Inorganic Chemistry

B. Sc. II 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; ionic radii, oxidation states, complex compound formation and magnetic properties. Their binary compounds, illustrating relative stability of their oxidation states, coordination number and geometry.

2. **Chemistry of Transition Elements (Second and Third Series) 10 hrs**
   General characteristics, comparative treatment with their analogues in respect of ionic radii, oxidation state, magnetic behaviour and stereochemistry.

3. **Oxidation and Reduction 8 hrs**

   Standard electrode potential, Reference 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, chelates. Nomenclature of coordination compounds (IUPAC system), isomerism in coordination compounds, stability of complexes and factors contributing to the stability. Valence bond theory for coordination compounds.

5. **Chemistry of Lanthanides 6 hrs**

   Electronic structure, oxidation states, ionic radii, lanthanide contraction and its consequences, complex formation, 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, 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, role of the solvent and strength of acids and bases.

7.

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, salvation and solvolysis, complex formation, merits and demerits.

Organic Chemistry

B. Sc. II 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 absrptivity, 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 nucleophilc 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, Hell-Volhard-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.

Halonitroarenes-reactivity, structure and nomenclature of amines. Physical properties. Separation of mixture of primary, secondary and tertiary amines. Structural features affecting basicily 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. II 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; Bi-Cd, 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.

1. 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, K_a of acids, solubility product of sparingly soluble salts, conductometric titrations.

2. 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 pK_a, determination pH using hydrogen, quinhydrone and glass electrodes by potentiometric methods. Mechanism of buffer action, Henderson equation. Hydrolysis of salts.

3. 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 II 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.*
- *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 06 (six) hours.*
- *Marks have to be submitted to the Registrar/Controller examination in a sealed envelop making a copy to the Principal/Head of the department.*