ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION

Model Syllabus for Chemistry (Minor) in consonance with Curriculum framework w.e.f. AY 2025-26

COURSE STRUCTURE

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
II	III	1	General Chemistry	3	3
			Qualitative Analysis of Simple Salt	2	1
	IV	2	Organic Chemistry	3	3
			Organic Qualitative Analysis	2	1
III	V	3	Inorganic Chemistry	3	3
			Inorganic Preparations	2	1
		4	Organic Chemistry and Spectroscopy	3	3
			Organic Preparations	2	1
	VI	5	Physical Chemistry	3	3
			Physical Chemistry Practical	2	1
		6	Analytical Chemistry	3	3
			Volumetric Analysis	2	1

SEMESTER-III

COURSE 1: GENERAL CHEMISTRY

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

I. LEARNING OBJECTIVES:

1. To understand the structure of the atom and its relation to periodic properties.
2. To explain different types of chemical bonding-ionic, covalent, metallic, hydrogen bonding.
3. To apply bonding theories to predict molecular structure and bonding nature.
4. To correlate periodic trends with physical and chemical properties of elements.
5. To evaluate acid-base behaviour using various theories and apply the HSAB principle.

II. COURSE OUTCOMES:

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

1. Describe the electronic configuration of elements and periodic trends.
2. Analyze the formation and properties of ionic and covalent compounds.
3. Apply VSEPR, hybridization, and MOT to predict molecular geometry and bonding.
4. Explain metallic bonding, hydrogen bonding, and intermolecular forces and relate them to physical properties.
5. Compare and evaluate acid-base theories and explain HSAB applications in predicting chemical reactivity.

III. SYLLABUS:

UNIT-1: ATOMIC STRUCTURE AND PERIODIC TABLE (9h)

Electronic configuration-Aufbau principle, Hund's rule and Pauli's exclusion principle. Periodic lawand arrangement of elements in the periodic table, horizontal, vertical, and diagonal relationships in the periodic table. Definition and periodic trends of atomic radii, ionic radii, covalent radii, ionization potential, electron affinity, and electro negativity, Pauling scale, variable valency, inert-pair effect.

UNIT-2: IONIC BOND (9h)

Properties of ionic compounds, factors favouring the formation of ionic compounds, Lattice energy: definition, factors affecting lattice energy, Born-Haber cycle - enthalpy of formation of ionic compound and stability, Covalent character in ionic compounds - polarization and Fajan's rules, effects of polarization.

UNIT-3:COVALENT BOND (9 h)

Valence Bond theory: Hybridization of atomic orbitals and geometry of molecules-$BeCl_2$, BF_3, CH_4, PCl_5, and SF_6

VSEPR model: Effect of bonding and nonbonding electrons on the structure of molecules- NH_3,H_2O,SF_4, ICl_2^- and XeF_4

Molecular orbital theory: LCAO method, construction of M.O. diagrams for homo nuclear and heteronuclear diatomic molecules (N_2, O_2, CO and NO)

UNIT -4: METALLICANDHYDROGENBONDS (9 h)

Metallic bond: Metallic properties, free electron theory, band theory of metals. Explanation of conductors, semiconductors and insulators.

Hydrogen bonding: Intra- and Inter molecular hydrogen bonding, influence on the physical properties of molecules, Vanderwaals forces, dipole-dipole interactions.

UNIT -5: ACIDS, BASESAND HSAB PRINCIPLE (9h)

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.

IV. REFERENCES:

1. J.D.Lee, Concise InorganicChemistry,5th ed.,BlackwellScience,London,1996.
2. B.R.Puri, L.R.Sharma, K.C.Kalia, Principles of Inorganic Chemistry, Shoban Lal Nagin Chand and Co.,1996.
3. D.F.ShriverandP.W.Atkins,InorganicChemistry,3rd ed., W.H.Freeman and Co, London,
4. James E. Huheey, **Inorganic Chemistry: Principles of Structure and Reactivity**, 4thed., 2017.
5. W.U. Malik, G.D Tuli, R.D Madan, Selected Topics in Inorganic Chemistry, S. Chand Publishing, 1998.

V. PROPOSED ACTIVITIES:

1. Chart on periodic trends like radii, ionization energy, electro negativity across groups/periods.
2. Worksheet solving- MOT diagrams, hybridization problems, salt hydrolysis calculations.
3. Case study- Analyze real-life use of acids and bases,
4. Model Building-Build 3D structures using kits/software for CH_4, PCl_5, XeF_4 etc.

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.

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SEMESTER-III

COURSE 1: QUALITATIVE ANALYSIS OF SIMPLE SALT

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

I.LEARNING OBJECTIVES:

1. To understand the theoretical principles behind classical qualitative analysis of cations and anions.
2. To develop the ability to identify common cations and anions in inorganic salts.
3. To practice laboratory safety and correct handling of reagents.
4. To record and interpret observations accurately in systematic salt 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. Apply systematic procedures to identify one cation and one anion in a given inorganic salt.
3. Analyze reactions based on solubility, color changes, and precipitate formation.
4. Interpret results to draw conclusions and confirm the identity of ions.

III. SYLLABUS:

Analysis of simple salt containing **one anion and one cation** from the following:

Anions: Carbonate, sulphate, chloride, bromide, acetate, nitrate, borate, phosphate.

Cations: Lead, copper, iron, aluminium, zinc, nickel, manganese, calcium, strontium, barium, ammonium.

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 2: ORGANIC CHEMISTRY

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

I. LEARNING OBJECTIVES:

1. To understand the structural theory behind reactivity in organic chemistry.
2. To classify hydrocarbons and understand the preparation and reactions of alkenes and alkynes.
3. To explain aromaticity and interpret mechanisms of key organic reactions.
4. To explore the structure, preparation, and substitution reactions of benzene.
5. Tounderstand the structure, reactivity, and mechanisms of halogenated organic compounds, alcohols and phenols

II. COURSE OUTCOMES:

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

1. Study Inductive effect, Mesomeric effect, hyper conjugation and its applications.
2. Explain the preparation and chemical properties of alkenes, alkynes and benzene.
3. Analyze and apply Huckel's rule to benzenoid and non-benzenoid aromatic compounds.
4. Analyze the reactivity and reaction mechanisms of alkyl halides, alcohols and phenols.
5. Differentiate betweenMarkownikoff and Antimarkownikoff addition, SN1 and SN2 mechanisms.

III. SYLLABUS:

UNIT-1: STRUCTURAL THEORY IN ORGANIC CHEMISTRY (9 h)

Functional groups in organic chemistry, Types of bond fission, Electrophiles, Nucleophiles, Reactive intermediates-carbocations, carbanions & free radicals. Inductive effect and its application: (a) Basicity of amines and (b) Acidity of carboxylic acids, Resonance or Mesomeric effect and its application: (a) Acidity of phenol, and (b) Acidity of carboxylic acids. Hyper conjugation and its application to the stability of carbonium ions.

UNIT-2: UNSATURATED HYDROCARBONS (ALKENES &ALKYNES) (9 h)

Alkenes: Preparation of alkenes by dehydration of alcohols, Saytzeffand Hofmann eliminations, Electrophilic Additions of X_2, H_2O, HX to alkene, Markownikoff and Anti-markownikoff addition, Ozonolysis, Diels-Alder reaction, 1,2- and1,4-addition reactions in conjugated dienes.

Alkynes: Additions of X_2, H_2O, HX to alkynes, acidity and alkylation of terminal alkynes.

UNIT-3: BENZENE AND ITS REACTIVITY (9 h)

Structure of Benzene, Preparation: polymerisation of acetylene and decarboxylation, Properties: Electrophilic aromatic substitution- Halogenation, Nitration, Friedel-Craft's alkylation and Friedel- Craft's acylation.

UNIT-4: AROMATICITY AND ALKYL HALIDES (9h)

Aromaticity: Concept of aromaticity, Huckel's rule - application to Benzenoid (Benzene, Naphthalene) and Non-Benzenoid compounds (cyclopropenylcation, cyclopentadienyl anion and tropylium cation).

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

UNIT-5: ALCOHOLS AND PHENOLS (9 h)

Alcohols: Preparation of $1^o,2^o,3^o$-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-Tiemannand Kolbe–Schmidt reactionwith mechanism.

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, 6thedition,1985.
3. S.P. Singh, O. Prakash, Reaction mechanism in organic chemistry, Laxmi Publications, 2017.
4. P.Y. Bruice, Organic Chemistry, 8thEdition, 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. Mechanism writing exercises- Electrophilic aromatic substitution, electrophilic additions.
2. Group quiz on aromaticity and reactive intermediates.
3. Concept mapping-Properties of alkane, alkene, alkyne, benzene.

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 2: 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 ofPractical 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-V

COURSE 3: INORGANIC CHEMISTRY

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

I. LEARNING OBJECTIVES:

1. To understand the structural and chemical properties of selected p-block compounds.
2. To classify and analyze the characteristics of d-block elements.
3. Understand the nomenclature, structure and isomerism of coordination compounds.
4. Apply VBT and CFT to explain bonding, geometry, magnetism, and reactivity in coordination complexes.

II. COURSE OUTCOMES:

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

1. Explain the structures and preparation of key p-block compounds.
2. Classify d-block elements and discuss their properties and oxidation states.
3. Analyze magnetic, catalytic, and color properties of transition metals.
4. Classify ligands and write IUPAC names of coordination compounds.
5. Explain VBT and CFT concepts to predict structures of complexes.

III. SYLLABUS:

UNIT-1: CHEMISTRY OF p-BLOCKELEMENTS – I (9 h)

Group 13: Preparation and structure of Diborane, Borazine and(BN)x.

Group 14: Preparation, classification and uses of silicones.

Group 15: Preparation and structure of Phosphonitrilic Chloride $P_3N_3Cl_6$.

UNIT-2: CHEMISTRY OFp-BLOCK ELEMENTS –II (9 h)

Group 16: Classification of oxides, structures of oxides and oxoacids of sulphur.

Group 17: Preparation and structures of Interhalogen compounds, Pseudohalogens.

UNIT-3:CHEMISTRYOFd-BLOCK ELEMENTS (9 h)

Characteristicsofd-blockelementswithspecialreferencetoelectronicconfiguration, variable valency, colour, magnetic properties, catalytic properties and ability to form complexes. Stability of various oxidation states of 3d-series.

UNIT-4:COORDINATION CHEMISTRY-I (9h)

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-5:COORDINATIONCHEMISTRY-II (9h)

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.

IV. REFERENCES:

1. J.D.Lee, Concise InorganicChemistry,5th ed.,BlackwellScience,London,1996.
2. B.R.Puri,L.R.Sharma,K.C.Kalia, Principles of Inorganic Chemistry, Shoban Lal Nagin Chand and Co.,1996.
3. D.F.Shriver, P.W.Atkins, Inorganic Chemistry, W.H.Freeman and Co, London,1999.
4. G.L. Miessler, P.J. Fischer, D.A. Tarr, Inorganic Chemistry, 5th Edition, Pearson, 2014.
5. J.E. Huheey, E.A. Keiter, R.L. Keiter, O.K. Medhi, Inorganic Chemistry- Principles of Structure and Reactivity, Pearson Education, 2009.
6. B.W. Pfennig, Principles of Inorganic Chemistry. John Wiley & Sons, 2015.

V. PROPOSED ACTIVITIES:

1. Group discussion: Trends in d-block properties across periods
2. Worksheet on writing IUPAC names and isomer structures of complex compounds.
3. Electron-count assignments of metal carbonyls.

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-V

COURSE 3: INORGANIC PREPARATIONS

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

I. LEARNING OBJECTIVES:

1. To understand and apply stoichiometry and principles of inorganic salt preparation.
2. To learn techniques such as crystallization, filtration, and drying.
3. To calculate percentage yields.
4. To handle reagents and lab apparatus safely and precisely

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. Describe the theoretical background for the preparation of inorganic salts.
3. Perform synthesis of potash alum, ferrous salts, and cuprous chloride following proper procedures.
4. Analyze colour changes, crystal formation, and yields to evaluate reaction completion.

III. SYLLABUS:

1. Preparation of Potash alum.
2. Preparation of Ferrous oxalate
3. Preparation of Ferrous ammonium sulphate.
4. Preparation of Cuprous chloride.
5. Preparation of Chrome alum.

IV. REFERENCES:

1. G. Svehla, Vogel's Textbook of Qualitative Inorganic Analysis, Pearson Education, 2008.
2. G.H. Jeffery, J. Bassett, J. Mendham, R.C. Denney, Vogel's Textbook of Quantitative Chemical Analysis, John Wiley and Sons, 1989.

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 4: ORGANIC CHEMISTRY AND SPECTROSCOPY

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

I. LEARNING OBJECTIVES:

1. To analyze the mechanisms of key reactions involving aldehydes and ketones.
2. To discuss the properties and synthetic applications of carboxylic acids.
3. To analyze stereochemistry through molecular representations and optical activity.
4. To understand the principles of interaction of electromagnetic radiation with matter

II. COURSE OUTCOMES:

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

1. Predict products and explain mechanisms of carbonyl compound reactions.
2. Demonstrate the preparation and properties of carboxylic acid with mechanisms.
3. Interpret stereochemical representations and identify chiral molecules.
4. Distinguish between different isomers and assign R/S and D/L configurations.
5. Describe the electromagnetic spectrum and principles behind UV-Visible and IR spectroscopy.

III. SYLLABUS:

UNIT-1: 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-2: 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- 3: STEREOCHEMISTRYOFCARBONCOMPOUNDS (9h)

Molecular representations-Wedge, Fischer, Newman and Saw-Horse formulae.

Optical isomerism: Optical activity, optical rotation and specific rotation. Chiral molecules-Symmetry elements, Enantiomers and Diastereomers, Explanation of optical isomerism with examples- Glyceraldehyde, Lactic acid, and Tartaric acid. Relative configuration (D, L-notation),CIP rules, Absolute configuration (R, S-Configuration).

UNIT-4: ELECTROMAGNETIC RADIATION (EMR) & UV-VISIBLE SPECTROSCOPY: (9h)

Electromagnetic spectrum - Characteristics and classification of electromagnetic waves.

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

UNIT- 5: IR AND ^{1}H-NMR SPECTROSCOPY (9h)

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

^{1}H-NMR spectroscopy: Principle,equivalent and non-equivalent protons, Position of signals, Splitting of NMR signals with examples.

IV. REFERENCES:

1. R.N. Morrison, R.N. Boyd,Organic Chemistry,Pearson Education, 7thedition, 2010.
2. P.Y. Bruice, Organic Chemistry, 8thEdition, Pearson, 2017.
3. T.W.G. Solomons, C.B. Fryhle, S.A. Snyder, Organic Chemistry, 12th Edition, Wiley, 2016.
4. P.S. Kalsi, Stereochemistry, New Age International, 2015.
5. D. Nasipuri, Stereochemistryof organic compounds, New Age International 2020.
6. D.L. Pavia, G.M. Lampman, G.S. Kriz, J.R. Vyvyan,Introduction to Spectroscopy, 5thEdition, Cengage Learning, 2014.
7. Y. R. Sharma, Elementary Organic Spectroscopy, Revised Edition, S. Chand Publishing, 2013.
8. P. S. Kalsi, Spectroscopy of Organic Compounds, 6thEdition, Wiley Eastern Ltd., 2007.

V. PROPOSED ACTIVITIES:

1. Lab-based Demonstration: Preparation of derivatives of carboxylic acids.
2. Reaction Mapping- Interconversion exercises between carboxylic acid derivatives.
3. Problem Solving - Calculate λ_{max} using Woodward-Fieser rules for various conjugated systems, IR and NMR calculations.

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-V

COURSE 4: ORGANIC PREPARATIONS

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

I. LEARNING OBJECTIVES:

1. Understand mechanisms and conditions for common organic synthesis reactions (nitration, bromination, esterification, acetylation).
2. Perform organic synthesis using appropriate techniques such as heating, reflux, crystallization, and filtration.
3. Develop safe laboratory practices and chemical handling procedures.

II. COURSE OUTCOMES:

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

1. Describe the theoretical background and reaction mechanisms of organic preparations.
2. Synthesize organic compounds using standard laboratory procedures.
3. Analyze reaction steps and evaluate the melting point, and yield of synthesized products.
4. Relate synthesis methods to pharmaceutical and industrial applications.

III. SYLLABUS:

1. Preparation of tribromo aniline
2. Preparation of p-nitroacetanilide
3. Preparation of nerolin
4. Preparation of aspirin (Acetylsalicylic acid)
5. Preparation of paracetamol (Acetaminophen)

IV. REFERENCES:

1. B.S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R.Tatchell,Vogel's Textbook ofPractical Organic Chemistry, Pearson, 2012.
2. V.K. Ahluwalia, R. Agarwal, Comprehensive Practical Organic Chemistry, University Press, 2010.

V. CO-CURRICULAR ACTIVITIES AND ASSESSMENT METHODS:

1. Internal Practical Assessment
2. Lab Record Evaluation
3. Final Practical Examination

Oral/Viva Voce

SEMESTER-VI

COURSE 5: PHYSICAL CHEMISTRY

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

I. LEARNING OBJECTIVES:

1. To understand the theoretical principles governing gases, liquids, solids, and colloidal systems.
2. To apply gas laws and interpret the behavior of real and ideal gases.
3. To describe physical properties of matter in various states and relate them to structural features.
4. To interpret phase diagrams and apply Gibbs' phase rule to one- and two-component systems.

II. COURSE OUTCOMES:

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

1. Explain gas laws, ideal and real gases behaviour, and critical phenomena.
2. Describe properties of liquids and classify types and applications of liquid crystals.
3. Derive Bragg's equation and identify types of crystal defects.
4. Apply the phase rule to interpret phase diagrams and systems with eutectic/congruent/incongruent points.
5. Differentiate between types of adsorption and colloidal systems, and evaluate their applications.

III. SYLLABUS:

UNIT-1: GASEOUS STATE (9 h)

Gas laws, Ideal Gas equation, Vander Waal's equation of state, Andrew's isotherms of carbon dioxide, Critical phenomena, Relationship between critical constants and van der Waal's constants, Law of corresponding states, Joule-Thomson effect, Inversion temperature.

UNIT-2: LIQUID STATE (9 h)

Physical properties of liquids: Definition of vapour pressure, boiling point, surface tension and coefficient of viscosity, Effect of temperature and addition ofsolutes on surface tension and viscosity.

Liquid crystals: Mesomorphic state, Differences between liquid crystal and solid/liquid. Classification of liquid crystals into Smectic and Nematic, Application of liquid crystals as LCD devices.

UNIT-3: SOLID STATE **(9 h)**

Law of constancy of interfacial angles, The law of rationality of indices-Miller indices, Symmetry in crystals,definition of lattice point, space lattice, unit cell, Bravais lattices and crystal systems,X-ray diffraction and crystal structure, Bragg's law and its derivation, Defects in crystals: Stoichiometric and Non-stoichiometric defects.

UNIT-4: PHASE RULE **(9 h)**

The concept of phase, components, degrees of freedom, Gibbs phase rule, Phase diagram of one component system – water system, Definition and examples for systems having congruent and incongruent melting point, Study of Phase diagrams of Simple eutectic systems (i) Pb-Ag system, desilverisation of lead (ii) NaCl-Water system, freezing mixtures

UNIT-5: SURFACE CHEMISTRY **(9 h)**

Colloids: Definition and classification of Colloids, Coagulation of colloids, Hardy-Schulze rule. Stability of colloids, Protection of Colloids-Gold number.

Adsorption: Physical and chemical adsorption, Freundlich and Langmuir adsorptionisotherm, applications of adsorption.

IV. REFERENCES:

1. P.W. Atkins, J.de.,Paula, Atkin's Physical Chemistry, 10thEdition, Oxford University Press, 2014.
2. D.W. Ball, Physical Chemistry, 2ndEdition,Cengage Learning, 2017.
3. G.W. Castellan, Physical Chemistry, 4th Edition, Narosa, 2014.
4. K.L. Kapoor, A Textbook of Physical Chemistry, 6thEdition, McGraw-Hill Education, 2015.

V. PROPOSED ACTIVITIES:

1. Model building: Bravais lattices and symmetry in crystals
2. Chart preparation of phase diagrams (Water, Pb-Ag, NaCl-H2O)
3. PPT: Adsorption isotherms or colloidal behavior.
4. List out applications of Liquid crystals in different display devices.
5. Peer Teaching: Phase rule and eutectic systems

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-VI

COURSE 5: PHYSICAL CHEMISTRY PRACTICAL

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

I. LEARNING OBJECTIVES:

1. To understand the concepts of surface tension and viscosity of liquids.
2. To familiarize students with using different lab equipment and glassware for the determination of the coefficient of viscosity and surface tension.
3. To gain hands-on experience in preparing colloidal solutions.

II. COURSE OUTCOMES:

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

1. Use glassware, equipment and follow experimental procedures in the laboratory.
2. Determine surface tension and viscosity using standard experimental techniques.
3. Prepare colloidal solutions and study their stability.
4. Conduct adsorption experiments and verify Freundlich isotherm

III. SYLLABUS:

1. Determination of surface tension of liquid by drop count method.

2. Determination of surface tension of liquid by drop weight method.

3. Determination of coefficient of viscosity of an organic liquid.

4. Preparation of sols: $Al(OH)_3$, $Fe(OH)_3$ and starch.

5. Adsorption of acetic acid on animal charcoal, verification of Freundlich isotherm.

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, 8thEdition, 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-VI

COURSE 6: ANALYTICAL CHEMISTRY

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

I. LEARNING OBJECTIVES:

1. To understand different concentration methods and their interconversion.
2. To comprehend the principles and theories underlying volumetric titrations including acid-base, redox, complexometric, and precipitation titrations.
3. To analyze and interpret analytical data using statistical tools for precision and accuracy.
4. To understand the theoretical principles and practical procedures involved in chromatographic techniques like TLC, Column Chromatography, and HPLC.
5. Appreciate the importance of data treatment and error minimization in analytical measurements

II. COURSE OUTCOMES:

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

1. Define and apply basic concepts such as mole concept, concentration units, and use of laboratory apparatus.
2. Describe the principles, types, and indicators of volumetric titrations.
3. Evaluate experimental data for accuracy and precision using appropriate statistical tools.
4. Perform and interpret chromatographic separation techniques such as TLC and Column Chromatography.
5. Describe the instrumentation and applications of HPLC in modern analytical science.

III. SYLLABUS:

UNIT-1:BASICS OF ANALYTICAL CHEMISTRY (9h)

Mole concept, Concentration terms- Molarity, Molality, Normality, Mole fraction, ppm and ppb, Primary standards and secondary standards, Standard solution. Description and use of common laboratory apparatus- volumetric flask, burette, pipette, measuring cylinders.

UNIT-2: VOLUMETRIC ANALYSIS (9 h)

Principle and requirements of volumetric analysis, Theories of acid-base, redox, complexometric and precipitation titrations(including-choice of indicators).

UNIT-3: TREATMENT OF ANALYTICAL DATA (9 h)

Accuracy and Precision, Methods of expressing accuracy-Absolute and Relative error, Methods of expressing precision-Mean, Median and Standard deviation. Determinate and indeterminate errors, minimization of errors, Confidence interval, Significant figures and their Importance.

UNIT-4: INTRODUCTION TO CHROMATOGRAPHYAND TLC (9 h)

Principle of chromatography, Classification of chromatographic methods, Nature of adsorbents, eluents, $R_f$values and factors affecting Rf values

Thin layer chromatography: Principle, Experimental procedure - preparation of plates, adsorbents and solvents, development of chromatogram, detection of spots, Applications and advantages.

UNIT-5: COLUMN CHROMATOGRAPHY AND HPLC (9h)

Column chromatography: Principle of Column chromatography, Experimental procedure, Stationary and mobile phase, applications of Column chromatography

HPLC: Instrumentation and Applications.

IV. REFERENCES:

1. D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Fundamentals of Analytical Chemistry, 9^{th}Ed., Cengage Learning, 2013.
2. G.D. Christian, Analytical Chemistry, 6^{th}Ed., John Wiley & Sons., 2004.
3. G.R. Chatwal, S.K. Anand, Instrumental Methods of Chemical Analysis, 5^{th}Edition, Himalaya Publishing House, 2014.
4. Willard, Merritt, Dean, Settle, Instrumental Methods of Analysis, 7^{th}Edition, CBS Publishers, 1986.

V. PROPOSED ACTIVITIES:

1. Prepare standard solutions of oxalic acid and sodium carbonate.
2. Group Discussion: Factors affecting Rf values in TLC.
3. Worksheets-Calculation of mean, median, standard deviation.

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-VI

COURSE 6: VOLUMETRIC ANALYSIS

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

I. LEARNING OBJECTIVES:

1. To develop practical skills in preparing and standardizing solutions.
2. To perform acid-base, redox, complexometric, and precipitation titrations accurately.
3. To develop competence in standard volumetric procedures and accurate titration techniques.
4. To train students in data recording, calculations, and inference drawing from experimental results.

II. COURSE OUTCOMES:

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

1. Use glassware, equipment and follow experimental procedures in the laboratory.
2. Accurately prepare standard solutions and handle analytical glassware.
3. Perform titrimetric analysis using appropriate techniques and indicators.
4. Interpret results using theoretical principles from acid-base, redox, complexometric, and precipitation chemistry.

III. SYLLABUS:

1. Determination of carbonate and bicarbonate in the given mixture using standard HCl.
2. Estimation of Iron (II) using standard Potassium dichromate.
3. Estimation of Mg using EDTA.
4. Estimation of Zn using EDTA.
5. Determination of Chloride ion by using Mohr's method.

IV. REFERENCES:

1. A.I.Vogel,Vogel's Textbook of Quantitative Chemical Analysis, 6thEd., Pearson Education, 2000.
2. V.K. Ahluwalia, R. Aggarwal, Comprehensive Practical Chemistry, Universities Press, 2018.
3. R. Gopalan, P.S. Subramanian, K. Raghavan,Elements of Analytical Chemistry, Sultan Chand & Sons., 2004.
4. G. Svehla, Vogel's Qualitative Inorganic Analysis, 7th Ed., Longman,1996.

V. CO-CURRICULAR ACTIVITIES AND ASSESSMENT METHODS:

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