Course Syllabus

Paper-I: Chemistry -I
(w.e.f. Academic Year: 2025-2026)

VAAGDEVI DEGREE AND PG COLLEGE
(Autonomous)

Under Graduate Courses (Under CBCS 2025–2026 onwards)
B.Sc - I Year, CHEMISTRY SEMESTER – I
Paper–I: Chemistry-I
W.e.f Academic year (2025-26) (CBCS)

Course Code: BS 105CH Course Type: DSC-3A

Total: 60 Hrs (4hrs/week)

Course Objectives:

1. To develop foundational knowledge of the chemistry of p-block elements including their structure, bonding, reactivity, and industrial relevance.
2. To understand basic organic chemistry principles, including structural theory, effects influencing reactivity, and mechanisms of hydrocarbon reactions.
3. To introduce key physical chemistry concepts such as quantum mechanics, chemical kinetics, and photochemistry for understanding molecular behavior and reaction dynamics.
4. To provide knowledge of general analytical principles including volumetric analysis, titration methods, and evaluation of analytical data
5. To explore the concepts of isomerism and stereochemistry, understanding molecular representations, conformations, and configurations.
6. To develop scientific reasoning and laboratory interpretation skills through understanding surface phenomena, adsorption, and error analysis in experimental data.

Course Outcomes:

1. Explain the structure, bonding, and reactivity of p-block compounds including boranes, carbides, nitrides, oxides, and halogen derivatives.
2. Apply structural and electronic effects (inductive, Mesomeric, and hyper conjugation) to predict the stability and reactivity of organic molecules.
3. Describe preparation methods and mechanisms of aliphatic and aromatic hydrocarbons and interpret electrophilic substitution reactions and orientation effects.
4. Interpret the principles of quantum mechanics and kinetics, derive rate equations, and solve numerical problems related to reaction rates and activation energy.
5. Demonstrate understanding of analytical and titrimetric methods, select appropriate indicators, and interpret titration curves with respect to chemical equilibria.
6. Differentiate types of isomerism and perform stereo chemical analysis, apply adsorption isotherms, and evaluate experimental data with statistical accuracy.

Unit-I(Inorganic Chemistry)15h(1h/week)

S1-I-1: Chemistry of P-Block Elements **15h**

Structure and bonding in diborane (B_2H_6), Boron nitrogen compounds ($B_3N_3H_6$and BN) , Lewis acid nature of BX_3.

Carbides - Classification-ionic, covalent, interstitial-Structures and reactivity. Industrial applications. Silicones- Classification -straight chain, cyclic and cross-linked and applications.

Nitrides- Classification-ionic, covalent and interstitial-Reactivity–hydrolysis.

Oxides and Oxiacids: Definition and Types of oxides (a) Normal-acidic, basic amphoteric and neutral (b) Mixed oxide (c) suboxide (d) peroxide (e) superoxide. Structure of oxides and oxy acids of B, C, N, P, S and Cl-reactivity, thermal stability, hydrolysis.

Inter halogens-Classification-general preparation-structures of AB, AB_3, AB_5 and AB_7 type and reactivity.

Poly halide: Definition and structure of ICl_2^-,ICl_4^- and I_3^-.

Pseudo halogens: Comparison with halogens.

Structure, bonding and reactivity of Xenon Compounds-Oxides, Halides and Oxy-halides.

Unit-II (Organic Chemistry) **15h**
(1h/week)

S1-O-1: Structural Theory in Organic Chemistry **5h**

Bond polarization: Factors influencing the polarization of covalent bonds, electro negativity – inductive effect. Application of inductive effect (a) Basicity of amines (b) Acidity of carboxylic acids (c) Stability of carbonium ions. Resonance - Mesomeric effect, application to acidity of phenol. (b) Acidity of carboxylic acids and Basicity of anilines. Stability of carbonations, carbanions and free radicals. Hyper conjugation and its application to stability of carbonium ions, free radicals and alkenes

S1-O-2: Acyclic Hydrocarbons 5h

Alkanes–Methods of preparation: Preparation of Alkanes from Grignard reagent. Chemical re activity- inert nature, free radical substitution, Halogenation example.

Alkenes-Preparation of alkenes (with mechanism)(a) by dehydration of alcohols (b).De hydro halogenation of alkyl halides (c) by dehalogenation of 1,2 dihalides, Zaitsev's rule.

Properties: Anti-addition of halogen and its mechanism. Addition of HX, Markovnikov's rule, addition of H_2O,HOX with mechanism and addition of HBr in the presence of p

pero xide (anti– Markovnikov's addition).Oxidation(cis–additions) hydroxylation by $KMnO_4$, OsO_4, anti-addition- peracids (via epoxidation), ozonolysis – location of double bond.

Alkynes– Preparation by dehydro halogenation of vicinal dihalides, dehalogenation of tetrahalides. **Physical Properties:** Chemical reactivity – electrophilic addition of X_2, HX, H_2O (tautomerism), Oxidation (formation of enediol) and reduction (catalytic hydrogenation).

S1-O-3: Aromatic Hydrocarbons 5h

Introduction to aromaticity: Huckel's rule – Benzene, Naphthalene and Anthracene. Reactions – General mechanism of electrophilic substitution, mechanism of nitration, sulphonation and Halogenation, Friedel Crafts alkylation and acylation. Orientation of aromatic substitution - Definition of ortho, para and Meta directing groups. Ring activating and deactivating groups with examples. Orientation – (i) activating groups: Amino, methoxy and alkyl groups. (ii) Deactivating groups - nitro, nitrile, carbonyl, carboxylic acid, sulphonic acid and halo groups.

Unit–III (Physical Chemistry) 15h

(1h/week)

S1-P-1: Elementary quantum mechanics 3h

Limitations of classical mechanics and Origin of quantum mechanics-Black body radiation, Rayleigh Jeans law; Planck's radiation law, photo electric effect, Compton Effect, de Broglie's hypo thesis. Heisenberg's uncertainty principle. Schrödinger wave equation (derivation not required) – significance of ψ and ψ^2.

S1-P-2: Chemical Kinetics 8h

Introduction to chemical kinetics, rate of reaction, rate laws and rate constant. Molecularity and Order of a reaction. Factors influencing the reaction rates. First order reaction, derivation of equation for rate constant. Characteristics of first order reaction. Units for rate constant. Half-life period, graph of first order reaction , Example - Decomposition of H_2O_2 problems. Pseudo first order reaction, Hydrolysis of methyl acetate, inversion of cane sugar, problems.

Second order reaction, derivation of expression for second order rate constant, example- Saponification of ester. Characteristics of second order reaction, units for rate constants, half- life period and second order plots. Problems. Methods for determining the order of a reaction. Arrhenius equation – activation energy -problems.

S1-P-3: Photochemistry 4h

Introduction to photochemistry – differences between dark and photo reactions. Laws of photochemistry; Quantum Yield – problems; Examples of photo chemical reactions with

different quantum yields. Photo chemical combinations of H2–Cl2and H2–Br2reactions.Abnormal quantum yield – high and low-examples with reasons. Singlet and triplet states. Jablonski diagram – non- radiative processes – Internal conversion and Intersystem crossing; radiative processes-Fluorescence and phosphorescence.

Unit-IV (General Chemistry) 15h (1h/week)

S1-G-1.General Principles of Inorganic quantitative Analysis:5h

Volumetric Analysis: Introduction,standardsolutions,indicators,endpoint,titrationcurves,Types of titrations:i)neutralizationtitration-principle,theoryofacidbaseindicators,titration curves and selection of indicators-strong acid-strongbase,strongacid–weakbase,weakacid- strong base and weak acid –weak base. Theory of redox titrations – internal ($KMnO_4$) and external indicators– use of diphenylamine and ferro inindicators.Theoryofcomplexometrictitrations– use of EBT, Murexide and Fast sulphone black indicators. Role of Ph in Complexometric titrations. Precipitation titrations – theory of adsorption indicators.

S1-G-2.Isomerism 5h

Isomerism: Definition of isomers. Classification of isomers: Constitutional and Stereoisomers-definition and examples.Constitutional isomers: chain, functional and positional isomers.
Stereoisomers: enantiomers and diastereomers – definitions and examples. Representation of stereoisomers – Wedge, Fischer, Sawhorse, Newmann projection formulae.
Conformational Analysis: Classification of stereoisomers based on energy. Definition and examples Conformational and configurational isomers. Conformational analysis of ethane, n-butane, 1,2- dichloromethane, 2-chloroethanol. Cis-trans isomerism: E-Z-Nomenclature.

S1-G-3 Surface Chemistry 2h

Adsorption: Types of adsorptions; Factors influencing adsorption; Freundlich adsorption isotherm and Langmuir adsorption isotherm. Applications

S1-G-4- **Evaluation of analytical Data 3h**

Significant figures, accuracy and precision. Errors-classification of errors-determinate and indeterminate errors, absolute and relative errors. Problems based on mean, median, range, standard deviation

References

General reference: B.Sc I Year Chemistry: Semester I, Telugu Academy publication, Hyd.

Unit-I

1. Puri,B.R.,Sharma,L.R.,&Kalia,M.S.(1996).Principlesofinorganicchemistry.VishalPublications.
2. Lee,J.D.(1981).Concise inorganic chemistry(3rded.).Oxford University Press.
3.Cotton,F.A.,Wilkinson,G.,&Gaus,P.L.(2001).Basicinorganicchemistry(3rded.). Wiley.
4.Huheey,J.E.,Keiter,E.A.,&Keiter,R.L.(1993).Inorganicchemistry:Principlesof structure and reactivity (4thed.). Harper Collins College Publishers.
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7. Gopalan,R.(2009).Text book of inorganic chemistry. Universities Press.

Unit-II

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2.Solomons, T. W. G., & Fryhle, C. B. (2016). Organic chemistry. Wiley (John Wiley &Sons).
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4.Wade,L.G.Jr.(2013).Organic chemistry. Pearson Education.
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6.Mc Murry,J.(2015).Organic chemistry. Cengage Learning(Brooks/Cole).
7.Soni,P.L.,&Soni,H.M.(2012).Organic chemistry. Sultan Chand &Sons.
8.Ghosh,S.K.(2009).General organic chemistry.Bharati Bhawan Publishers.
9.Pillai,C.N.(2008).Organic chemistry. Universities Press (India) Pvt.Ltd.

Unit-III

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2.Raj,G.(2009).Advanced physical chemistry(35thed.).Goel Publishing House.
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5.Kapoor,K.L.(1994).Atextbookofphysicalchemistry(Vols.4&5).MacmillanIndia Ltd.
6.Laidler,K.J.(1987).Chemical kinetics(3rded.).Mc GrawHill.
7.Rajaraman,J., &Kuriacose, J.(1993).Kinetics and mechanismof chemical transformations. Macmillan India.
8.Turro,N.J.(1978).Molecular photo chemistry.W.A. Benjamin,Inc.
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11.Kalidas,C.&Sangaranarayanan,M.V.(2019).Physicalchemistry:Problemsand solutions. Universities Press.

Unit-IV

1.Jeffery,G.H.,Bassett,J.,Mendham,J.,&Denney,R.C.(1999).Vogel'stextbookof quantitative chemical analysis (5thed.). Addison Wesley Longman Inc.
2.Day,R.A.,&Underwood,A.L.(2004).Quantitativeanalysis(6thed.).PrenticeHallof India.
3.Svehla,G.(1996).Vogel'squalitativeinorganicanalysis(7thed.).PrenticeHall.
4.Morrison,R.T.,&Boyd,R.N.(2011).Organicchemistry.PearsonEducation.
5.Solomons,T.W.G.,&Fryhle,C.B.(2016).Organic chemistry. Wiley.

6.Bruice,P.Y.(2017).Organic chemistry. Pearson Education.
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8.Levine,I.N.(2009).Physical chemistry(6th ed.).Mc GrawHill.
9.Kapoor,K.L.(1994).Atextbookofphysicalchemistry(Vols.4&5).MacmillanIndia Ltd.
10.Atkins,P.,&dePaula,J.(2010).Atkins'physicalchemistry(9th ed.).OxfordUniversity Press.
11.Mc Quarrie, D. A., & Simon, J. D. (1997). Physical chemistry: A molecular approach. Viva Books Pvt. Ltd.
12.Satake,M.,Hayashi,Y.,Mido,Y.,Iqbal,S.A.,&Sethi,M.S.(2014).Colloidaland surface chemistry. Discovery Publishing Pvt. Ltd.

B.Sc (Chemistry) -I year, Semester - I

Paper–I: Paper-I: Quantitative Analysis (Pr) lab

Course Code: BS 105CH (P) Course type:DSC-3A (P)

No. of hours per week: 2

Course Objectives:

1. Conduct chemical experiments safely and accurately, using various laboratory techniques and equipment.
2. Analyze and interpret experimental data, drawing conclusions based on evidence.
3. Communicate laboratory results effectively through written and oral presentations.
4. Apply critical thinking skills to solve chemical problems and understand chemical phenomena.

Course Outcomes:

1. Perform quantitative analysis of chemical compounds using volumetric analysis, acid-base titrations, and Complexometric titrations.
2. Apply laboratory techniques, including estimation of carbonate, bicarbonate, and alkali content.
3. Analyze experimental data, including calculation of errors and statistical analysis.

Laboratory Course-I **30h (2h/week)**

Paper-I: Quantitative Analysis

Acid-Base Titrations

1. Estimation of Carbonate in Washing Soda.
2. Estimation of Bicarbonate in Baking Soda.
3. Estimation of Carbonate and Bicarbonate in the Mixture.
4. Estimation of Alkali content in Antacid using HCl.

Redox Titrations

1. Determination of Fe(II) using $K_2Cr_2O_7$
2. Determination of Fe(II) using $KMnO_4$with sodium oxalate as primary standard.
3. Determination of Cu(II)using $Na_2S_2O_3$ with $K_2Cr_2O_7$as primary standard

ComplexometricTitrations

1. Estimation of $Mg^{2+}$by EDTA
2. Estimation of $Cu^{2+}$by EDTA

References

1.Jeffery,G.H.,Bassett,J.,Mendham,J.,&Denney,R.C.(1999).Vogel's text book of quantitative chemical analysis (5th ed.). Addison Wesley Longman Inc.
2.Vogel,A.I.Vogel'sText book of Quantitative Chemical Analysis,6thEdition,Pearson Education, 2000. ISBN: 9780582226289
3.Giri,A.N.(2010).AtextbookofpracticalchemistryHimalayaPublishingHouse.
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VAAGDEVI DEGREE AND PG COLLEGE
(Autonomous)

Under Graduate Courses (Under CBCS 2025–2026 onwards)
B.Sc - I Year, CHEMISTRY SEMESTER – II
Paper–II: Chemistry-II
W.e.f Academic year (2025-26) (CBCS)

Course Code: BS 205CH Course Type: DSC-3B

Course Objectives:

1. To understand the properties and chemistry of transition and inner transition elements, including their electronic configurations, oxidation states, and coordination behavior.
2. To explain the structure, reactivity, and mechanisms of reactions involving halogen, hydroxy, ether, and carbonyl compounds in organic chemistry.
3. To introduce the principles of electrochemistry**,** emphasizing ionic conductance, electrode potentials, and electrochemical cells.
4. To provide knowledge of molecular orbital theory, bonding in homo- and hetero-nuclear diatomic molecules, and their stability and magnetic properties.
5. To develop an understanding of stereochemistry, including optical activity, chirality, and configuration assignments using the R/S and D/L systems.
6. To describe colligative properties of solutions, their dependence on solute concentration, and their use in determining molecular masses.

Course outcome

1 Discuss the characteristic features of d- and f-block elements, explain their variable oxidation states, magnetic properties, and color formation, and relate them to their catalytic and complex-forming abilities.

2. Predict and explain reaction mechanisms of halogen, hydroxy, ether, and carbonyl compounds based on SN1/SN2 reactivity, Nucleophilic addition, oxidation, and reduction reactions

3. Apply electrochemical principles to calculate cell potentials, determine pH, analyze conductometric and Potentiometric titrations, and interpret ionic mobility and transport numbers.

4. Construct molecular orbital diagrams for diatomic molecules, determine bond order and magnetic properties, and compare their stability.

5. Identify and represent stereoisomers, determine chirality, assign absolute configurations (R/S), and interpret optical activity in organic molecules.

6. Solve numerical problems on colligative properties, including boiling point elevation, freezing point depression, and osmotic pressure to determine molecular masses.

Unit-I (Inorganic Chemistry)
15h (1h/week)

S2-I-1Chemistry of d-block elements 7h

Characteristics of d-block elements with special reference to electronic configuration, variable oxidation states, color properties, d-d spectral transitions, ability to form complexes, magnetic properties, calculation of magnetic moment-spin only formula & catalytic properties. Comparative treatment of second and third transition series with their 3d analogues.

S2-I-2: Chemistry of f-block elements 8h

Chemistry of Lanthanides: Position in periodic table, electronic structure, oxidation state, ionic and atomic radii/ionic radii- lanthanide contraction- cause and consequences, anomalous behaviorofpostlanthanides-complexation-typeofdonorligandspreferred.Magnetic properties-paramagnetism, color and spectra, f-f transitions-occurrence and separation-ion exchange method, solvent extraction.

Chemistry of actinides: General features-electronic configuration, oxidation state, actinide contraction, color and complex formation. Comparison with lanthanides.

Unit-II(Organic Chemistry)15h(1h/week)

S2-O-1: Halogen compounds 4h

Classification: alkyl (primary, secondary, tertiary), aryl, aralkyl, Chemical reactivity- reduction, formation of RMgX, Nucleophilic substitution reactions – classification into S_N1 and S_N2.Characteristics of S_N1 and S_N2 reactions , Mechanism, Stereo chemistry and energy profile diagrams of (Tertiary Butyl chloride and 1-Bromo- 1-Phenyl Propane) S_N1 and (Methyl Chloride & 2-Bromo Butane) $S_N2$reactions.

S2-O-2: Hydroxy compounds and ethers 5h

Alcohols: Preparation: 1°, 2° and 3° alcohols using Grignard reagent, Reduction of Carbonyl compounds, carboxylic acids and esters. Physical properties: H-bonding, Boiling point and Solubility. Reactions with Sodium, $HX/ZnCl_2$ (Lucas reagent), oxidation with conc. HNO_3 and Oppenauer oxidation (Mechanism).

Phenols: Preparation: (i) from diazonium salts of anilines and (ii) from benzene sulphonic acids. Properties: Acidic nature, formation of phenoxide and reaction with R-X, electrophilic substitution; halogenations, Riemer Tiemann reaction (Mechanism), Gattermann-Koch reaction, Schotten-Baumann reaction.

Ethers: Nomenclature, preparation by Williamson synthesis. Chemical properties – inert nature, action of conc. H_2SO_4.

S2-O-3Carbonyl compounds 6h

Preparation of aldehydes & ketones from acid chlorides, nitriles and carboxylic acids. Special methods of preparing aromatic aldehydes and ketones by Oxidation of arenes. Physical properties– absence of Hydrogen bonding. Reactivity of the carbonyl groups in aldehydes and ketones. Chemical reactivity: Addition of (a) $NaHSO_3$ (b)HCN (c)RMgX (d)2,4-DNP (Schiff base). Addition of H_2O to form hydrate, addition of alcohols -hemiacetal and acetal formation. Cannizzaro reaction. Oxidation reactions – $KMnO_4$ oxidation, reduction – catalytic hydrogenation, mechanism of Clemmensen reduction, Meerwein-Ponndorf-Verley reduction

Unit-III (Physical Chemistry) 15h (1h/week)

S2-P-1: Electro chemistry 15h

Revision of conductance, specific conductance, equivalent conductance and factors influencing conductance of electrolytes. Ionic mobility, definition and significance of transport number. Kohlrausch'slaw–its applications: determination of degree of dissociation and acid dissociation constant (K_a) of weak acids, solubility product determination and conductometric titrations.Ostwald'sdilution law–issues and limitations.Debye-Hückel-Onsager'sequation for strong electrolytes (elementary treatment only).

Types of electrodes with examples – Types of reversible electrodes -the gas electrode, metal-metal ion, metal-insoluble salt, redox electrodes and ion-selective electrode. Reversible and irreversible cells; Nernst equation – EMF of a cell; representation of cell-problems; electrode

potentials-electrochemical series and its significance. Determination of pH – using quinhydrone and glass electrodes. Potentiometric titrations.

Unit–IV (General Chemistry) 15h(1h/week)

S2-G-1: Chemical Bonding 5h

Molecular orbital theory: Shapes and sign convention of atomic Orbitals. Modes of bonds. Criteria for orbital overlap. LCAO concept. π and σ overlapping. Concept of Types of molecular orbitals: bonding, antibonding and non-bonding.MOED of homonuclear diatomic molecules-H_2,N_2,O_2,$\mathbf{O^-}$,$\mathbf{O^{2-}}$,F_2(unhybridized diagrams only)and hetero nuclear diatomic-CO,CN^-, NO, NO^+ and HF, their bond order, stability and magnetic properties.

S2-G-2: Stereo isomerism 5h

Optical activity: Definition, wave nature of light, plane polarized light, optical rotation and specific rotation, chiral centers. Chiral molecules: definition and criteria-absence of plane, center and S_n axis of symmetry – asymmetric and dissymmetric molecules. Examples of asymmetric molecules (Glyceraldehydes, Lactic acid, Alanine) and dissymmetric molecules (trans-1,2-dichloro cyclo propane).Molecules with constitutionally symmetrical chiral carbons (Tartaric acid) Molecules with constitutionally unsymmetrical chiral carbons(2,3dibromopentane). D, L configuration – examples. R, S – configuration: Cahn-Ingold-Prelog (CIP) rules.

S2-G-3: Colligative Properties 5h

Definition of colligative properties- relative lowering of vapour pressure-Raoult's law; Osmotic pressure; elevation of boiling point and depression of freezing point; thermodynamic relation between molecular weight and colligative proper ty (derivations not required) -Problems.

References

General reference:

B.Sc Year Chemistry: Semester II, Telugu Academy publication, Hyd.

Unit I

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2. Lee, J.D.(1981).Concise inorganic chemistry (3rded.).Oxford University Press.
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UNIT II

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Unit III

1. Glasstone, S.,& Lewis,D.(1966).Elements of physical chemistry. Macmillan.
2. Maron, S.H.,& Lando, J.B.(1966).Fundamentals of physical chemistry.Mac millanLimited.
3. Puri, B. R., Sharma, L. R., & Pathania, M. S. (2013). Principles of physical chemistry (46thed.). Vishal Publishing Company.
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5. Kapoor, K.L.(2004).Physical chemistry(Vols.3 & 5).Macmillan Publishers.
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8. Sangara narayanan, M.V.&Mahadevan, V.(2011).Text Book of Physical chemistry. Univ. Press.

Unit IV

1. Day, R.A.,& Underwood, A.L.(2004).Quantitative analysis (6thed.).Prentice Hall of India.
2. Atkins, P.W.(2001).Physical chemistry (7thed.).Oxford University Press.
3. Kapoor, K.L.(2004).Physical chemistry(Vols.3&5).Macmillan Publishers.
4. Puri, B. R., Sharma, L. R., & Pathania, M. S. (2013). Principles of physical chemistry (46thed.) Vishal Publishing Company.
5. Raj, G.(2009).Advanced physical chemistry (35thed.).Goel Publishing House.
B.Sc (Chemistry) -I year, Semester - II

Paper–II: Qualitative Analysis-Semi micro analysis of mixtures

Course Code: BS 205CH (P)

No. of hours per week: 2

Course objectives

1. Identify and analyze anions and cations in a given mixture using semi-micro analysis techniques
2. Develop skills in qualitative analysis of inorganic compounds
3. Apply chemical principles to separate and identify ions in a mixture
4. Understand interfering ions and develop strategies to handle them

Course outcome

1. Students will be able to analyze and identify anions and cations in a mixture
2. Students will develop practical skills in qualitative analysis
3. Students will apply chemical principles to real-world problems

4. Students will improve their laboratory techniques and reporting skills

Laboratory Course-II **30 h(2h/week)**

Paper II-Qualitative Analysis-Semi micro analysis of mixtures

Analysis of two anions (one simple, one interfering) and two cations in the given mixture.

Anions: CO_3^{2-},SO_3^{2-},S^{2-},Cl^-,Br^-,I^-,CH_3COO^-,NO_3^-,PO_4^{3-},BO_3^{3-},SO_4^{2-}

Cations: Hg_2^{2+},Ag^+,Pb^{2+},

Hg^{2+}, Bi^{3+}, Cd^{2+}, Cu^{2+}, As^{3+} / As^{5+} , Sb^{3+} / Sb^{5+}, Sn^{2+} / Sn^{4+}, Al^{3+}, Cr^{3+}, Fe^{3+}
Mn^{2+}, Co^{2+},
Ni^{2+}, Zn^{2+}
Ca^{2+}, Ba^{2+},
Sr^{2+}
Mg^2,NH_4^+

References

1. Svehla, G.(1996).Vogel's qualitative inorganic analysis (7th ed.).Prentice Hall.
2. Gopalan, R., Subramanian,P.S.,& Raghavan,K.(2004).Elements of analytical chemistry. Sultan Chand & Sons.
3. Ahluwalia,V.K.,and Sunita Dhingra,(2005). A Laboratory Manual of Organic and Inorganic Chemistry, 1st Edition, University Press, Hyderabad, ISBN: 9788173715623
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VAAGDEVI DEGREE AND PG COLLEGE
(Autonomous)

Under Graduate Courses (Under CBCS 2025–2026 onwards)
B.Sc - II Year, CHEMISTRY SEMESTER – III
Paper–III: Chemistry-III
W.e.f Academic year (2026-27) (CBCS)

Course Code: BS 305CH Course Type: DSC-3C

Course Objectives:

1. To understand the structure, bonding, and isomerism of coordination compounds, and explain their geometry and magnetic properties using Valence Bond Theory.
2. To introduce organometallic and metal carbonyl compounds, emphasizing their structure, preparation, bonding concepts, and industrial applications.
3. To study the preparation, properties, and mechanisms of reactions involving carboxylic acids, nitro compounds, and amines, along with their functional group transformations.
4. To understand the structure of solids and liquids, including crystal systems, Bragg's law, surface tension, and viscosity, and their experimental determination.
5. To explain the biological significance of metal ions, their role in biological systems, and the function of metallo proteins in oxygen transport and photosynthesis.
6. To introduce heterocyclic and phase rule concepts, explaining the structure, aromaticity, and reactivity of heterocycles, and the application of Gibbs phase rule to one- and two-component systems.

Course outcome

1. Explain the fundamental concepts of coordination chemistry, including nomenclature, bonding theories, and types of isomerism in metal complexes.
2. Apply theoretical models such as Valence Bond Theory, EAN rule, and Bragg's equation to interpret structure and bonding in inorganic and solid-state systems.
3. Describe preparation methods, properties, and reaction mechanisms of carboxylic acids, nitro compounds, and amines.
4. Analyze the reactivity patterns and mechanistic pathways of organic compounds including esterification, substitution, and rearrangement reactions.
5. Determine and interpret physical properties of liquids and solids such as surface tension, viscosity, and crystal structures using experimental and theoretical approaches
6. Discuss the biological roles of metal ions, aromaticity of heterocyclic compounds, and apply the

phase rule to one- and two-component systems.

Unit-I(Inorganic Chemistry) 15h(1h/week)

S3-I-1: Coordination Compounds-I 10h

Simple in organic molecules and coordination complexes. Nomenclature – IUPAC rules, 1. Coordination number, coordination geometries of metal ions, types of ligands. 2. Brief review of Werner's theory, Sidgwick's electronic interpretation and EAN rule and their limitations. (Valence bond theory (VBT) – postulates and application to (a) tetrahedral complexes $[Ni(NH_3)_4]^{2+}$,$[NiCl_4]^{2-}$and$[Ni(CO)_4]$ (b) Squareplanar complexes$[Ni(CN)_4]^{2-}$,$[Cu(NH_3)_4]^{2+}$, $[PtCl_4]^{2-}$(c)Octahedral complexes$[Fe(CN)_6]^{4-}$,$[Fe(CN)_6]^{3-}$,$[FeF_6]^{4-}$,$[Co(NH_3)_6]^{3+}$,$[CoF_6]^{3-}$ ·Limitations of VBT. 3. Isomerism in coordination compounds, stereo isomerism-(a)Geometrical isomerism in (i) Square planar metal complexes of the type$[MA_2B_2]$, $[MA_2BC]$, $[M(AB)_2]$, [MABCD]. (ii) Octahedral metal complexes of the type $[MA_4B_2]$, $[M(AA)_2B_2]$, $[MA_3B_3]$ using suitable examples, (b) Optical isomerism in (i). Tetrahedral complexes [MABCD], (ii). Octahedral complexes $[M(AA)_2B_2]$, $[M(AA)_3]$ using suitable examples. Structural isomerism: ionization, linkage, coordination ligand isomerism using suitable examples.

S3-I-2: Metal Carbonyls and related compounds 2h

Metal Carbonyls: Classification, Structural features of $Ni(CO)_4$,$Fe_2(CO)_9$, $Fe_3(CO)_{12}$, $Fe(CO)_5$ and $Cr(CO)_6$-18 valence electron rule.

S3-I-3: Organometallic Chemistry 3h

Definition, nomenclature and classification of organo metallic compounds. Methods of preparation, properties and applications of alkyl and aryl compounds of Li& Mg.

Unit-II(Organic Chemistry)15h(1h/week)

S3-O-1: Carboxylic acids 6h

Preparation :(a) Hydrolysis of Nitriles, amides and esters. (b) Carbonation of Grignard reagents. Special methods of preparation of Aromatic Acids -Oxidation of Arenes. Physical properties-hydrogen bonding, dimeric association, Chemical properties – Reactions involving H, OH and COOH groups -salt formation, anhydride formation, Acid halide formation, Esterifi cation (mechanism) &Amide form ation. Reduction of acid to the corresponding primary alcohol - via ester or acid chloride. Arndt – Eistert synthesis, Halogenation by Hell – Volhard -Zelinsky reaction.

S3-O-2: Nitro hydrocarbon 4h

Preparation of Nitro alkanes. Reactivity- halogenation, reaction with HNO_2 (Nitrousacid), Nef reaction, reduction. Aromatic Nitro hydrocarbons: Preparation of Nitrobenzene by Nitration.

Physical properties, chemical reactivity–Reduction of Nitrobenzene in different media.

S3-O-3: Amines 5h

Amines: classification into1°,2°,3°Amines and quaternary ammonium compounds. Preparative methods – Ammonolysis of alkyl halides, Gabriel synthesis, Hoffmann bromamide reaction (mechanism). Reduction of Amides and Schmidt reaction. Physical properties. Chemical Properties: a)Alkylation b) Acylation c) Carbylamine reaction d)Hinsberg separation. Reaction with Nitrous acid of 1°, 2°, 3°amines (aliphatic and aromatic).Electrophilic substitutions of Aromatic amines – Bromination and Nitration.

Unit-III (Physical Chemistry)15h(1h/week)

S3-P-1: Solid state Chemistry 6h

Classification of Crystalline Solids; Definition of space lattice, unit cell. Brava is Lattices and Seven Crystal systems (a brief review). Laws of Crystallography-(i) Law of Constancy of interfacial angles (ii) Law of Symmetry- Symmetry elements in crystals (iii) Law of rationality of indices.; X-ray diffraction by crystals; Derivation of Bragg's equation. Determination of structure of NaCl (Bragg's method and Powder method)

S3-P-2: Dipole moment & Liquid State 9h

Dipole moment: Defination, Units, Arising of Dipole moments, Types of Dipole moment (Examples) , Factors effecting and Applicatins.

Liquid state: Inter molecular forces, Structure of liquids, Structural differences between solids, liquids. Surface tension and its determination using a stalagnometer. Viscosity of liquids and determination of viscosity coefficient of viscosity using Ostwald viscometer. Effect of Temperature on Surface tension and viscosity coefficient of a liquid (Qualitative treatment only).

Unit–IV (General Chemistry) 15h (1h/week)

S3-G-1.Bio inorganic Chemistry: 5h

Essential elements, biological significance of Na, K, Mg, Ca, Fe, Co, Ni, Cu, Zn and chloride (Cl^-). Toxicity of Cd, As, Hg and Pb. Oxygen transport and storage: structure of hemoglobin, binding and transport of oxygen. Fixation of CO_2 in photosynthesis.

S3-G-2: Heterocyclic Compound 5h

Introduction and definition: 5-membered ring compounds with one hetero atom Ex. pyrrole,furan and thiophene. Importance of ring systems – and numbering in heterocyclic compounds. Aromatic character, Resonance structures: Explanation of feebly acidic character of pyrrole, preparation of pyrrole, furan and thiophene Paal-Knorr synthesis. Electrophilic substitution, halogenation, nitration and sulfonation. Basicity, aromaticity of pyridine – comparison with pyrrole –preparation by Hantzsch method and properties – reactivity towards Nucleophilic substitution reaction – Chichibabin reaction.

S3-G-3: Phase Rule 5h

Statement and meaning of the terms–Phase, Component and Degrees of freedom, Gibb's Phase rule, phase equilibria of one component system – water system. Phase equilibria of two-

component system – Solid-Liquid equilibria, simple eutectic –Pb-Ag system, de silverisation of lead

Reference

General reference: **B.Sc II Year Chemistry: Semester III, Telugu Academy publication, Hyd**

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Unit-III

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Unit-IV

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4. Bruice, P.Y.(2012).Organic chemistry. Pearson Education.
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B.Sc (Chemistry) -II year, Semester - III

Paper–III: (Organic Synthesis)

Course Code: BS 305CH (P) Course type: DSC-3C (P)

No. of hours per week: 2

Course Objectives:

1. To enable students to understand and perform basic organic synthesis techniques involving acetylation, nitration, halogenation, oxidation, methylation, condensation, and diazotisation reactions.
2. To study the reaction mechanisms of different organic transformations and recognize their significance in synthetic organic chemistry.
3. To expose students to environmentally friendly and efficient synthesis methods such as microwave-assisted organic synthesis.
4. To train students in the proper handling of laboratory apparatus, reagents, and safe laboratory practices.
5. To relate theoretical knowledge of organic reaction mechanisms to experimental outcomes and product characterization.

Course outcome:

1. Understand and perform common organic synthesis reactions such as acetylation, nitration, halogenation, oxidation, methylation, condensation, and diazotisation.
2. Develop practical skills in the synthesis, purification, and characterization of organic compounds.
3. Gain hands-on experience in handling laboratory apparatus and following safety protocols in organic synthesis experiments.
4. Correlate theoretical knowledge of organic reaction mechanisms with experimental outcomes.

5. Demonstrate the preparation of important organic compounds such as aspirin using microwave-assisted synthesis techniques and understand the advantages of green chemistry approaches.

Laboratory Course-III

Paper III (Organic Synthesis) **30h**
(2h/week)

1. **Synthesis of Organic compounds:**

Acetylation: Acetylation of salicylic acid.

Aromatic electrophilic substitution: Nitration: Preparation of nitro benzene. **Halogenation:** Preparation of p-bromo acetanilide.

Oxidation: Preparation of benzoic acid from benzyl chloride. **Methylation:** Preparation of β-naphthyl methyl ether..**Condensation:** Preparation of Benzilidine aniline and Benzaldehyde and aniline. Diazotisation: Azo coupling of β-Naphthol.

2. Microwave assisted synthesis of Aspirin –DEMO (demonstration only)

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VAAGDEVI DEGREE AND PG COLLEGE
(Autonomous)

Under Graduate Courses (Under CBCS 2025–2026 onwards)
B.Sc - II Year, CHEMISTRY SEMESTER – IV
Paper–IV: Chemistry-IV
W.e.f Academic year (2026-27) (CBCS)

Course Code: BS 405CH Course Type: DSC-4C

Course Objectives:

1. To understand the principles and applications of Crystal Field Theory, stability, and bonding in coordination compounds.
2. To develop knowledge of the structure, properties, and inter conversion of carbohydrates and amino acids.
3. To apply thermodynamic laws to chemical systems and understand concepts like entropy, enthalpy, and free energy.
4. To explain the preparation, properties, and applications of colloids and reactions involving carbanions.
5. To introduce the role of Artificial Intelligence (AI) and Machine Learning (ML) in modern chemical research and data analysis.
6. To build analytical and computational skills for interpreting chemical data, predicting molecular properties, and solving chemical problems.

Course outcome:

1. Interpret and apply the concepts of Crystal Field Theory to explain color, magnetism, and stability of coordination compounds.
2. Illustrate the structure and reactions of carbohydrates and amino acids, and explain their biological significance.
3. Solve numerical problems related to thermodynamics and predict spontaneity and equilibrium of chemical reactions.
4. Describe and classify colloids, emulsions, and gels, and explain their industrial and biological applications.
5. Understand and apply the chemistry of carbanions in various organic synthesis reactions.
6. Utilize AI tools and databases in chemistry to predict molecular properties, analyze chemical data, and understand ethical considerations in AI applications.

Unit-I (Inorganic Chemistry) 15h (1h/week)

S4-I-1: Coordination Compounds–II 12h

Crystal field theory (CFT)- Postulates of CFT, splitting patterns of d-orbitals in octahedral, tetrahedral, square planer with suitable examples. Crystal field stabilization energies and its calculations for various d^n configurations in octahedral complexes. High Spin and Low Spin complexes. Colour and Magnetic properties of transition metal complexes. Calculations of magnetic moments spin only formula. Detection of complex formation - basic principles of various methods- change in chemical properties, solubility, colour, pH, conductivity, magnetic susceptibility.

S4-I-2: Hard and soft acids bases (HSAB):

Classification, Pearson's concept of hardness and softness, application of HSAB principles – Stability of compounds / complexes, predicting the feasibility of reaction.

S4-I-3: Stability of metal Complexes: 3h

Thermodynamic and kinetic stability of transition of metal complexes. Stability of metal complexes –stepwise and overall stability constant and their relationship. Determination of composition of complex by Job's method and mole ratio method.

Unit-II (Organic Chemistry) 15h (1h/week)

S4-O-1: Carbohydrates 8h

Introduction: Classification and nomenclature. Monosaccharides: All discussion to be confined to (+) glucose as an example of aldo hexoses and (-) fructose as example of ketohexoses. Chemical properties: Evidences for straight chain penta-hydroxy aldehyde structure. Number of optically active isomers possible for the structure and configuration of glucose based on D-glyceraldehyde as primary standard (No proof for configuration is required).Evidence for cyclic structure of glucose (Pyranose structure, anomeric Carbon and anomers). Proof for the ring size (methylation, hydrolysis and oxidation reactions). (Haworth formula and chair conformational formula).Structure of fructose: Evidence of 2 –ketohexose structure. Same osazone formation from glucose and fructose, Cyclic structure for fructose (Furanose structure, Haworth formula).

Inter Conversion of Mono saccharides: Arabinose to D-glucose, D- mannose (Kiliani –Fischer method).D-glucose to D-Arabinose by Ruff degradation. Aldohexose (+)(glucose) to ketohexose (–) (fructose) and Ketohexose(Fructose) to aldohexose (Glucose).

S4-O-2: Aminoacids and proteins 7h

Classification. Methods of synthesis: General methods of synthesis of alpha amino acids (specific examples–Glycine, Alanine,and Valine) by following methods: a) From halogenated

Carboxylic acid b)Malonic ester synthesis. Physical properties: Optical activity of naturally Occurring amino acids. Zwitterion structure – salt like character, definition of isoelectric point. Chemical properties: General reactions due to amino and carboxyl groups – Lactam from gamma and delta amino acids by heating peptide bond (amide linkage). Structure and nomenclature of peptides.

Unit III(Physical Chemistry) 15h(1h/week)

S4-P-1: Thermodynamics 15h

Revision of terms of thermodynamics: I law of thermodynamics-statements-concepts of Internal energy, enthalpy, heat capacity, work and heat. Expression for work done in isothermal and adiabatic processes -reversible (PV^y= constant) and irreversible processes – problems. Heat capacities at constant pressure and volume. Derivation of C_p-C_v= R. Limitations of I law-scope of II law-statements of second law of thermodynamics. Spontaneous and non-spontaneous processes, spontaneity and equilibrium. Cyclic process -Carnotcycle-derivation of efficiency based on entropy concept–problems. Physical significance of entropy. Change in entropy of an ideal gas as a function of P, V and T. Entropy changes of an ideal gas in various processes. Entropy as a criterion for spontaneity. Free energy–Gibb's free energy & Helmholtz free energy (work function), relation between w and ΔA and ΔG. Free energy-Variation of G with T,V and P-problems. Derivation of equation ΔG =ΔH –TΔS. ΔG as criteria of equilibria or spontaneity of a reaction.

Unit IV (General Chemistry) 15h (1h/week)

S4-G-1: Colloids: Definition of colloids-classification of colloids-examples. Solid in liquid (sol)-Preparation, kinetic and electrical properties, stability and protection of colloids – Hardy-Schulzerule and Gold number. Liquid in liquid (emulsion)-types of emulsions and emulsifier. Liquid insolid (gel)-types and properties. Applications of colloids.

S4-G-2: Carbanions 5h

Introduction, acidic nature of α-hydrogen's and tautomerism in carbonyl compounds, nitro hydrocarbons, ethyl acetoacetate, diethyl malonate.Terminal alkynes. Stability of carbanions Reactions: Aldol reaction, Perkin reaction, Benzoin condensation, halo form reaction, conversion of smaller alkynes to higher alkynes. Mannish reaction, Michael addition and Knovenagel condensation Synthetic applications of Aceto acetic ester. Acid hydrolysis and ketonic hydrolysis

S4-G-3: AI (Artificial Intelligence) applications in Chemistry

6h

Introduction to AI:

Definition of AI; Machine Learning (ML) and Types: Supervised, Unsupervised, Reinforcement Learning, AI vs. Traditional Programming. (Only conceptual information, very brief).Examples in daily life (voice assistants, image recognition)

AI Tools in Chemistry :

Usage of AI in Chemistry - Prediction of physical properties (solubility, pKa, boiling points) ; Molecular property prediction (toxicity, bioactivity).Chemical Data Formats: Datasets and Descriptors Chemical data- SMILES, InChI, Molecular descriptors (size, shape, polarity),
Popular Free Chemical Databases*:* Pub Chem, Chem Spider, ChEM BLAI in drug design

Basics of Using AI Tools

Introduction to user-friendly tools like: ACD/Labs, Molecule Net, Chem Rxiv AI, And Chat GPT for quick analysis Case study: Predicting solubility or boiling point of compounds (e.g., ethanol. Caffeine) using a free ML tool

Ethics, Limitations & Future Scope in Chemistry

Limitations of AI in science, Ethics in data and model predictions

References:

General reference: B.Sc II Year Chemistry: Semester IV, Telugu Academy publication, Hyd.

Unit-I

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Unit-II

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9. Molecule Net(AI-ready data sets for chemical properties)Website:https://moleculenet.org
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11. Chat GPT(AI chat bot for Q&Aand explanations)Website :https://chat.openai.com
12. Pub Chem Website:https://pubchem.ncbi.nlm.nih.gov
13. Chem SpiderWebsite:http://www.chemspider.comMaintainedby:TheRoyalSocietyof Chemistry
14. ChEMBLWebsite:https://www.ebi.ac.uk/chemblMaintainedby: The European Bio i formatics Institute (EMBL-EBI

B.Sc (Chemistry) -II year, Semester - IV
Paper–IV: (Organic Synthesis)

Course Code: BS 405CH (P) Course type: DSC-4C (P)

No. of hours per week: 2

Course Objectives:

1. Develop a systematic approach for the qualitative analysis of organic compounds using classical laboratory techniques.
2. Understand and perform preliminary tests such as ignition and solubility tests to identify the type and nature of unknown organic compounds.
3. Identify functional groups present in organic compounds through specific chemical tests.
4. Learn the procedure for the preparation of solid derivatives to confirm the identity of the given unknown organic substance.
5. Gain practical experience in handling laboratory reagents, maintaining safety protocols, and recording experimental observations accurately.
6. Correlate experimental data with theoretical knowledge to deduce the structure and class of organic compounds.

Course outcome:

1. Systematically identify unknown organic compounds based on their physical and chemical characteristics
2. Perform and interpret ignition and solubility tests to distinguish between different classes of organic compounds.
3. Detect the presence of specific functional groups such as carboxylic acids, phenols, amines, aldehydes, ketones, esters, carbohydrates, and aromatic hydrocarbon
4. Synthesize and characterize solid derivatives (e.g., 2,4-DNPs, oximes, semi carbazones, acetates, etc.) to confirm compound identity.
5. Demonstrate good laboratory practices — including safe handling of chemicals, accurate observation, and precise reporting.
6. Apply qualitative analysis techniques to solve analytical problems and infer the molecular nature of unknown organic samples.

Laboratory Course–IV

Qualitative Analysis of Organic Compounds: 30h (2h /week)

Qualitative analysis: Identification of unknown organic compounds through the functional group analysis- ignition test, solubility test, functional group tests and preparation f suitable derivatives of the following: Carboxylic acids, phenols, amines, carbohydrates, aldehydes, ketones, ester and naphthalene.

References

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5. Venkatesgwarlu P.(2023) Comprehensive Approach toPractical Organic Chemistry (QualitativeAnalysis,SynthesisandUV,IR,NMR&MSSpectralIdentification)by Pharma Med PRESS,BSPB Pvt. L, An Imprint of BSP Books Pvt. Ltd.