UNDERGRADUATE SYLLABUS

CHEMISTRY

B. Sc. Pass Course

ANNUAL SYSTEM

Academic Year 2021-22 and onwards

Papers and distribution of marks for different Years

Year	Paper I	Marks	Paper II	Marks	Paper III	Marks	Practical Marks
First	Inorganic	33	Organic	33	Physical	34	50
Second	Inorganic	33	Organic	33	Physical	34	50
Third	Inorganic	33	Organic	33	Physical	34	50

*Each theory paper shall consist two **sections A and B**.*

***Section A**: (Short answers type with reasoning);20 marks, seven questions of four marks each, any five have to be attempted).*

***Section B**: (Long answers type);13 marks in case of I and II paper,14 marks for III paper. Two questions of six and half marks (seven marks in case of III paper) with internal choice would be given, both have to be attempted.*

B. Sc. 1st Year

Inorganic Chemistry

60 hrs(2 hrs/week)

CHE101 **Paper I** **Max. Marks 33**

1. **Atomic Structure:** 6 hrs

Dual nature of matter; de Broglie concept. Heisenberg uncertainty principle; its significance. Atomic orbitals, Schrödinger wave equation (no derivation); significance of ψ and $\psi 2$. Quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p and d orbitals. Aufbau energy diagram, Pauli's exclusion principle. Hund's rule of maximum multiplicity. Electronic configuration of elements (s block, p block and first series of d-block elements). Effective nuclear charge, screening or shielding effect, Slater rules, variation of effective nuclear charge in periodic table.

2. Periodic Properties: 5 hrs

Atomic (metallic, covalent and Van der Waals radius) and ionic radii, ionization potential, electron affinity, electronegativity-definition, methods of determination/evaluation, trends of variation in periodic table and their application in prediction and explaining the chemical behaviour of elements and compounds thereof.

3. Chemical Bonding: 16 hrs

(a) Ionic bond, ionic structures, radius-ratio effects and coordination number. Limitation of radius ratio rule. Lattice defects, semiconductors, insulators, lattice energy and Borne-Haber cycle. Hydration energy, Solvation energy and solubility of ionic solids. Polarizing power and polarizability of ions; Fajan's rule. Metallic bond- Electron Pool, VB and MO theories.

Weak interactions-hydrogen bonding; types, effects on chemical forces, melting and boiling points, solubility effects. Van der Waals forces; ionic dipole interactions, dipole-dipole interactions, induced dipole interactions, instantaneous dipole-induced dipole interactions.

(b) Covalent bond-Valence Bond Theory and its limitations; directional nature of covalent bond; Resonance and resonance energy, various types of hybridization and shapes of different inorganic molecules and ions. Valence shell electron pair repulsion theory (VSEPR) and shapes of NH_3, H_2O, H_3O^+, SF_4, ClF_3 and ICl_2^-.

Molecular Orbital Theory as applied to diatomic homonuclear (Li_2, B_2, C_2, N_2, O_2, F_2) and heteronuclear (CO and NO) inorganic molecules and their ions, difference between VB and MO theories. Multicentre bonding in electron deficient molecules. Polarization of covalent molecules; percentage ionic character from dipole and electronegativity difference.

4. s-Block elements: 6 hrs

General discussion with respect to all periodic and chemical properties, diagonal relationship, salient features of hydrides, solvation and complexation tendencies, an introduction to their alkyls and aryls. Role of alkali and alkaline earth metal ions in bio-systems. Anomalous behavior of Li and Be.

5. p-Block elements: 16 hrs

General discussion and comparative study (all periodic and chemical properties) of groups 13 to 17 elements; anomalous behavior of first member of each group, catenation, allotropy, inert pair effect (in 13, 14 and 15 group heavier elements), its consequences in redox properties of their halides; $d\pi - p\pi$ bonding. Chemistry of hydrides, carbides and borides and their classification. Borohydrides, diborane-properties & structure, boron nitrides, boric acid and borates. Diamond, graphite, fullerenes, oxides and oxy acids of Nitrogen, Phosphorus, Sulphur and chlorine; interhalogen compounds, polyhalide ions, pseudohalogens and basic character of iodine.

7. Chemistry of Noble gases 5 hrs

Chemical properties of the noble gases, chemistry of Xenon. Clathrates, preparation and properties of XeF_2, XeF_4, XeF_6 and XeO_3; structure and bonding in noble gas compounds- XeF_2, XeF_4, XeF_6, $XeOF_2$, $XeOF_4$, XeO_2F_2 and XeO_3.

8. Metallurgical processes: 6 hrs

Minerals & ores; general metallurgical processes-concentration ores, calcination, roasting, smelting, slag & flux. Extraction and refining of metals., Chemistry of extraction and isolation of Lithium and Beryllium.

Organic Chemistry

B.Sc. I year 60 hrs(2 hrs/week)

CHE102 **Paper II** **Max. Marks 33**

1. Structure and bonding 5 hrs

Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bond, van der Waals interactions, inclusion compounds, clatherates, charge transfer complexes, resonance, hyperconjugation, aromaticity, inductive and field effects, hydrogen bonding.

2. Mechanism of organic reactions 8 hrs

Curved arrow notation, drawing electron movements with arrows, half headed and double headed arrows, homolytic and heterolytic bond breaking. Types of reagents- electrophiles and nucleophiles. Types of organic reactions. Energy considerations. Reactive intermediates; carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples). Assigning formal charges on intermediates and other ionic species. Methods of determination of reaction mechanism (product analysis, intermediates, isotope effects, kinetic and stereochemical studies).

3. Stereochemistry of organic compounds 12 hrs

Concepts of isomerism. Types of isomerism.Optical isomerism- elements of symmetry, molecular chirality, enantiomers, stereogenic centers, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometric isomerism; determination of configuration of geometric isomers, E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds.

Conformational isomerism; conformational analysis of ethane and n- butane, conformational conformations of cyclohexane, axial and equatorial bonds, conformations of monosubstituted cyclohexane derivatives. Newman projection and Sawhorse formulae, Fischer and flying wedge formulae. Difference between configuration and conformation.

4 Alkanes and Cycloalkanes 7 hrs

IUPAC nomenclature of branched and unbranched alkanes, the alkyl group, classification of carbon atoms in alkanes. Isomerism in alkanes, sources, methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids), physical properties and chemical reactions of alkanes. Mechanism of free radical halogenation of alkanes: Mechanism of free radical, halogenation of alkanes: orientation, reactivity and selectivity.

Cycloalkanes**;** nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring-banana bonds.

5. Alkenes, Cycloalkenes, Dienes and Alkynes 12 hrs

Nomenclature of alkenes , methods of formation, mechanism of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. The Saytzeff Rule, Hoffmann Elimination, physical properties and relative stabilities of alkenes. Chemical reaction of alkenes - mechanism involved in hydrogenation, electrophilic and free radical additions, Markownikoff's Rule, hydroboration-oxidation, oxymercuration-reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$, Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes. Industrial applications of ethylene and propene. Methods of formation, conformation and chemical reactions of cycloalkenes. Nomenclature and classification of dienes; isolated, conjugated and cumulative dienes. Structure of allenes and butadiene, methods of formation, polymerization. Chemical reactions- 1,2 and 1,4 additions, Diels Alder reaction.

Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, hydroboration- oxidation, metal- ammonia reduction, oxidation and polymerization.

6. Arenes and Aromaticity 8 hrs

Nomenclature of benzene derivatives. The aryl group. Aromatic nucleus and side chain. Structure of benzene: Molecular formula and Kekule structure. Stability and carbon –carbon bond length of benzene, resonance structure, MO picture. Aromaticity –the Hückel rule, aromatic ions.

Aromatic electrophilic substitution reaction –general pattern of the mechanism , role of σ and π and complex. Mechanism of nitration , halogenation, sulphonation, mercuration and Friedel- Crafts reaction. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction. Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl.

7. Alkyl and Aryl Halides 8 hrs

Nomenclature and classes of alkyl halides, methods of formation, chemical reactions. Mechanism of nucleophilic substitution reactions of alkyl halides , SN2 and SN1 reaction with energy profile diagrams.

Polyhalogen compounds - Chloroform , carbon tetrachloride. Methods of formation of aryl halides, nuclear and side chain reaction. The addition elimination mechanism and the elimination addition mechanisms of nucleophilic substitution reactions. Relative reactivity of alkyl halides vs allyl, vinyl and aryl halides. Synthesis and uses of DDT and BHC.

Physical Chemistry

B.Sc. I year 60 hrs(2 hrs/week)

CHE103 Paper III Max. Marks 34

1. Gaseous States 10 hrs

Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waal's equation of states, Critical phenomena – PV isotherms of real gases, relationship between critical constants and van der Waals constants, the law of corresponding states, reduced equation of state.

Molecular velocities: Root mean square, average and most probable velocities, qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter, liquification of gases (based on Joule-Thomson effect).

2. Liquid State 8 hrs

Intermolecular forces, structure of liquids (a qualitative description) Structural differences between solids, liquids and gases. Physical properties of liquids including their methods of determination: surface tension, viscosity and refractive index. Liquid crystals, difference between liquid crystal, solids and liquids.

3. Solid State 8 hrs

Definition of space lattice, unit cell, crystal planes, Miller indices, Laws of crystallography – (i) law of constancy of interfacial angels (ii) law of rationality of indices (iii) law of symmetry. Symmetry elements in crystals, X-ray diffraction by crystals,. Derivation of Bragg's equation. Determination of crystal structure of NaCl, KCl and CsCl (Laue's method and powder method).

4. Colloidal State 6 hrs

Definition of colloids, classification of colloids. Solids in liquids (sols): properties – kinetic, optional and electrical; stability of colloids, protective action, Hardy-Schulze law, gold number. Liquids in liquids (emulsions): types of emulsions, preparation, emulsifier. Liquids in solids (gels): classification, preparation and properties, inhibition, general application of colloids.

5. Chemical Kinetics and Catalysis 14 hrs

Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction– concentration, temperature, pressure, solvent, light, catalyst. Concentration dependence of rates mathematical characteristics of simple reaction – zero order, first order, second order, pseudo order, half life determination of the order of reaction – differential method, method of integration, method of half life period and isolation methods concept of activation energy.

Radioactive decay a first order phenomenon. Catalysis, characteristics of catalyzed reactions, classification of catalysis, miscellaneous examples.

6. Thermodynamics I 14 hrs

Definition of thermodynamic terms, system, surroundings etc. types of systems, intensive and extensive properties, state and path functions and their differentials, thermodynamic process, concept of heat and work, First law of thermodynamics, definition of internal energy and enthalpy. Heat capacity – heat capacities at constant volume and at constant pressure and their relationship, Joule – Thomson coefficient and inversion temperature, calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible processes, Thermochemistry; standard state, Standard enthalpy of formation – Hess's law of heat summation and its application, heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization, bond dissociation energy and its calculation from thermochemical data, temperature dependence of enthalpy, Kirchoff's equation.

Lab course **B. Sc. Chemistry 1st year** **Max. Marks 50**

6 hrs/week

1. Laboratory hazards and safety precautions; errors, significant figures, lab report writing.

2. Qualitative analysis: Mixture analysis; preparation of sodium carbonate extract, identification of anions cations including anions in combination and interfering radicals. Preparation of original solution for basic radical analysis; problems based on Law of mass action, Le Chatelier Principle; common ion effect, solubility product, pH and buffer solutions. Total number of cations and anions in a mixture shall be six.

3. Quantitative analysis: Volumetric exercises; preparation of a solution in normal/molar terms, its standardization using a primary standard solution, determination of the strength of unknown solution. Double titration-based on redox reactions involving internal as well as external indicators. Iodometry.

4. Determination of viscosity and relative viscosity of given liquids using Ostwald's viscometer. Determination of surface tension and relative surface tension of given liquids using drop pipette.

One exercise each from inorganic mixture(qualitative 06 radicals), physical chemistry experiment and volumetric exercise (quantitative) shall be given in the examination.

Distribution of marks shall be as given below:

i) Inorganic mixture for six radicals	12
ii) Physical chemistry experiment	08
iii) Volumetric exercise	13
iv) *Viva - voce	05
v) Annual lab record and attendance(06 for each)	12

*Viva-Voce test of ex-students shall carry 17 marks.

Note:

The lab work of the student has to be evaluated and assessed carefully and periodically. A minimum of 12 experiments covering all the kind of exercises has to be performed during an academic year. The annual record has to be maintained by the department/college as an official record.
Less than zero mark will not be awarded
The total number of students to be examined per batch shall not be more than sixty.
Duration of the practical examination shall be of 06 (six) hours.
Marks have to be uploaded on to the University Examination Portal and the hard copy of the same have to be submitted to the Registrar/Controller examination in a sealed envelop making a copy to the Principal/Head of the department.

Inorganic Chemistry

B. Sc. 2nd year

60 hrs(2 hrs/week)

CHE201 **Paper I** **Max Marks 33**

1. Chemistry of Transition Elements (First Transition Series) 10 hrs

Characteristic properties of the elements; electronic configuration, atomic radii, ionic radii, ionization energy, oxidation states, complex compound formation, colour, catalytic properties, magnetic properties, melting and boiling points, density, formation of interstitial compounds, alloy formation. Difference between transition elements and those of s- & p-block elements. Their binary compounds; oxides of vanadium, chromium, manganese and halides of vanadium and titanium, illustrating relative stability of their oxidation states.

2. Chemistry of Transition Elements (Second and Third Series) 10 hrs

General characteristics including electronic configuration, oxidation states, atomic & ionic radii, catalytic properties, magnetic properties, complex formation tendency, metal-metal bonding and ionization energy. Comparative treatment with their analogues in respect of atomic radii and ionic radii, oxidation state, magnetic behavior, electronic configuration, geometry of the complexes.

3. Oxidation and Reduction 8 hrs

Oxidation state, Oxidation reduction process. Electrode potential, standard electrode potential, Reference electrodes (hydrogen and calomel electrode). Determination of electrode potential. Electrochemical series. Uses of electrode potential data, reaction feasibility and computation of equivalent weight.

4. Coordination Chemistry 10 hrs

Werner's theory for coordination compounds; its experimental verification, effective atomic number concept (EAN), 18-electron rule, chelates. Nomenclature of coordination compounds (IUPAC system), isomerism in coordination compounds, stability of complexes and factors contributing to the stability. Valence bond theory (VBT) for coordination compounds (inner and outer orbital complexes).

5. Chemistry of Lanthanides 6 hrs

Electronic configuration, oxidation states, atomic & ionic radii, lanthanide contraction and its consequences, complex formation, magnetic properties, colour, methods of separation of lanthanides- fractional crystallization, fractional precipitation, change in oxidation state, solvent extraction and ion exchange methods.

6. Chemistry of Actinides 4 hrs

General features of actinides-electronic configuration, atomic and ionic radii, magnetic properties, colour, ionization potential, oxidation states and complex formation.

7. Acids and Bases 6 hrs

Arrhenius concept, Bronsted-Lowry concept, Lux-Flood and Lewis concept of acids and bases. Solvent system concept- role of the solvent (leveling effect and differentiating solvents), effect of electron withdrawing and electron donating groups on the strength of acids and bases.

8. Non Aqueous Solvents 6 hrs

Classification of solvents, their general characteristics, physical properties of the solvents, reaction in non-aqueous solvents-liquid NH_3 and SO_2 (auto-ionization, precipitation reactions, acid-base reaction, oxidation-reduction reactions, solvation and solvolysis, complex formation, merits and demerits.

Organic Chemistry

B. Sc. 2nd year

60 hrs(2 hrs/week)

CHE202 **Paper II** **Max Marks 33**

1. Electromagnetic Spectrum; Absorption Spectroscopy 8 hrs

Ultraviolet (UV) absorption spectroscopy-absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation, concept of chromophore and auxochrome. Bathochromic, hypochromic, hyperchromic and hypsochromic shifts. UV spectra of conjugated enes and enones.

Infra Red (IR) absorption spectroscopy- molecular vibrations, Hook's Law, selection rules, intensity and position of IR bands, measurement of IR spectrum, finger print region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds.

2. Alcohols 6 hrs

Classification and nomenclature. Monohydric alcohols; methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature. Reactions of alcohols. Dihydric alcohols-methods of preparation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacol-pinacolone rearrangement. Trihydric alcohols-methods of formation, chemical reactions of glycerol.

3. Phenols 6 hrs

Nomenclature, structure and bonding. Preparation of phenols, physical properties and acidic character. Comparative acidic strength of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols-electrophilic aromatic substitution, acylation and

carboxylation. Mechanism of Fries rearrangement, Claisen condensation, Gatterman synthesis, Houben-Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction.

4. Ethers and Epoxides 3 hrs

Nomenclature, methods of preparation. Physical properties. Chemical reactions-cleavage and auto-oxidation, Ziesel's method. Synthesis of epoxides. Acid and base catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organo-lithium reagents with epoxides.

5. Aldehydes and Ketones 10 hrs

Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones with particular reference to the synthesis from acid chlorides, synthesis using 1,3-dithianes, synthesis of ketones from nitriles and carboxylic acids. Physical properties. Mechanism of nuecleophilc additions to carbonyl groups with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensation. Condensation with ammonia and its derivatives; Wittig reaction, Mannich reaction.

Use of acetals as protecting group. Oxidation of aldehydes, Baeyer-Villiger oxidation of ketones, Cannizzaro reaction, MPV, Clemensen, Wolf-Kishner, $LiAlH_4$ and $NaBH_4$ reductions. Halogenation of enolizable ketones. An introduction to α-, β-unsaturated aldehydes and ketones.

6. Carboxylic Acids and their Derivatives 9 hrs

Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Preparation of carboxylic acids. Reactions of carboxylic acids, HellVolhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids, mechanism of decarboxylation.

Methods of formation and chemical reactions of halo acids, hydroxy acids- malic, tartaric, and citric acids. Methods of preparation and chemical reactions of unsaturated monocarboxylic acids. Dicarboxylic acids-methods of preparation and effect of heat and dehydrating agents.

Carboxylic acid derivatives- Structure and nomenclature of acid chlorides, esters, amides (urea) and acid anhydrides. Relative stability of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution. Preparation of carboxylic acid derivatives, chemical reactions. Mechanism of esterification and hydrolysis (acid and base)

7. Nitrogen Containing Organic Compounds 12 hrs

Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanism of nucleophilic substitution in nitroarenes and their reactions in acidic, neutral and alkaline media. Picric acid.

Halo nitroarenes-reactivity, structure and nomenclature of amines. Physical properties. Separation of mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amines. Amine salts as phase-transfer catalysts. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles), reductive amination of aldehydic and ketonic compounds. Gabriel-phthalimide reaction, Hofmann bromamide reaction.

Reaction of amines, electrophilic aromatic substitution in aryl amines, reaction of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling.

8. Organic Synthesis via Enolates 6 hrs

Acidity of hydrogen, alkylation of diethylmalonate and ethylacetoacetate. Synthesis of ethylacetoacetate, the Claisen condensation. Keto-enol tautomerism of ethylacetoacetate.

Physical Chemistry

B. Sc. 2nd year

60 hrs(2 hrs/week)

CHM203 **Paper III** **Max Marks 34**

1. Thermodynamics II 18 hrs

Second law of thermodynamics, need of the law, different statements of the law. Carnot cycle and its efficiency, Carnot theorem. Thermodynamic scale of temperature. Concept of entropy: entropy as a state function, entropy as a function of V and T, entropy as a function of P and T, entropy change in physical and chemical processes, entropy change in reversible and irreversible processes. Clausius inequality, entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases. Gibbs and Helmoltz functions. Gibbs function (G) and Helmoltz function (A) as thermodynamic quantities, A and G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change. Variation of G and A with P, V and T. Gibbs-Helmoltz equation, Clapeyron equation, Clausius-Clapeyron equation, reaction isotherm and reaction isochore.

2. Chemical Equilibrium 06 hrs

The law of mass action, free energy and equilibrium constant, factors influencing equilibrium constant, relationship between Kp and Kc. Thermodynamic derivation of the law of mass action, application of law of mass action to some homogenous and heterogeneous equilibrium, Le-Chatelier's principle.

3. Phase Equilibrium 10 hrs

Statement and meaning of the terms: phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component systems- water, carbon dioxide and sulphur. Phase equilibria of two component systems: solid-liquid equilibra, simple eutectic; BiCd, Pb-Ag systems, desilverisation of lead. Solid solutions-compound formation with congruent melting point (Mg-Zn) and incongruent melting point (NaCl-H_2O, $FeCl_3$-H_2O and $CuSO_4$-H_2O systems). Freezing mixtures, acetone- dry ice. Liquid-liquid mixtures: ideal liquid mixtures, Raoult's and Henry's law. Non-ideal systems-azeotropes; HCl-H_2O and ethanol-water systems. Partially miscible liquids; phenol-water, trimethylamine water, nicotine-water systems. Lower and upper consolute temperature. Effect of impurity on consolute temperature; immiscible liquids, steam distillation. Nernst distribution law: its thermodynamic derivation and applications.

4. Electrochemistry I 12 hrs

Electrical transport-conduction in metals and electrolytic solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution. Arrhenius theory of electrolytic dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law, its uses and limitations. Debye-Hückel theory, equation for strong electrolytes (elementary treatment only). Migration of ions, Transport number, definition and determination by Hittorf and moving boundary methods, Kohlrausch's law. Application of conductivity measurements determination of degree of dissociation, Ka of acids, solubility product of sparingly soluble salts, conductometric titrations.

5. Electrochemistry II 10 hrs

Types of reversible electrodes-gas-metal ion, metal-metal ion, metal-insoluble salt anion and redox electrodes. Electrode reactions, Nernst equation, derivation of cell EMF and single electrode potential, standard hydrogen electrode-reference electrode, standard electrode potential, sign conventions, electrochemical series and its significance. Electrolytic and Galvanic cells-reversible and irreversible cells, conventional representation of electrochemical cells. EMF of a cell and its measurements. Computation of cell EMF. Calculation of thermodynamic quantities of cell reactions (ΔG, ΔH and K), polarization decomposition potentials, over potential and hydrogen over voltage. Definition of pH and pKa, determination pH using hydrogen, quinhydrone and glass electrodes by potentiometric methods. Mechanism of buffer action, Henderson equation. Hydrolysis of salts.

6. Surface Chemistry 04 hrs

Types of adsorption, Freundlich's and Langmuir's adsorption isotherms and their applications, charge on the colloidal particle, size of the colloidal particle, Perrin's method of determination of the Avogadro's number.

Lab Course **B. Sc. Chemistry 2nd year** **Max Marks 50**

06 hrs/week

1. Laboratory hazards and safety precautions.
2. Inorganic quantitative analysis-gravimetric estimation of Ba^{2+}, Fe^{3+} Ni^{2+}, Cu^{2+} and Zn^{2+}.
3. Inorganic synthesis – cuprous chloride, potash alum, chrome alum, ferrous oxalate, ferrous ammonium sulphate, tetraamminecopper(II) sulphate and hexaamminenickel(II) chloride. Crystallization of compounds.
4. Organic qualitative analysis- Preparation of sodium extract, identification of special elements, identification of simple organic compounds-hydrocarbons (aliphatic & aromatic)- their derivatives.

One exercise each from gravimetric estimation, synthesis of compounds and organic chemistry exercise shall be given in the examination.

Distribution of marks shall be as given below:

i) Gravimetric estimation	15
ii) Inorganic Synthesis `	08
iii) Identification of Organic compound	10
iv) *Viva-Voce test	05
v) Annual lab record and attendance(06 for each)	12

*Viva voce test for ex-students shall carry 17 marks

Note: *The lab work of the student has to be evaluated and assessed carefully and periodically. A minimum of 12 experiments covering all the kind of exercises has to be performed during an academic year. The annual record has to be maintained by the department/college as an official record.*
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Duration of the practical examination shall be 06 (six) hours.
Marks have to be uploaded onto the University Examination Portal and hard copy of the same has to be submitted the Controller examination in a sealed envelop making a copy to the Principal/Head of the department.

Inorganic Chemistry

B. Sc. 3rd year

60 hrs (2 hrs/week)

CHE301 **Paper I** **Max Marks 33**

1. Hard and Soft Acid-Base Theory 07 hrs

Classification of acids and bases as hard and soft. Pearson's Hard and Soft Acid Base (HSAB) concept, acid base strength and hardness and softness. Limitations of HSAB principle. Symbiosis, theoretical basis of hardness and softness, electronegativity and hardness and softness. Applications of HSAB principle.

2. Metal-Ligand Bonding in Transition Metal Complexes 10 hrs

Limitations of valence bond theory(VBT), Crystal Field Theory (CFT); crystal field splitting in octahedral and tetrahedral complexes, tetragonal distortion from octahedral geometry (Jhon-Teller distortion), crystal field splitting in square planar complexes, crystal field splitting energy (CFSE), 10Dq, factors affecting 10Dq (Δ_0, Δ_t). Magnetic properties (high spin and low spin) and colour of coordination complexes.

3. Magnetic Properties of Transition Metal Complexes 07 hrs

Types of magnetic behaviour, methods of determining magnetic susceptibility; Gouy's and Quincke's methods, spin only formula, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moments, application of magnetic moment data for 3d metal complexes.

4. Electronic Spectra of Transition Metal Complexes 07 hrs

Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states (Russel Saunder's coupling), spectrochemical series. Orgel energy level diagram for d^1, d^4, d^6 and d^9 configuration in octahedral and tetrahedral fields, discussion of the electronic spectrum of $[Ti(H_2O)_6]^{3+}$ complex ion.

5. Thermodynamic and Kinetic Aspects of Coordination Compounds. 05 hrs

A brief outline of thermodynamic and kinetic stability of metal complexes and factors affecting the stability of coordination compounds. Substitution reactions in square planar complexes, trans effect, application of trans effect, theories of trans effect.

6. Organometallic Chemistry 10 hrs

Definition, nomenclature and classification based on nature of metal-carbon bond. Metal carbonyls. Mononuclear carbonyls, nature of bonding, structure and preparation. EAN and 18-electron rule. General methods of preparation of organometallic compounds and a brief account of metal-ethylenic complexes, Zeise's salt structure.

7. Bioinorganic Chemistry 10 hrs

Role of metal ions in biology, essential and trace elements in biological systems, toxic elements, elementary idea of structure and oxygen binding mechanism in metallo-porphyrins with special reference to haemoglobin and myoglobin. Role of sodium and potassium ions in biological system-mechanism of transport across cell membrane, biochemistry of magnesium and calcium.

8. Inorganic Polymers of Silicon and Phosphorus 04 hrs

Inorganic polymers- Classification, comparison with those of organic polymers. Synthesis, structure and applications of Silicones. Phosphazenes, structure and nature of bonding in triphosphazenes.

Organic Chemistry

B. Sc. 3rd year

60 hrs (2 hrs/week)

CHM302 **Paper II** **Max Marks 33**

1. Spectroscopy 08 hrs

Nuclear magnetic resonance (NMR) spectroscopy; Proton magnetic resonance (1H NMR) spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin spin splitting and coupling constants, areas of signals, interpretation of pmr spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone, Problems pertaining to the structure elucidation of simple organic compounds using UV, IR and PMR spectroscopic techniques.

2. Organo-metallic Compounds 04 hrs

Organo-magnesium compounds; the Grignard reagents-formation, structure and chemical reactions. Organozinc compounds; formation and chemical reactions.

3. Organo-sulphur compounds 04 hrs

Nomenclature, structural features, methods of formation and chemical reactions of thiols, thioethers, sulphonic acid, sulphonamides and sulphaguanidine.

4. Heterocyclic compounds 08 hrs

Introduction: Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechnism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole.

Introduction of condensed five- and six membered heterocycles. Preparation and reactions of quinolene and isoquinolene with special reference to Fischer-Indole synthesis, Skraup's synthesis and Bischler-Napieralski synthesis. Mechnaism of electrophilic substitution reactions of quinolene and isoquinolene.

5. Carbohydrates 08 hrs

Classification and nomenclature. Monosaccharides, mechanism of osazone formation, inter conversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threo diastereomers. Conversion of glucose into mannose. Formation of glycosides, ethers and esters. Determination of ring size of monosaccharides. Cyclic structure of D(+)-glucose. Mechanism of mutarotation. General study of disaccharides (structure determination not required). General introduction of structure of ribose and deoxyribose.

6. Amino Acids, Peptides, Proteins and Nucleic Acids 08 hrs

Classification, structure and stereochemistry of amino acids. Acid-base behaviour, isoelectric point and electrophoresis. Preparation and reactions of α -amino acids. Nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, solid-phase peptide synthesis. Levels of protein structure. Protein denaturation/renaturation.

Nucleic acids: introduction, constituents of nucleic acids. Ribonucleosides and ribonucleotides. The double helical structure of DNA.

7. Fats, Oils and Detergents 02 hrs

Natural fats and common fatty acids, glycerides, hydrogenation of unsaturated oils. Saponification value, iodine value and acid value. Soaps, synthetic detergents, alkyl and aryl sulphonates.

8. Synthetic Polymers 04 hrs

Addition or chain-growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler-Natta polymerization and vinyl polymers. Condensation or step-growth polymerization. Polyesters, polyamides, phenol formaldehyde resins, urea formaldehyde resins, epoxy resins and polyurethanes. Natural and synthetic rubber.

9. Synthetic Dyes 06 hrs

Colour and constitution (electronic concept), classification of dyes. Synthesis and uses of Methyl orange, Malachite green, Phenolphthalein, Fluorescein, Alizarin and Indigo.

10. Natural Products 08 hrs

Classification, extraction and general methods of structure determination of terpenoids (limonene, citral) and alkaloids (nicotine, cocaine).

Physical Chemistry

B. Sc. 3rd year

60 hrs (2 hrs/week)

CHM303 **Paper III** **Max Marks 34**

1. Elementary Quantum Mechanics 12 hrs

Black-body radiation, Plank's radiation law, photoelectric effect, Bohr's model of hydrogen atom (no derivation) and its defects. Compton effect, de Broglie hypothesis, Heisenberg's uncertainty principle, operator concept, Hamiltonian operator, Schrödinger wave equation and its importance, physical interpretation of the wave function.

2. Spectroscopy 20 hrs

Introduction; electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppenheimer approximation. Degrees of freedom, types of energies in linear and non-linear molecules, derivation and applications of Maxwell-Boltzmann distribution law. Rotational spectrum Diatomic molecules, energy levels of a rigid rotor (semi-

classical principle), selection rules, special intensity, determination of bond length, qualitative description of non-rigid rotor, isotopic effect. Vibrational spectrum Infrared spectrum, energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of harmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups. Raman spectrum, concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules. Electronic spectrum Concept of potential curves for bonding and antibonding molecular orbitals, qualitative description of selection rules and Frank-Condon principle, Qualitative description of σ, π, and n M.Os, their energy levels and the respective transitions.

3. Photochemistry 08 hrs

Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry; Grothuss-Drapper law, Lambert's law, Lambert Beer's law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, nonradiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions-energy transfer processes (simple examples).

4. Physical Properties and Molecular Structure 06 hrs

Optical properties and their relation with chemical constitution, polarization, Clausius Mossotti equation, orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment-temperature method and refractivity method, dipole moment and its application in determining the structure of molecules.

5. Solutions and Colligative Properties 08 hrs

Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solutions, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular mass determination. Osmosis, law of osmotic pressure and its measurement, determination of molecular mass from osmotic pressure. Elevation of boiling point and depression in freezing point. Experimental methods for determining various colligative properties. Abnormal molar mass, degree of dissociation and association of solutes.

6. Thermodynamics III 06 hrs

Statement and concept of residual entropy, third law of thermodynamics, unattainability of absolute zero, Nernst heat theorem. Evaluation of absolute entropy from heat capacity data.

Lab Course **B. Sc. Chemistry 3rd year** **Max Marks 50**

06 hrs/week

1. Laboratory hazards and safety precautions.
2. Organic qualitative analysis; binary mixture of organic compounds separable by H_2O and $NaHCO_3$
3. Organic synthesis; through nitration, halogenation, acetylation, sulphonation and simple oxidation.
4. Physical chemistry experiments based on solubility, transition temperature and phase equilibria, thermochemistry and electrochemistry
5. Demonstrative chromatographic experiments; Paper chromatography/TLC (analytical separation of simple organic molecules).

One exercise each from organic binary mixture, organic synthesis and physical chemistry experiments shall be given in the examination.

Distribution of marks shall be as given below:

i. Organic qualitative analysis	16
ii. Organic synthesis	07
iii. Physical chemistry experiment	10
iv. *Viva-Voce test	05
v. Annual record and attendance (06 for each)	12

*Viva-Voce test for ex-students shall carry 17 marks.

Note:

The lab work of the student has to be evaluated and assessed carefully and periodically. A minimum of 12 experiments covering all the kind of exercises has to be performed during an academic year. The annual record has to be maintained by the department/college as an official record.
Less than zero mark will not be awarded.
The total number of students to be examined per batch shall not be more than sixty.
Duration of the practical examination shall be of 06 (six) hours.
Marks have to be uploaded onto the University Examination Portal and hard copy of the same has to be submitted to the Controller examination in a sealed envelope making a copy to the Principal/Head of the department.

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