B.Sc. CHEMISTRY SYLLABUS

(Common Core Syllabus Under CBCS)

With Effect From The Academic Year 2025-26 Onwards

Accredited with **'A^+ ' *by* NAAC**

Department of Chemistry

Kakatiya University

Warangal, Telangana- 506009

Chemistry Course Structure

KAKATIYA UNIVERSITY , WARANGAL.

B.Sc. CBCS COMMON CORE SYLLABUS FOR ALL UNIVERSITIES IN TELANGANA STATE

APPROVED SCHEME FOR CHOICE BASED CREDIT SYSTEM IN

B.Sc. CHEMISTRY

(Effect from the academic year 2025 – 2026 onwards)

FIRST YEAR-SEMESTER I				
CODE	**COURSE TITLE**	**COURSE TYPE**	**HPW**	**CREDITS**
BS 101	**Major – 1: Chemistry – I** **Laboratory Course – I** **(Quantitative Analysis – Titrations)**	DSC-1A	4T+2P = 6	4+1 = 5
BS 102	Major – 2	DSC-2A	4T+2P = 6	4+1 = 5
BS 103	Minor	DSC-3A	4T+2P = 6	4+1 = 5
BS 104	English	AEC-1A	5	5
BS 105	Second Language	AEC-2A	5	5
	TOTAL CREDITS		**28**	**25**
FIRST YEAR-SEMESTER II				
BS 201	**Major – 1: Chemistry – II** **Laboratory Course - II** **(Qualitative Analysis - Semi Micro Analysis of Mixtures)**	DSC-1B	4T+2P = 6	4+1 = 5
BS 202	Major – 2	DSC-2B	4T+2P = 6	4+1 = 5
BS 203	Minor	DSC-3B	4T+2P = 6	4+1 = 5
BS 204	English	AEC-1B	5	5
BS 205	Second Language	AEC-2B	5	5
	TOTAL CREDITS		**28**	**25**
SECOND YEAR-SEMESTER III				
CODE	**COURSE TITLE**	**COURSE TYPE**	**HPW**	**CREDITS**
BS 301	**Major – 1: Chemistry – III** **Laboratory Course - III** **(Synthesis of Organic compounds)**	DSC-1C	4T+2P = 6	4+1 = 5
BS 302	Major – 2	DSC-2C	4T+2P = 6	4+1 = 5
BS 303	Minor	DSC-3C	4T+2P = 6	4+1 = 5
BS 304	English	AEC-1C	5	5
BS 305	Second Language	AEC-2C	5	5
	TOTAL CREDITS		**28**	**25**
SECOND YEAR-SEMESTER IV				
BS 401	**Major – 1: Chemistry – IV** **Laboratory Course - IV** **(Qualitative Analysis of Organic Compounds)**	DSC-1D	4T+2P = 6	4+1 = 5
BS 402	Major – 2	DSC-2D	4T+2P = 6	4+1 = 5
BS 403	Minor	DSC-3D	4T+2P = 6	4+1 = 5
BS 404	English	AEC-1D	5	5
BS 405	Second Language	AEC-2D	5	5
	TOTAL CREDITS		**28**	**25**

THIRD YEAR-SEMESTER V				
CODE	**COURSE TITLE**	**COURSE TYPE**	**HPW**	**CREDITS**
BS 501	**Major – 1: Chemistry – V A/B** **A. Spectroscopy and Chromatography** **(Or)** **B. Metallurgy, Dyes, Batteries and Nanomaterials** **Laboratory Course – V** **(Experiments in Physical Chemistry)**	DSC-1E	4T+2P = 6	4+1 = 5
BS 502	Major – 2	DSC-2E	4T+2P = 6	4+1 = 5
BS 503	**MDC: Foundations of Chemistry – Concepts and Applications**	MDC-1	4	4
BS 504	Skill Enhancement Course – 1:	SEC-1	2	2
BS 505	Skill Enhancement Course – 2:	SEC-2	2	2
BS 506	Value Added Course - 1	VAC-1	3	3
	TOTAL CREDITS		**23**	**21**
THIRD YEAR-SEMESTER VI				
BS 601	**Major – 1: Chemistry–VI A/B** **A. Medicinal Chemistry** **(Or)** **B. Agricultural and Fuel Chemistry** **Laboratory Course - VI** **(Experiments in Physical Chemistry)**	DSC-1F	4T+2P = 6	4+1 = 5
BS 602	Major – 2 (A/B)	DSC-2F	4T+2P = 6	4+1 = 5
BS 603	Skill Enhancement Course – 3:	SEC-3	2	2
BS 604	Skill Enhancement Course – 4:	SEC-4	2	2
BS 605	Value Added Course - 2	VAC-2	3	3
BS 606	Internship/ Project Work		4	4
	TOTAL CREDITS		**23**	**21**
	GRAND TOTAL			**142**

DSC: Discipline Specific Course, **AEC:** Ability Enhancement Course, **MDC:** Multi-Disciplinary Course,

SEC: Skill Enhancement Course. **VAC:** Value Added Course

Note: Under the proposed CBCS structure for Undergraduate Programmes (2025-2026), students will pursue two Majors and one Minor, collectively reffered to as Discipline Specific Course (DSC). Both Major and Minor courses will remain integrated up to the fourth semester, after which students will have the option to drop one Minor course in both the fifth and sixth semesters. The syllabus and credits for Major and Minor courses will remain consistent up to the fourth semester, wilh the Major continuing through the fifth and sixth semesters.

Credits under Non-CGPA
(Community Engagement & Service)

1.	NSS/NCC/Sports/Extracurricular	Up to 6 Credits (2 in each year)
2.	IKS	Up to 4 (2 in each, after I & II years)

Credits under -CGPA

Major – 1	30
Major – 2	30
Minor	20
AEC (Ability Enhancement Course) – English	20
Second Language	20
MDC (Multi-Disciplinary Course)	4
SEC (Skill Enhancement Course)	8
VAC (Value Added Course)	6
Project	4
Total	**142**

KAKATIYA UNIVERSITY
FACULTY OF SCIENCE
Theory Model Question Paper for End-Examinations-Semester I, II, III & IV
With Effect From the Academic Year 2025-2026 Onwards

B.Sc - CHEMISTRY (CBCS)

Time:3Hours **Max. Marks:80**

Part-A
(Short Answer Type)

I. Write any eight (8)questions of the following **(8x4=32Marks)**

1, 2, 3 — Unit - I
4, 5, 6 — Unit - II
7, 8, 9 — Unit - III
10, 11, 12 — Unit - IV

Part-B
(Essay Answer Type)

II. Answer all Questions **(4x 12= 48 Marks)**

13 a) OR b) — Unit - I

14 a) OR b) — Unit - II

15 a) OR b) — Unit - III

16 a) OR b) — Unit - IV

KAKATIYA UNIVERSITY
FACULTY OF SCIENCE

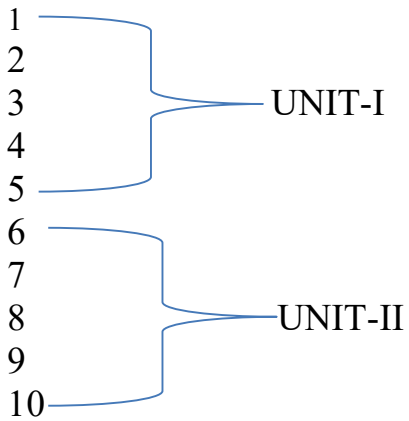
Scheme of Internal Assessment-I- from the Academic Year 2025-2026 Onwards

[DSC Subjects only]

Course : B. Sc : Chemistry

Time: 90 Min. **Max. Marks: 20**

Answer ALL Questions. Each Question Carries Equal Marks **(10 × 2 = 20 Marks)**



KAKATIYA UNIVERSITY

FACULTY OF SCIENCE

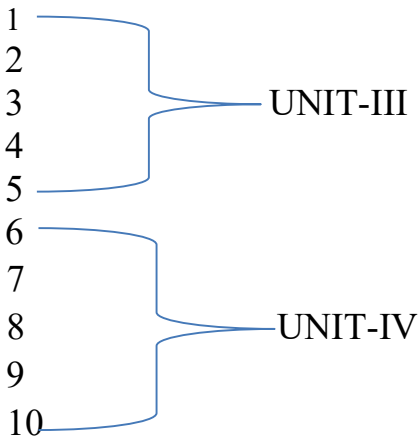
Scheme of Internal Assessment-II- from the Academic Year 2025-2026 Onwards

[DSC Subjects only]

Course : B. Sc- Chemistry

Time: 90 Min. **Max. Marks: 20**

Answer ALL Questions. Each Question Carries Equal Marks (10 × 2 = 20 Marks)



KAKATIYA UNIVERSITY

FACULTY OF SCIENCE

B. Sc-CHEMISTRY (CBCS)

Practical Examination Marks & Credits

Semester	Time Duration	Total (Marks)	Credits
I	3 Hours	25	1
II	3 Hours	25	1
III	3 Hours	25	1
IV	3 Hours	25	1

B.Sc. I YEAR CHEMISTRY
SEMESTER- I
Paper – I
Chemistry–I

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.

Interhalogens-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 (a) acidity of phenol. (b) acidity of carboxylic acids and basicity of anilines. Stability of carbo cations, 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) dehydrohalogenation 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 peroxide (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 dehydrohalogenation 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 hypothesis. 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,Hydrolysisofmethylacetate,inversionofcanesugar,problems. Secondorderreaction,derivationofexpressionforsecondorderrateconstant,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 H_2–$Cl_2$and H_2–Br_2reactions.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, standard solutions, indicators, end point, titration curves, Types of titrations: i) neutralization titration- principle, theory of acid base indicators, titration curves and selection of indicators- strong acid - strong base, strong acid –weak base, weak acid-strong base and weak acid –weak base. Theory of redox titrations – internal ($KMnO_4$) and external indicators – use of diphenylamine and ferroin indicators. Theory of complexometric titrations – 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- dichloroethane, 2-chloroethanol. Cis-trans isomerism: E-Z-Nomenclature.

S1-G-3Colloids&Surface Chemistry **5h**

Colloids: Definition of colloids-classification of colloids-examples. Solid in liquid (sol)-Preparation, kinetic and electrical properties, stability and protection of colloids - Hardy-Schulze rule and Gold number. Liquid in liquid (emulsion)-types of emulsions and emulsifier. Liquid in solid (gel)-types and properties. Applications of colloids.

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

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). Principles of inorganic chemistry. Vishal Publications.
2. Lee, J. D. (1981). Concise inorganic chemistry (3rd ed.). Oxford University Press.
3. Cotton, F. A., Wilkinson, G., & Gaus, P. L. (2001). Basic inorganic chemistry (3rd ed.). Wiley.
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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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Unit III

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11. Kalidas, C. & Sangaranarayanan, M. V. (2019). Physical chemistry: Problems and solutions. Universities Press.

Unit IV

1. Jeffery, G. H., Bassett, J., Mendham, J., & Denney, R. C. (1999). Vogel's textbook of quantitative chemical analysis (5th ed.). Addison Wesley Longman Inc.
2. Day, R. A., & Underwood, A. L. (2004). Quantitative analysis (6th ed.). Prentice Hall of India.
3. Svehla, G. (1996). Vogel's qualitative inorganic analysis (7th ed.). Prentice Hall.
4. Morrison, R. T., & Boyd, R. N. (2011). Organic chemistry. Pearson Education.
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11. McQuarrie, 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). Colloidal and surface chemistry. Discovery Publishing Pvt. Ltd.

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$KMnO_4$withsodium oxalate as primary standard.
3. Determination of Cu(II) using$Na_2S_2O_3$with$K_2Cr_2O_7$asprimary standard

Complexometric Titrations

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 textbook of quantitative chemical analysis (5th ed.). Addison Wesley Longman Inc.
2. Vogel, A. I. Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition, Pearson Education, 2000. ISBN: 9780582226289
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B. Sc I YEAR CHEMISTRY
SEMESTER II
Paper – II
Chemistry–II

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 behavior of post lanthanides-complexation-type of donor ligands preferred. 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. Mechanism and energy profile diagrams of S_N1 and S_N2 reactions. Stereochemistry of S_N2 (Walden Inversion)2-bromobutane,S_N1 (Racemization)1- bromo-1-phenylpropane.

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-3 Carbonyl 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:Electrochemistry **15h**

Revision of conductance, specific conductance, equivalent conductance and factors influencing conductance of electrolytes. Ionic mobility, definition and significance of transport number. Kohlrausch's law – its applications: determination of degree of dissociation and acid dissociation constant (K_a) of weak acids, solubility product determination and conductometric titrations. Ostwald's dilution law – issues and limitations. Debye-Hückel -Onsager's equation 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 a 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, $\mathbf{O_2^-}$,$\mathbf{O_2^{2-}}$, F_2 (unhybridized diagrams only) and heteronuclear diatomics - CO, CN^-, NO, NO^+ and HF, their bond order, stability and magnetic properties.

S2-G-2: Stereoisomerism **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 (Glyceraldehyde, Lactic acid, Alanine) and dissymmetric molecules (trans-1,2-dichlorocyclopropane).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 property (derivations not required) -Problems.

References

Generalreference:B.Sc.IYearChemistry:SemesterII,TeluguAcademypublication,Hyd.

Unit I

1. Puri, B. R., Sharma, L. R., & Kalia, M. S. (1996). Principles of inorganic chemistry. Vishal Publications.
2. Lee, J. D. (1981). Concise inorganic chemistry (3rded.). Oxford University Press.
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UNIT II

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Unit III

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

Paper II - Qualitative Analysis- Semi micro analysis of mixtures

Analysis of two anions (one simple, on einterfering) 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^+

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B .Sc II YEAR CHEMISTRY
SEMESTER III
Paper-III
Chemistry-III

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) Square planar 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 $Ni(CO)_4$, $Fe(CO)_5$,$Fe_2(CO)_9$, $Fe_3(CO)_{12}$and $Cr(CO)_6$-18 valence electron rule.

S3-I-3: Organometallic Chemistry 3h

Definition, nomenclature and classification of organometallic 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, Esterification (mechanism) & Amide formation. 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 Nitroalkanes. 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 into 1°, 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. Bravais 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: Catalysis **9h**

Definition of a catalyst and catalysis. Comparison of homogeneous and heterogeneous catalysis with specific examples. General characteristics of catalytic reactions.

Acid-base catalysis- Specific acid and general acid catalysis- Examples, Specific base and general base catalysis – Examples. Effect of pH on reaction rate of acid and base catalysed reactions.

Enzyme catalysis- Characteristics of enzyme catalysis, Examples: Factors affecting enzyme catalysis. Effect of temperature, pH, concentration and effect of inhibitor on enzyme catalysed reactions, Catalytic efficiency. Michaelis-Menten Equation (Derivation not required). Significance of Michaelis constant (K_m) and maximum velocity (V_{max}), Lineweaver-Burk plot.

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

S3-G-1Bioinorganic 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, desilverisation of lead.

References

General reference: B.ScII Year Chemistry: Semester III, Telugu Academy publication, Hyd

Unit-I

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Unit-II

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2. Ghosh, S. K. (2008). General organic chemistry. New Age Publishers Pvt. Ltd.
3. Morrison, R. T., & Boyd, R. N. (2009). Textbook of organic chemistry (6thed.). Pearson Education.
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3. Puri, B. R., & Sharma, L. R. (2017). Textbook of physical chemistry. S. Nagin Chand & Co.
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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 - naphthyl methyl ether.

Condensation:Preparation of Benzilidine aniline and Benzaldehyde and aniline.

Diazotisation: Azocoupling of β-Naphthol.

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

References

1. Vogel, A. I., Furniss, B. S., Hannaford, A. J., Smith, P. W. G., & Tatchell, A. R. (1989). Vogel's textbook of practical organic chemistry (5th ed.). Longman.
2. Ahluwalia, V. K., & Aggarwal, R. (2000). Comprehensive practical organic chemistry: Preparation and quantitative analysis. Universities Press.
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B.Sc. II YEAR CHEMISTRY

SEMESTER WISE SYLLABUS

SEMESTER IV

Paper-IV Chemistry-IV

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 Monosaccharides: 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:Amino acids 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. Zwitter ion 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^{γ} = 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 - Carnot cycle- 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: Evaluation of analytical Data 4h

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

S4-G-2: Carbanions 5h

Introduction, acidic nature of α-hydrogens and tautomerism in carbonyl compounds, nitro hydrocarbons, ethyl acetoacetate, diethyl malonate. Terminal alkynes. Stability of carbanions Reactions: Aldol reaction, Perkin reaction, Benzoin condensation, haloform reaction, conversion of smaller alkynes to higher alkynes. Mannich reaction, Michael addition and Knoevenagel 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*:* PubChem, ChemSpider, ChEMBL AI in drug design

Basics of Using AI Tools

Introduction to user-friendly tools like: ACD/Labs, Molecule Net, ChemRxiv AI, ChatGPT 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

1. Puri, B. R., Sharma, L. R., & Kalia, M. S. (1996). Principles of inorganic chemistry. Vishal Publications.
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Unit III

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8. ACD/Labs ChemSketch (Freeware) – Draw molecules, get properties, IUPAC names Link: https://www.acdlabs.com/resources/free-chemistry-software-apps/chemsketch-freeware
9. MoleculeNet (AI-ready datasets for chemical properties) Website: https://moleculenet.org
10. ChemRxiv (Chemistry Preprint Server) Website: https://chemrxiv.org
11. ChatGPT (AI chatbot for Q&A and explanations) Website: https://chat.openai.com
12. PubChem Website: https://pubchem.ncbi.nlm.nih.gov
13. ChemSpider Website: http://www.chemspider.com Maintained by: The Royal Society of Chemistry
14. ChEMBL Website: https://www.ebi.ac.uk/chembl Maintained by: The European Bioinformatics Institute (EMBL-EBI)

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 of suitable derivatives of the following: Carboxylic acids, phenols, amines, carbohydrates, aldehydes, ketones, ester and naphthalene.

References

1. Furniss, B. S., Hannaford, A. J., Smith, P. W. G., & Tatchell, A. R. (1989). Vogel's textbook of practical organic chemistry (5thed.). Longman.
2. Ahluwalia, V. K., & Aggarwal, R. (2000). Comprehensive practical organic chemistry: Qualitative analysis. Universities Press.
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Annexure – I (Credits)
Proposed CBCS Structure from 2025-26 for Under Graduate Courses

Courses		Papers	Total Credits	Credits for each paper / Semester						Credits for each paper / Semester						Credits for each paper / Semester					
				BA						B.Com.						B.Sc.					
				I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
Core Courses DSC	Major-1	6	30	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	Major -2	6	30	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	Minor-1	4	20	5	5	5	5	-	-	5	5	5	5	-	-	5	5	5	5	-	-
MIL/AEC (First Language)	English	4	20	5	5	5	5	-	-	5	5	5	5	-	-	5	5	5	5	-	-
Second Language (Telugu, Hindi, Urdu, etc.)		4	20	5	5	5	5	-	-	5	5	5	5	-	-	5	5	5	5	-	-
Multi-Disciplinary Course	MDC 1	1	4	-	-	-	-	4	-	-	-	-	-	4	-	-	-	-	-	4	-
Sec 1, 2		2	4					2	2					2	2					2	2
Sec 3, 4		2	4					2	2					2	2					2	2
Value added course (VAC)	VAC 1, 2	2	6	-	-	-	-	3	3	-	-	-	-	3	3	-	-	-	-	3	3
Internships	Internship / Project	1	4	-	-	-	-	-	4	-	-	-	-	-	4	-	-	-	-	-	4
Total Credits in each semester			142	25	25	25	25	21	21	25	25	25	25	21	21	25	25	25	25	21	21
Total Credits in UG				142						142						142					
Credits under Non-CGPA (Community engagement and service)		NSS /NCC /sports / Extra curricular	6	Upto 6 (2 in each year)						Upto 6 (2 in each year)						Upto 6 (2 in each year)					
		IKS	4	Upto 4 (2 in each, after I & II years)						Upto 4 (2 in each, after I & II years)						Upto 4 (2 in each, after I & II years)					