Critical indicator of student's learning and teaching methods adopted by teachers throughout the semester.

SEMESTER-IV

COURSE 8: ORGANIC CHEMISTRY-III PRACTICAL

Practical	Credits: 1	2 hrs/week

I. LEARNING OBJECTIVES:

1. To understand the principles and mechanisms involved in substitution reactions.
2. To apply laboratory safety protocols and precise techniques during organic synthesis.
3. To identify functional groups in amino acids using qualitative colour reactions such as the Ninhydrin and Xanthoproteic tests.
4. To detect simple carbohydrates by qualitative tests like Molisch's, Benedict's, Barfoed's, and Seliwanoff's tests.

II. COURSE OUTCOMES:

At the end of the course the student will be able to

1. Perform acylation, benzoylation and halogenation reactions.
2. Demonstrate skill in safe and accurate laboratory practices for organic compound synthesis.
3. Evaluate the differences between monosaccharides like glucose and fructose.
4. Identify functional groups in amino acids through characteristic colour reactions.

III. SYLLABUS:

1. Benzoylation of aniline.
2. Acetylation of aniline.
3. Bromination of aniline (Synthesis of p-Bromoaniline from Aniline).
4. Identification of Functional Groups in Amino Acids by Ninhydrin test & Xanthoproteic test.
5. Qualitative tests for Glucose/Fructose-Molisch's, Benedict's, Barfoed's, and Seliwanoff's tests.
6. Estimation of Glucose by using Fehling's solution.

IV. REFERENCES:

1. B.S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, Pearson, 2012.
2. V.K. Ahluwalia, R. Aggarwal, Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press, 2004.
3. D.L. Pavia, G.M. Lampman, G.S. Kriz, R.G. Engel, Introduction to Organic Laboratory Techniques, Cengage Learning, 2014.

V. CO-CURRICULAR ACTIVITIES AND ASSESSMENT METHODS:

1. Internal Practical Assessment
2. Lab Record Evaluation
3. Final Practical Examination
4. Oral/Viva Voce

SEMESTER-IV

COURSE 9: PHYSICAL CHEMISTRY-III

Theory **Credits: 3** **3 hrs/week**

I. LEARNING OBJECTIVES:

1. To analyze ionic equilibria in aqueous solutions, including pH, buffer systems, and solubility.
2. To evaluate acid-base behaviour using various theories and apply the HSAB principle
3. To grasp fundamental thermodynamic concepts such as energy, enthalpy, and heat capacity.
4. To apply the first law of thermodynamics to chemical systems and calculate work and heat changes.
5. To explore entropy, spontaneity, and laws of thermodynamics in physical and chemical processes.

II. COURSE OUTCOMES:

At the end of the course the student will be able to

1. Compare and evaluate acid-base theories and explain HSAB applications in predicting chemical reactivity.
2. Interpret concepts of pH, buffer solutions, solubility product, and ionic equilibria.
3. Apply the first law of thermodynamics to closed and open systems.
4. Calculate thermodynamic parameters (q, w, U, H) for ideal gases under various conditions.
5. Analyze entropy changes and distinguish between reversible, irreversible, spontaneous, and non-spontaneous processes.

III. SYLLABUS:

UNIT - 1: ACIDS, BASES AND HSAB PRINCIPLE (9 h)

Definition of Acid and base- Arrhenius, Bronsted-Lowry, Lewis theories, the solvent system, Classification of solvents, pH, Types of salts, Salt hydrolysis.

Pearson's concept, HSAB principle and its application.

UNIT - 2: IONIC EQUILIBRIUM (9 h)

Degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. pH-scale, Buffer solutions, Henderson's equation.

Common ion effect and its applications, Solubility and solubility product of sparingly soluble salts, applications of solubility product.

UNIT- 3: THERMODYNAMICS- I **(9 h)**

Intensive and extensive variables, State function and Path function, Isolated, closed and open systems, Concept of heat (q), work (w), internal energy (U), First law of thermodynamics, Enthalpy (H), Heat capacities at constant volume and pressure and their relation.

UNIT - 4: THERMODYNAMICS- II **(9 h)**

Calculations of q, w, U and H for reversible, irreversible processes, Joule-Thomson effect-coefficient, Calculation of work for the expansion of perfect gas under isothermal and adiabatic conditions for reversible processes. Temperature dependence of the enthalpy of formation-Kirchoff's equation.

UNIT - 5: THERMODYNAMICS- III **(9 h)**

Second law of thermodynamics: Different Statements of the law, Carnot cycle and its efficiency, Concept of entropy, entropy as a state function, entropy changes in reversible and irreversible processes. Entropy changes in spontaneous and equilibrium processes. Spontaneous and non-spontaneous processes, Third law of thermodynamics.

IV. REFERENCES:

1. P.W. Atkins, J.de. Paula, Atkin's Physical Chemistry Ed., 10th Edition, Oxford University Press, 2014.
2. K.L. Kapoor, A Textbook of Physical Chemistry, 3rd Edition, McGraw-Hill Education, 2015.
3. B.R. Puri, L.R. Sharma, M.S. Pathania, *Principles of Physical Chemistry,* Vishal Publishing, 2020.
4. S. Glasstone, Thermodynamics for Chemists, Ewp, 2008.
5. W.U. Malik, G.D Tuli, R.D. Madan, Selected Topics in Inorganic Chemistry, S. Chand Publishing, 1998.

V. PROPOSED ACTIVITIES:

1. pH measurement of common household items using pH paper or indicators.
2. Case study- Analyze real-life use of acids and bases, HSAB principle in metallurgy/pharmaceuticals.
3. Buffer preparation and Henderson equation calculations.
4. Debate on spontaneous vs. non-spontaneous reactions.
5. Concept map activity linking the laws of thermodynamics and entropy.

VI. CO-CURRICULAR ACTIVITIES AND ASSESSMENT METHODS:

1. Continuous Internal Evaluation (CIA): Monitoring the progress of student's learning.
2. Class Tests, Worksheets, Quizzes, Industrial/Field visits, Student seminars, Poster and PPT presentations, Peer learning, Project-based learning, Assignments, Debates, Group Discussions: Enhances critical thinking skills.
3. Semester End Examination (SEE): Critical indicator of student's learning and teaching methods adopted by teachers throughout the semester.

SEMESTER-IV

COURSE 9: QUALITATIVE ANALYSIS OF INORGANIC MIXTURE

Practical **Credits: 1** **2 hrs/week**

I. LEARNING OBJECTIVES:

1. Handle laboratory reagents and equipment safely and responsibly
2. Understand group-wise separation and detection of cationic and anionic radicals.
3. Systematically analyze inorganic salt mixtures using confirmatory chemical tests.
4. Distinguish between interfering ions and eliminate them during analysis.

II. COURSE OUTCOMES:

At the end of the course the student will be able to

1. Demonstrate safe use of laboratory equipment and chemical handling.
2. Identify the presence of common anions and cations in a given salt mixture.
3. Apply group analysis techniques for systematic detection and separation.
4. Perform confirmatory tests and recognize characteristic colors, precipitates, and reactions.

III. SYLLABUS:

Analysis of a mixture salt containing two anions and two cations (From two different groups):

Anions: Carbonate, Sulphate, Chloride, Bromide, Acetate, Nitrate, Borate, Phosphate.

Cations: Lead, Copper, Iron, Aluminium, Zinc, Nickel, Manganese, Calcium, Strontium, Barium, magnesium and Ammonium.

Minimum of five mixtures should be analyzed.

IV. REFERENCES:

1. G. Svehla, Vogel's Textbook of Qualitative Inorganic Analysis, Pearson Education, 2008.
2. K. Nagaraj, S. Kamalesu, S. Lokhandwala, N.M. Parekh, Textbook of Semi-micro Inorganic Qualitative Analysis, Notion Press, 2023.
3. G. Pass, H. Sutcliff, Practical Inorganic Chemistry. 2nd edition, John-Wiley & Sons, 2020.

V. CO-CURRICULAR ACTIVITIES AND ASSESSMENT METHODS:

1. Internal Practical Assessment
2. Lab Record Evaluation
3. Final Practical Examination
4. Oral/Viva Voce

SEMESTER-IV

COURSE 10: APPLIED AND PHYSICAL CHEMISTRY

Theory **Credits: 3** **3 hrs/week**

I. LEARNING OBJECTIVES:

1. Understand polymer classification, methods of polymerization, and applications of commercial polymers.
2. Describe the fundamentals, properties, synthesis, and applications of nanomaterials.
3. Classify drugs, understand their development process, and identify their forms.
4. Apply rate laws to chemical reactions and determine kinetic parameters.
5. Analyze enzyme kinetics using rate theories and the Michaelis-Menten equation.

II. COURSE OUTCOMES:

At the end of the course, the student will be able to:

1. Explain polymer classification and applications of commercial polymers.
2. Describe types, synthesis methods, and applications of nanomaterials.
3. Explain basic pharmaceutical concepts, including drug development and dosage forms.
4. Apply kinetic laws to analyze reaction rates and derive rate equations.
5. Evaluate the role of activation energy and enzyme catalysis in chemical reactions.

III. SYLLABUS:

UNIT-1: POLYMERS **(9 h)**

Classification of polymers, Methods of polymerization- addition, condensation, co-polymerization. Structure and applications of some important polymers: Polythene, PVC, Nylon, Polyesters, Bakelite, Natural rubber. Biodegradable and non-biodegradable polymers-examples.

UNIT-2: NANOMATERIALS **(9 h)**

Definition and classification of nanomaterials, Magnetic and mechanical properties of nanomaterials, Types of nanomaterials (metal-based, carbon-based, and polymer-based), Synthesis of nanomaterials by Top-down approach and Bottom-up approach, Applications of nanomaterials in medicine and environment.

UNIT-3: DRUGS **(9 h)**

Definition of Drug and Medicine, Drug discovery-preclinical and clinical trials, Classification of drugs based on therapeutic use. Classification of dosage forms-solid, liquid, gaseous and

semisolid dosage forms, Generic and brand names of any four drugs, Introduction to Computer Aided Drug Design (CADD).

UNIT - 4: CHEMICAL KINETICS-I (9 h)

The concept of reaction rates. Factors affecting reaction rates. Order and molecularity of a reaction, Derivation of integrated rate equations for zero, first and second order reactions (similar reactants). Half–life of a reaction. General methods for the determination of the order of a reaction.

UNIT-5: CHEMICAL KINETICS-II (9 h)

Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Enzyme catalysis- Specificity, factors affecting enzyme catalysis, Inhibitors and Lock & key model. Michaels- Menten equation- derivation.

IV. REFERENCES:

1. F.W. Billmeyer, Text Book of Polymer Science, Wiley Inter Science, 2007.
2. B.R. Puri, L.R. Sharma, M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing, 2020.
3. Charles P. Poole Jr, Frank J. Owens, Introduction to nanotechnology, Wiley India, 2003.
4. K.K. Choudhary, Nanoscience and Nanotechnology, Narosa Publishing, 2016.
5. G. Patrick, Introduction to Medicinal Chemistry, Oxford University Press, 2017.
6. H. Singh, V.K. Kapoor, Medicinal & Pharmaceutical Chemistry, Vallabh Prakashan, 1996.
7. P.W. Atkins, J.de. Paula, Atkin's Physical Chemistry, Oxford University Press, 2014.
8. Gurudeep Raj, Advanced physical chemistry, Krishna Prakashan Media, 2016.

V. PROPOSED ACTIVITIES:

1. Industrial Visit: Visit to a plastic or rubber manufacturing plant
2. Seminar or case study on nanomedicine or nanofiltration
3. Solve numerical problems on half-life, Arrhenius equation, rate laws.

VI. CO-CURRICULAR ACTIVITIES AND ASSESSMENT METHODS:

1. Continuous Internal Evaluation (CIA): Monitoring the progress of student's learning
2. Class Tests, Worksheets, Quizzes, Industrial/Field visits, Student seminars, Poster and PPT presentations, Peer learning, Project-based learning, Assignments, Debates, Group Discussions: Enhances critical thinking skills.
3. Semester End Examination (SEE): Critical indicator of student's learning and teaching methods adopted by teachers throughout the semester.

SEMESTER-IV

COURSE 10: APPLIED AND PHYSICAL CHEMISTRY PRACTICAL

Practical | **Credits: 1** | **2 hrs/week**

I. LEARNING OBJECTIVES:

1. To develop practical skills in measuring the rate of chemical reactions and understanding factors affecting reaction rates.
2. To introduce students to basic nanomaterial synthesis with a focus on zinc oxide nanoparticles.
3. To develop an understanding of pharmaceutical terminology and differentiate between generic and brand names of common drugs.

II. COURSE OUTCOMES:

1. Evaluate the influence of concentration on the rate of a chemical reaction experimentally.
2. Analyze temperature dependence on reaction rate and interpret kinetic data.
3. Compare the strengths of different acids based on kinetic measurements in ester hydrolysis.
4. Synthesize zinc oxide nanoparticles and understand their significance in modern chemistry and nanotechnology.
5. Identify and categorize commonly used drugs by comparing their generic and brand names.

III. SYLLABUS:

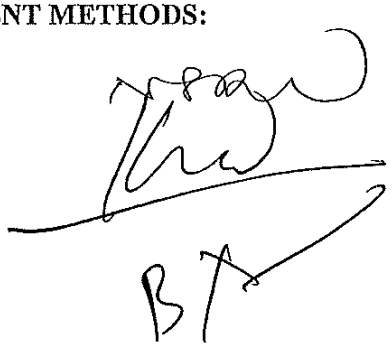
1. Determination of the rate constant of acidic hydrolysis of an ester.
2. Study the effect of concentration on the rate of reaction between sodium thiosulphate and hydrochloric acid.
3. Study the effect of temperature on the rate of reaction between sodium thiosulphate and hydrochloric acid.
4. Comparison of the strengths of HCl and H_2SO_4 by studying the kinetics of hydrolysis of methyl acetate.
5. Preparation of Zinc oxide nano particles.
6. Prepare a chart of 10 commonly used drugs with their generic and brand names and therapeutic classification.

IV. REFERENCES:

1. B.R. Puri, L.R. Sharma, M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing, 2020.
2. P.W. Atkins, J.de. Paula, Atkin's Physical Chemistry, Oxford University Press, 2014.
3. K.K. Choudhary, Nanoscience and Nanotechnology, Narosa Publishing, 2016..
4. Tripathi, K. D. Essentials of Medical Pharmacology (9th ed.). Jaypee Brothers Medical Publishers, 2021.

V. CO-CURRICULAR ACTIVITIES AND ASSESSMENT METHODS:

1. Internal Practical Assessment
2. Lab Record Evaluation
3. Final Practical Examination
4. Oral/Viva Voce



SEMESTER-V

COURSE 11: ORGANIC SPECTROSCOPY

Theory | Credits: 3 | 3 hrs/week

I. LEARNING OBJECTIVES:

1. **To understand** the principles of interaction of electromagnetic radiation with matter.
2. **To interpret** infrared (IR) spectra to identify functional groups and molecular vibrations in organic compounds.
3. **To analyze** the structure of organic molecules using chemical shifts, splitting patterns, and coupling constants in proton NMR spectroscopy.
4. **To apply** spectroscopic techniques (UV-Vis, IR, NMR, Mass) in a complementary manner to deduce the structure of simple organic compounds.

II. COURSE OUTCOMES:

At the end of the course the student will be able to

1. Describe the electromagnetic spectrum and principles behind UV-Visible, IR, and NMR, spectroscopy.
2. Analyze molecular structures using electronic transitions, chromophores, and λmax calculations.
3. Interpret IR spectra to identify functional groups and molecular vibrations.
4. Analyze NMR spectra for different compounds using chemical shifts and splitting patterns.
5. Interpret mass spectra using molecular ion peaks, fragmentation patterns, and rearrangements

III. SYLLABUS:

UNIT-1: ELECTROMAGNETIC RADIATION (EMR) & UV-VISIBLE SPECTROSCOPY: (9h)

Electromagnetic spectrum - Characteristics and classification of electromagnetic waves,

Selection rules for electronic spectra, types of electronic transitions in molecules, concept of chromophore and auxochrome, effect of conjugation, types of shifts, Woodward-Fieser rules for calculating λ_{max} of conjugated dienes.

UNIT- 2: IR SPECTROSCOPY (9h)

Principle of Infrared spectroscopy, types of molecular vibrations, fingerprint and functional group region. IR spectra of alkanes, alkenes, alkynes, simple alcohols, aldehydes, ketones, carboxylic acids and their derivatives.

UNIT- 3: NMR SPECTROSCOPY-I (PMR) (9h)

Nuclear spin, Principle of proton magnetic resonance, equivalent and non-equivalent protons, shielding and de-shielding effect, TMS, Position of signals. Chemical shift, Factors affecting chemical shift.