

RTM NAGPUR UNIVERSITY NAGPUR
SEMESTER PATTERN SYLLABUS
(To be implemented from session 2013-14)

SUBJECT CHEMISTRY
B.Sc. –I, Semester - I
CH – 101: Paper- I (Inorganic Chemistry)

Unit-I

(7.5 Hrs)

(A) Atomic structure-Idea of de-Broglie matter Waves, Heisenberg's uncertainty principle. Schrodinger wave equation, significance of Ψ and Ψ^2 , Quantum numbers, shapes of s, p, and d orbitals, Aufbau principle, Pauli's exclusion principles and Hund's rule of maximum multiplicity. Electronic Configuration of elements and ions ($Z = 1$ to 30)

(B) Periodic Properties: Atomic and ionic radii, ionization energy, electron affinity and electronegativity- Definition, trends in periodic table. Factors affecting ionization potential. Pauling's and Muliken's scale of electronegativity. Effective nuclear charge and Slater's rule with some exercises

Unit-II

(7.5 Hrs)

(A) Covalent Bond: Valency Bond Theory, Formation of Hydrogen molecule, Limitations, directional characteristics of covalent bond, overlap criterion and bond strength. Bond energy, bond length, Bond order, Bond angle. Various types of hybridization and shape of inorganic molecules. Valence shell electron pair repulsion (VSEPR) theory to NH_3 , SF_4 , ClF_3 , and H_2O

(B) Ionic solids: Ionic structures, Lattice energy and Born-Haber cycle. Solvation energy and solubility of ionic solids, polarizing power and polarisability of ions, Fajans rule.

Unit – III

(7.5 Hrs)

(A) s- block elements-Comparative study: Electronic configuration, atomic and ionic radii, Ionisation potential, Reducing properties. Diagonal Relationships (Li-Mg). Hydrogen bonding. Classification and effect of Hydrogen bonding on viscosity, solubility, M.pt. and B.pt

(B) Chemistry of Noble Gases: Chemical properties of the noble gases, Chemistry of Xenon, Structure and bonding in xenon fluorides and oxyfluorides (XeOF_2 and XeOF_4)

Unit- IV

(7.5 Hrs)

(A) p-block elements -Comparative study of groups 13 to 17: Atomic and ionic radii, Ionisation potential, electronegativity, redox properties, oxidation state. Diagonal relationship (B-Si).

(B) Hydrides: Comparative study with respect to structure of NH_3 , PH_3 , AsH_3 and SbH_3 .

Oxides: Structure of P_2O_3 , P_2O_5 and Oxyacids of Phosphorous (H_3PO_3 and H_3PO_4)

Peroxyacids of sulphur: Preparation and structure of Caro's and Marshall's acids.

Hydrides of boron: Structure and bonding of diborane, structure of borazine.

CH – 102 : Paper- II (Physical Chemistry)

Unit-I

(7.5 Hrs)

Gaseous State

A) Postulates of kinetic theory of gases, derivation of kinetic gas equation, deduction of various gas laws from kinetic gas equation. Qualitative discussion of the Maxwell-Boltzmann distribution of molecular velocities. Effect of temperature on molecular velocities. Different types of molecular velocities (most probable, R.M.S. and average and expressions for them, their inter relationships. Definitions of Mean free path collision diameter and collision number.

(B) Ideal gas and real gases, behavior of real gases, deviations from ideal behavior, explanation of the terms – Compressibility factors and Boyle temperature. Causes of deviation from ideal behaviors. Vander Wall's equation of state, explanation of behaviour of real gases. Critical phenomenon (P-V isotherms of real gases). The isotherms of Van der Wall's equation, Relationship between critical constants and Van der Wall's equation, Relationship between critical constants and Vander Waal's constants.

Unit-II

Solid State

(7.5Hrs)

Laws of crystallography

- i) Law of constancy of interfacial angles
 - ii) Law of rationality of indices
 - iii) Law of symmetry, symmetry elements in crystals.
- Unit cell, space lattice, orientation of lattice plane (Miller indices). Bravais lattices, crystal systems, X-ray diffraction by crystal, derivation of Bragg's equation. Determination of crystal structure of NaCl, KCl and CsCl Laue's method and powder method.

Unit- III

(7.5 Hrs)

Liquid State

- A)** Intermolecular forces, structure of liquids (a qualitative description), structural differences between solids, liquids and gases, liquid crystals, Classification, structure of Nematic and Cholesteric phases, Thermographic and seven segment cell.
- B)** Properties of liquid :
- i) Surface tension : Explanation, methods of determination, Capillary rise method and drop number method, Parachor value and its application .
 - ii) Viscosity : Explanation, coefficient of viscosity, Effect of temperature on Viscosity, relative viscosity, specific viscosity and intrinsic viscosity and reduced viscosity. Method of determination by Ostwald viscometer.
 - iii) Refractive index : specific refraction, molar refractions and chemical constitution. Method of determination by Abbe's Refractometer.

Unit- IV

Surface Chemistry and Catalysis-

(7.5 Hrs)

- A) Adsorption-** General introduction, Factors affecting adsorption of Gases by Solids, Types of adsorption, Adsorption Isotherms : Freundlich Adsorption Isotherm, Langmuir Adsorption Isotherm, B.E.T. Equation (no derivation), Application of B.E.T. Equation in Determination of Surface Area of Adsorbent, , Effect of Dissolve substance on Surface Tension of the solvent (Adsorption at the Surfaces of Solutions), Application of Adsorption.
- B) Catalysis:-** Introduction, Homogeneous & Heterogeneous Catalysis Examples , Action of Catalytic Promoters & Inhibitors, enzyme catalysis, auto catalysis , Kinetics of Enzyme Catalysed Reactions- Machaelis-Menten Equation

CH-103: Laboratory Course

Practical- I(Inorganic Chemistry): Semi micro Qualitative Analysis

Qualitative analysis of inorganic salt mixture containing two acidic radicals of different group and two basic radicals of same groups. (At least six mixtures to be analysed)

Practical- II (Physical Chemistry)

- 1) Determination of relative viscosity of unknown liquid by Ostwald viscometer.
- 2) To determine the percentage composition of given binary mixture (Ethanol-water) by viscosity method.
- 3) 'Determination of surface tension of a given liquid by drop number method (Stalagmometer method)
- 4) Comparison of cleaning action of surfactants.
- 5) Determination of refractive index of given liquid by Abbe's refractometer.
- 6) Construction of various crystal models of NaCl unit cell.
- 7) To verify the Freundlich & Langmuir's adsorption isotherm of acetic acid on charcoal.

B.Sc. -I, Semester - II

CH – 201: Paper- I (Organic Chemistry)

Unit - I

(7.5 Hrs)

- A) Structure and Bonding :** Hybridization in case of Methane, Ethane, Ethylene and Acetylene, Bond lengths, bond angles and bond energies. Elementary ideas of Inductive effect, Electromeric effect. Resonance effect, Hyperconjugation (definition and examples). Hydrogen bonding in organic compounds (with reference to alcohol) and its consequences. .
- B) Mechanism of Organic Reactions :** Homolytic & heterolytic bond fission with examples . Electrophiles & nucleophiles definition and example both neutral and charged. Types of organic reactions addition, substitution, elimination, rearrangement. Reactive intermediates carbocations, carbanions, free radicals, carbenes, formation, geometry, stability.

Unit - II

(7.5 Hrs)

Stereochemistry of Organic Compounds : Concept of isomerism. Types of isomerism with suitable examples. Optical isomerism-elements of symmetry, molecular chirality, enantiomers, stereogenic centre(lactic acid as example). Optical activity, chiral and achiral molecules with two stereogenic centres (Tartaric acid) diastereo-isomers, mesocompound. Resolution of enantiomers biological and chemical methods. Inversion retention and racemisation. Asymmetric synthesis. Relative and absolute configuration, sequence rules, D & L and R & S system of nomenclature.

Geometrical isomerism : E & Z system of nomenclature, geometric isomerism in maleic acid and fumaric acid and 2-butene.

Conformational isomerism : Conformational analysis of ethane and n-butane.

Newman's projection and sawhorse formulae. Difference between configuration and conformation.

Unit - III

7.5 Hrs

A) Alkanes: IUPAC nomenclature of branched and unbranched alkanes. Alkyl group, methods of formation (Ethane) - Wurtz reaction, Kolbe's reaction, decarboxylation of carboxylic acid. Physical properties and chemical reactions of alkanes: halogenation, nitration, sulphonation, isomerization, cyclization, aromatization, pyrolysis and cracking oxidation, L. P. G., Octane number. Mechanism of free radical chlorination of methane.

Cycloalkanes : Nomenclature, Baeyer's strain theory and its limitations. Ring strain in small rings cyclopropane and cyclobutane. Theory of strainless rings. Conformational analysis of cyclohexane, axial and equatorial bonds.

B) Alkenes : Nomenclature of alkenes, methods of formation (ethylene & propylene) - dehydrogenation, dehydrohalogenation of alkyl halides, dehydration of alcohol dehalogenation of dihalides. Chemical reactions of alkenes (ethylene and propylene) - hydroboration, oxidation KMnO_4 , HIO_4 , Epoxidation, Ozonolysis, Hydroxylation, Polymerization Substitution in allylic position of alkenes. Markownikoff's Rule and peroxide effect. Ionic Mechanism of addition of Br_2 to ethene and HBr to propene Free radical mechanism of addition of HBr to propene.

Unit - IV

7.5 Hrs

A) Dienes: Nomenclature and classification of dienes Methods of formation of 1, 3 - butadiene. Chemical reactions of butadiene - 1, 2 and 1, 4 additions Diels-Alder reaction.

Alkynes: Nomenclature, structure and bonding in Alkynes. Methods of formation of acetylene from - calcium carbide, dehydrohalogenation of dihalides Chemical reaction - hydroboration, oxidation metal ammonia reduction & polymerization. Oxyacetylene flame. Acidity of alkynes.

B) Aromatic compounds and Aromaticity: Nomenclature of Benzene derivatives, structure of benzene, Molecular formula and Kekule structure. Resonance structure, MO picture, Huckel rule, aromatic ions (cyclopentadienyl anion and cycloheptatrienyl cation). Aromatic electrophilic substitution mechanism with energy profile diagram (eg. nitration and sulphonation).

CH – 202: Paper- II (Physical Chemistry)

UNIT-I : Thermodynamics

7.5 Hrs

(A) Recapitulation of thermodynamic terms : system, surrounding, types of system (closed, open & isolated), Thermodynamic, variables, intensive & extensive properties, thermodynamic processes isothermal, adiabatic, isobaric, isochoric, cyclic, reversible & irreversible. State function & path functions, concept of heat & work.

(B) Statements of first law of thermodynamics, definition of internal energy & enthalpy, heat capacity, heat capacity at constant volume and at constant pressure, their relationship. Joule-Thomson experiment, Joule-Thomson coefficient & inversion temperature, calculations of w , q ΔE & ΔH for expansion of gases for isothermal & adiabatic conditions for reversible process,.

Thermo chemistry : Heat of reaction ,relation between heat of reaction at constant volume and constant pressure. Hess's law of constant heat of summation & its applications. Average bond energy ,bond dissociation energy and its calculations from thermochemical data,

UNIT-II : Phase Equilibria

7.5 Hrs

(A) Phase rule : Statement of phase rule, definition of phase, component and degree of freedom, Applications of phase rule to one component system i) water system, ii) Sulphur system. Need of reduced phase rule equation. Two component system (Pb-Ag system) ,Pattinson,s process.

(B) Liquid-Liquid mixtures : Ideal liquid mixtures, Raoult's law of ideal solutions, Henry's law, non-ideal systems, azeotropes : $\text{HCl-H}_2\text{O}$ & ethanol- water system. Partial miscible liquids : phenol-water system, trimethylamine-water, nicotine-water system, lower & upper consolute temperature, effect of impurity on consolute temperature , Nernst distribution law, limitations and applications(association and dissociation).

UNIT-III : Electrochemistry**7.5 Hrs**

- A) Electrical transport : Conductance in metals (electronic) & in electrolyte solutions (ionic conductance), conductivity of electrodes, specific, equivalent and molar conductance, measurement of equivalent conductance, variation of equivalent & specific conductance with dilution, mobility of ions & Kohlrausch's law, Arrhenius theory of electrolyte dissociation & its limitation, Debye-Huckel theory (elementary treatment). Relaxation effect, Electrophoretic effect and Onsager equation.
- B) Migration of ions, velocity of ions & change in concentration around electrode, transport number : definition & determination by Hittorf's method & moving boundary method, factors affecting transport number of ions, relation between transport number & ionic conductance. Application of Kohlrausch's law & conductance for the determination of degree of dissociation, dissociation constant of acids, solubility of sparingly soluble salt, conductometric titrations (Acid-base & precipitation titrations) .

UNIT-IV: Chemical Kinetics**7.5 Hrs**

- (A) Concept of reaction rate, factors affecting the rate of a reaction – concentration., temperature, pressure, solvent, light, catalyst. Order and molecularity, Zero order. Mathematical expression for rate constant of first and second order reactions, their characteristics. Pseudo order reactions. Half life and mean life of reactions with examples. Methods of determination of order of reaction –integration method, differential method, graphical method, method of half life period and isolation method. Effect of temperature on rate of reaction. Arrhenius equation, concepts of activation energy.
- (B) Collision theory of bimolecular reactions (hard sphere model). Transition state theory, expression for rate constant based on equilibrium constant and thermodynamic aspects. Lindmann's theory of unimolecular reactions

CH-203: Laboratory Course**Practical I (Organic Chemistry):**

A) Qualitative Analysis: Element detection(N, Cl , Br, F & S), Identification of functional groups (-COOH, Phenolic -OH, -CHO, Aromatic -NH₂, -CONH₂) ,determination of M.P & B.P.

- B) Preparation: i) Hydrolysis : Preparation of Benzoic acid from Benzamide
 ii) Oxidation: Preparation of Benzoic acid from Benzaldehyde
 iii) Bromination of Phenol

Practical II(Physical Chemistry):

- 1 To determine the heat of solution of potassium nitrate calorimetrically.
- 2 To determine the heat of ionization of acetic acid calorimetrically
- 3 To determine the solubility of benzoic acid at different temperatures and to determine heat of solution of benzoic acid.
- 4 To construct the phase diagram of three component system(Acetic acid-chloroform-water)
5. To determine the critical solution temperature of two partially miscible liquids(phenol-water systems).
- 6 To study the distribution of Iodine between Water and Carbon tetrachloride/Kerosene
7. To determine the strength of the given acid (HCL or CH₃COOH) conductometrically using standard alkali solution.
8. To determine the specific reaction rate of the hydrolysis of methyl acetate catalyzed by H⁺ ions at room temperature.
- 9 .To determine the specific reaction rate of hydrolysis of ethyl acetate catalysed by base (saponification)

B.Sc. –II , Semester - III**CH – 301:Paper- I (Inorganic Chemistry)****Unit – I****7.5 Hrs**

(A) **MO theory** :LCAO approximation, wave equation for molecular orbitals. Difference between bonding and anti bonding MO in terms of energy and electron density distribution curves, order of energy levels in MO. Molecular Orbital diagrams for homonuclear diatomic molecules of elements (with $Z= 1$ to 9) Concepts of nonbonding MO in HF molecule. Coulson's MO diagram of CO and NO diatomic molecule.

(B).Preparation ,properties and structure of tetrasulphur tetranitride (S_4N_4) and Interhalogen compounds. Poly halides (Structure of I_3^- , I_5^- , and ICl_4^-).

Unit- II:**7.5 Hrs****A) Chemistry of elements of first transition series:**

Characteristic properties of the elements of first transition series with reference to their: Electronic configuration, Atomic and ionic radii, Ionization potential, Variable oxidation states, Magnetic properties , Colour, Complex formation tendency and catalytic activity.

B) Non-aqueous solvents:

Classification of solvents and characteristic reactions(acid base, redox & precipitation reactions) in Non-aqueous solvents with reference to i)Liquid Ammonia and ii) Liquid Sulphur dioxide.

Unit – III:**7.5 Hrs****A) Chemistry of elements of second and third transition series:**

Electronic configuration of 4d and 5d transition series .Comparative treatment with their 3d- analogous (Group Cr-Mo-W, Co-Rh-Ir.) in respect of oxidation states and magnetic behavior.

B) Errors in Chemical Analysis:

i) Random and Systematic errors, Explanation of terms: Accuracy and Precision, Uncertainty, Absolute and Relative errors, Mean , Median, Average and Standard deviations, Significant figures, numerical problems.

ii) Statistical Test of Data: Q-test, 2.5d and 4d Rules for rejection of data. Numerical problems

Unit – IV:**7.5 Hrs****A) Chemistry of Lanthanides:**

Position in periodic table , electronic configuration, Oxidation states, Atomic and ionic radii, Lanthanide contraction and its consequences, Complex forming tendency. Occurrence and separation of lanthanides (ion exchange and solvent extraction).

B) Chemistry of Actinides:

Position in periodic table, electronic configuration, Oxidation states, Atomic and ionic radii.

CH-302 : Paper- II (Organic Chemistry)**Unit –I 7.5 Hrs**

Orientation : Activating ($-OH$, $-NH_2$) & deactivating ($-Cl$, $-NO_2$, $-COOH$) substituent's, their orientation and directive influence on further electrophilic substitution, o/p ratio. Methods of formation and chemical reactions of alkyl benzene (Toluene) and biphenyl.

Alkyl halides : Nomenclature, classification, methods of formation, chemical reactions. Mechanism of nucleophilic substitution reactions of alkyl halides S_N^1 and S_N^2 with energy profile diagrams.

Polyhalogen compounds : Chloroform and carbon tetrachloride – formation and chemical reactions.

Nuclear and side chain halogen derivatives of benzene (Aryl halides) : Chlorobenzene and benzyl chloride preparation and reactions. Relative reactivity of alkyl halides vs aryl halides. Synthesis and uses of DDT and BHC.

Unit – II**7.5 Hrs**

A) Alcohols : Classification and nomenclature,

Dihydric alcohols : Nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage ($\text{Pb}(\text{OAc})_4$ and HIO_4) and Pinacol – pinacolone rearrangement.

Trihydric alcohols : Nomenclature and methods of formation, chemical reactions of glycerol.

(C) **Phenols** : Nomenclature, structure and bonding, Preparation of phenols From cumene, chlorobenzene (Dows and Raschig process) and diazonium salts. Physical properties and acidic character, Resonance stabilization of phenoxide ion, Reactions of phenols, Electrophilic aromatic substitution, acetylation and carboxylation, Claisen rearrangement, Gatterman synthesis reaction Mechanism of i) Fries Rearrangement, ii) Reimer-Tiemann reaction.

Unit – III

7.5 Hrs

Aldehydes and ketones : Nomenclature and structure of the carbonyl group, synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides and ketones from nitriles. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensation, Wittig reaction, Mannich reaction, oxidation of aldehydes (by KMnO_4 , Tollens reagent and Fehlings solution), Baeyer-Villiger oxidation of Ketones, Cannizzaro reaction, (with mechanism) MPV, Clemmensen, Wolf-Kishner, LiAlH_4 and NaBH_4 reductions,

Unit IV

7.5 Hrs

A) Carboxylic Acids : Nomenclature, structure & bonding, Physical properties, acidity of carboxylic acids, effect of substituent's on acid strengths preparation of carboxylic acids (from G.R. and cyanides), Reactions of carboxylic acids, Hell-Volhard-Zelinsky reactions. Reduction of carboxylic acids, Mechanism of decarboxylation. Methods of formation and chemical reactions of unsaturated monocarboxylic acids (crotonic acid and cinnamic acid).

Dicarboxylic acids : Methods of formation and effect of heat and dehydrating agents. (Succinic acid, Phthalic acid).

(B) Carboxylic acid derivatives : Structure & nomenclature of acid chlorides, esters, amides and acid anhydrides. Interconversion of acid derivatives by nucleophilic acyl substitution. Preparation of carboxylic acid derivatives, Chemical reactions, Mechanism of esterification and hydrolysis (acidic and basic).

CH- 303: Laboratory Course

Practical-I (Inorganic Chemistry):

Volumetric Analysis (All 5 Expts. to be performed)

Preparation of standard solution by weighing is compulsory

- 1) Estimation of Fe(II) by dichromate using internal indicator.
- 2) Determination of acetic acid in commercial vinegar using NaOH
- 3) Determination of alkali content in antacid tablet using HCl
- 4) Determination of Zn by complexometric titration with EDTA
- 5) Determination of total Hardness of water (permanent and Temporary) by EDTA

Practical- II(Organic Chemistry):

Complete analysis of simple organic compound involving following steps :-

- (i) Preliminary examination
- ii) Detection of elements
- iii) Detection of functional group
- iv) Determination of M.P. / B.P.
- v) Preparation of derivative and its M.P./B.P.
- vi) Performance of specific test if any

B.Sc. –II , Semester – IV

CH – 401: Paper- I (Inorganic Chemistry)

Unit-I:

7.5 Hrs

Coordination compounds:

Distinction among simple salts, double salts and coordination compounds. Werner's Coordination theory and its experimental verification. Sidgwick's electronic interpretation, EAN rule with examples, Nomenclature of Coordination compounds. Chelates: Classification and their application, Valence Bond Theory of transition metal complexes.

Unit- II:

7.5 Hrs

A) Isomerism in coordination compounds:

Structural isomerism and Stereoisomerism in coordination compounds.

B) Oxidation and reduction:

Use of redox potential data: Analysis of Redox cycle, redox stability in water, Latimer diagram of Chlorine and Oxygen, Frost diagram of Nitrogen and Oxygen, and Pourbaix diagrams of Iron.

Unit- III:**7.5 Hrs****A) Organometallic Chemistry**

Definition, Nomenclature and Classification of Organometallic compounds. Preparation properties and application of Alkyl and Aryls of Li and Al. A brief account of metal ethylenic complexes (Structure only). Homogeneous Hydrogenation (Wilkinson's Catalyst reaction).

B) Metal carbonyls-Definition, preparation, properties, structure and bonding in mononuclear carbonyls- Ni(CO)₄, Fe(CO)₅ and Cr(CO)₆

Unit –IV :**7.5 Hrs**

A) Bioinorganic Chemistry: Essential and Trace elements in biological processes, Metalloporphyrins with special reference to structure and role of Hemoglobin and Myoglobin in transport of Oxygen. Biological role of Na⁺ and K⁺ and Ca²⁺ metal ions.

B) Hard and Soft Acids and Bases: Classification of Acids and Bases as Hard and Soft. Pearson's HSAB Concept and its applications. Symbiosis.

CH – 402:Paper- II (Physical Chemistry)**UNIT- I ; Thermodynamics****7.5 Hrs**

(A) Second law of thermodynamics : Need for second law of thermodynamics, statements of second law of thermodynamics, Carnot's cycle and its efficiency, thermodynamic scale of temperature, concept of entropy, entropy as a state function of V & T, P & T, entropy change in phase change for ideal gas, entropy as criteria of spontaneity & equilibrium.

(B) Free energy functions: Helmholtz free energy (A) & Gibb's free energy (G) and their properties, standard free energies, effect of temperature on free energy (Gibb's – Helmholtz equation) & its applications, A & G as criteria for thermodynamic equilibrium.

(C) Systems of variable composition: Partial molar quantities, chemical potential, Van't-Hoff's reaction isotherm, relation between standard free energy change & equilibrium constant (thermodynamic derivation of law of mass action), effect of temperature on equilibrium constant (reaction isochore).

UNIT –II : Electrochemistry**7.5 Hrs**

(A) Galvanic cells, irreversible & reversible cells, emf of cells & its measurement, calculation of thermodynamic quantities of a cell reactions (ΔG , ΔH & ΔS & equilibrium constant)

(B) Types of reversible electrodes : gas electrode, metal-metal ion electrode, amalgam electrode, metal insoluble salt-anion, redox electrodes, Half cell reactions, Nernst equation, calculation of cell emf from single electrode potential, reference electrodes, standard electrode potential, concentration cells with & without transference, liquid-junction potential, salt bridge & its functions, Applications of emf measurements in : (i) pH determination using hydrogen electrode, quinhydrone electrode & glass electrode (ii) potentiometric titration (Acid –Base and Redox titrations).

Unit-III**7.5 Hrs**

A) Nuclear chemistry : Composition of Nucleus, Mass defects, nuclear binding energy, Average binding energy per nucleon, explanation of nuclear stability on the basis of graph between average binding energy per nucleon and atomic mass number. Nuclear reactions : Fission and fusion. Nuclear models : Liquid drop model, Shell model and comparison between them. Explanation of fission by liquid drop model. Applications of radioisotopes in medicine, agriculture, carbon dating and structure determination

B) Dipole moment

Electrical dipole moment, polarization of molecules (Clausius Mosotti equation), orientation of dipoles in an electric field. Determination of dipole moment. Bond moments. Group moments for benzene derivatives. Application of dipole moment to (i) % ionic character (ii) Shape of molecules, (iii) study of geometrical isomers and (iv) substituted benzene molecules.

Unit IV : Spectroscopy**7.5 Hrs****A) Rotational Spectroscopy :**

Introduction to spectroscopy, Dipole moment and Rotational Spectra. Rotational spectra of diatomic molecules, Energy levels of rigid rotor. Selection rule for transition between energy levels. Expression for wave number (cm⁻¹) of spectral lines in terms of rotational constant (B) and rotational quantum number (J). Intensity of spectral lines. Application of rotational spectra for determination of bond length of diatomic molecules. Introduction to non-rigid rotor.

B) Vibrational Spectra :

Energy levels of simple harmonic oscillator, Energy level diagram, relative populations of energy levels. Selection rule for pure vibrational spectra (harmonic oscillations), Force constant. Anharmonic oscillator,

Morse equation, selection rules, idea of overtones. Degrees of freedom and normal modes of vibration for polyatomic molecules. Idea of vibrational frequencies of different functional groups.

CH-403: Laboratory Course

Practical-I (Inorganic Chemistry):

A) Gravimetric Analysis

- i) Estimation of Ba^{2+} as BaSO_4 ,
- ii) Estimation Ni^{2+} as Ni-DMG

B) Chromatographic separation of binary mixtures (at least Two) containing Cu(II), Co(II) and Ni(II) ions by paper chromatography and determination of R_f values.

Practical-II (Physical Chemistry):

1. To determine the strength of strong acid and a weak acid in a given mixture conductometrically by titrating it with standard alkali solution.
2. To determine the solubility and solubility product of a sparingly soluble salt conductometrically.
3. To determine the ionization constant of weak acid conductometrically.
4. To titrate potentiometrically ferrous ammonium sulphate solution using potassium dichromate solution as titrate and calculate the redox potential of $\text{Fe}^{2+}/\text{Fe}^{3+}$ system on hydrogen scale.
5. To determine the dissociation constant of weak acid potentiometrically by titrating it against alkali.
6. To determine heat of solution of solid calcium chloride and calculate lattice energy of calcium chloride from its enthalpy change data using Born-Haber cycle.
7. To determine the strength of given acid (HCL or CH_3COOH) potentiometrically using standard alkali solution
8. To determine the molecular state of Benzoic Acid by distribution method .

B.Sc. –III, Semester – V**CH- 501:Paper- I (Organic Chemistry)****UNIT- I****7.5 Hrs**

Organic compounds of Nitrogen : Preparation of nitroalkanes and nitrobenzene, chemical reactions of nitroalkanes. Mechanism of nucleophilic substitution in nitrobenzene and their reduction in acidic, neutral and alkaline media. Picric acid- preparation and uses,

Amines : Structure and nomenclature of amines, Physical properties, stereochemistry of amines, separation of mixture of 1°, 2° and 3° amines, structural features affecting basicity of amines, preparation of alkyl & aryl amines (reduction of nitro compounds and nitriles), reductive amination of aldehydic and ketonic compounds, Gabriel phthalimide reaction, Hofmann bromamide reaction, Reactions of amines, Preparation and synthetic transformations of aryl diazonium salts.

UNIT – II**7.5 Hrs****HETEROCYCLIC COMPOUNDS :**

Molecular orbital picture and aromaticity of furan, thiophene, pyrrole and pyridine. Methods of synthesis of pyridine. Mechanism of electrophilic and nucleophilic substitution reaction of pyridine. Chemical reaction of pyridine. Structure of pyridine. Comparison of basicity of pyrrole and pyridine. Introduction to condensed five and six membered heterocycles. Preparation and reactions of Indole, Quinoline and Isoquinoline with special reference to Fischer Indole synthesis, Skraup synthesis and Bischler Napieralski synthesis.

UNIT-III**7.5 Hrs**

A) Quantitative Analysis : Estimation of carbon, hydrogen, nitrogen, sulphur and halogens (only principles and calculations). Calculation of Empirical and molecular formula with Numericals

B) Organometallic compounds :

Organomagnesium compound : Grignard reagent formation, chemical reactions and structure.

Organozinc compounds : Formation and chemical reactions. Organolithium compounds: Formation and chemical reactions.

UNIT-IV**SPECTROSCOPY :**

A) Electromagnetic spectrum : Absorption spectra, Ultraviolet absorption spectroscopy, Absorption laws (Beer Lambert law), molar absorptivity, Presentation and analysis of UV spectra, Types of electronic transitions, Effect of conjugation, concept of chromophores and auxochromes, Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated dienes and enones.

B) Infrared (IR) absorption spectroscopy : Molecular vibrations, Hook's law, Selection rules, Intensity and position of IR bands, measurement of IR spectrum. Fingerprint region, characteristic absorptions of various functional groups and application of IR spectra.

CH- 502:Paper- II (Physical Chemistry)**Unit I : Quantum Chemistry I****7.5 Hrs**

A) Failure of classical mechanics : Explanation on the basis of Black body radiation, Photoelectric effect, heat capacity of solids and Bohr's model of Hydrogen atom (No derivation) . Plank's quantum theory. De Broglie's hypothesis (Derivation and experimental proof). Heisenberg's uncertainty principle (Explanation and experimental proof).

B) Introduction to wave functions (Ψ), well behaved wave functions. Interpretation of wave function (Ψ) and its square (Ψ^2). Schrodinger wave equation. Normalized and orthogonal wave functions (only qualitative idea no problems). Introduction to operators. Postulates of quantum mechanics, Derivation of Schrodinger wave equation from postulates of quantum mechanics. Particle in a one dimensional box : derivation of energy and normalized wave function. Graphical representation of Ψ and its square Ψ^2 . Applications of particle in a one dimensional box. Numerical problems.

Unit II :**7.5 Hrs**

- A) **Quantum Chemistry** Schrodinger wave equation for hydrogen atom, separation in to three equations (without derivation, in terms of r , θ and Φ), Total wave function for hydrogen atom in terms of radial and angular wave functions, energy of hydrogen atom (no derivation). Hydrogen like wave functions, radial wave functions and angular wave functions. Interpretation of quantum, numbers. Concept of orbital and radial probability distribution curves for 1s, 2s, 2p, 3p and 3d orbitals.
- B) **Molecular orbital theory** : Criteria for forming M. O. from A. O., LCAO-MO method for H_2^+ molecule, expression for energy levels for bonding and antibonding wave functions. Normalized wave functions for bonding and antibonding (no derivation). Physical pictures of bonding and antibonding wave functions. Introduction to M. O. theory for H_2 molecule (Qualitative treatment, without derivation). Introduction to Valance bond theory for H_2 molecule.

Unit III**7.5 Hrs****A) Solutions and Colligative properties**

Methods of expressing concentration of solutions, Raoult's law of relative lowering of vapour pressure, molecular mass determination from relative lowering of vapour pressure. Osmosis, osmotic pressure and its measurement by Barkeley and Hartley method. Determination of molecular mass from osmotic pressure. Elevation of boiling point, determination of molecular mass from elevation of boiling point. Depression of freezing point. Determination of molecular mass from depression of freezing point. Van't Hoff factor, degree of dissociation and association of solute.

B) Magnetic properties :

Electron spin angular momentum, spin quantum number, electron as magnetic dipole, magnetic moment of electron, Bohr magneton, relation between magnetic moment and number of unpaired electrons. Magnetic properties of substances. Diamagnetism, paramagnetism, ferromagnetism, determination of magnetic susceptibility using Gouy method. Determination of magnetic moment of paramagnetic substances. Applications of magnetic susceptibility measurements.

Unit IV**7.5 Hrs****A) Photochemistry :**

Interaction of radiation with matter, difference between thermal and photochemical process, Beer – Lamberts, laws of photochemistry : Grothus-Draper law, Stark-Einstein law, Jablonski diagram depicting various processes (nonradiative and radiative) fluorescence, phosphorescence, chemiluminesence, quantum yield, determination of quantum yield of reactions, causes for low and high quantum yields. Some examples of photochemical reactions (e.g. Photochemical decomposition of Hydrogen iodide, Photosynthesis of HBr from H_2 and Br_2 and photosynthesis of HCl from H_2 and Cl_2 Photosensitized reactions. Energy transfer processes.

B) Raman Spectroscopy :

Raman effect, Concept of polarizability, Pure rotational Raman spectra of diatomic molecules. Applications of rotational spectra.

CH-503: Laboratory Course**Practical I (Organic Chemistry):**

- Estimations
- i) Estimation of Glucose
 - ii) Estimation of Amide
 - iii) Estimation of Nitro group
 - iv) Estimation of Carboxylic group
 - v) Saponification of oil

Practical II (Physical Chemistry):

1. To verify law of refraction for mixture (glycerol-water) using Abbe's refracto meter.
2. To determine the specific rotation of a given optically active compound.
3. To verify Beer-Lambert law for $KMnO_4$ and determine the concentration of the given solution of $KMnO_4$.
4. To determine molecular mass of a non-volatile solute by Rast method.
5. To determine the molecular weight of polymer by Viscometric method.
6. To determine the surface tension of methyl alcohol, ethyl alcohol & n-hexane at room temperature & also calculate atomic parachors of carbon, hydrogen & oxygen.
7. To determine the energy of activation of reaction between persulphate iodide .
8. To study the rate of acid catalysed iodination of acetone.

B.Sc. –III, Semester – VI**CH – 601: Paper- I (Inorganic Chemistry)****Unit- I****A) Metal ligand bonding in Transition Metal Complexes:****7.5 Hrs**

Limitations of Valency bond theory, Crystal field theory: Splitting of d-orbital in octahedral, tetrahedral and square planar complexes. Factors affecting the Magnitude of $10Dq$, Crystal field Stabilisation Energy of Octahedral and Tetrahedral complexes (Numericals)

B) Electronic spectra of Transition Metal Complexes:

Jahn Teller Effect, Selection Rules (Laporte and Spin selection Rules). Hole Formalism Principle. Electronic spectrum of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ and $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ complex ions

Unit-II**A) Magnetic Properties of Transition Metal Complexes:****7.5 Hrs**

Method of determining of Magnetic Susceptibility by Gouy's Method. Spin only formula and orbital contribution to magnetic moment. Magnetic properties of Octahedral and Tetrahedral complexes with respect to CFT. Numericals on magnetic moments

B) Thermodynamic and Kinetic aspect of metal complexes:

Thermodynamic and Kinetic stability of metal complexes, their relation. Stepwise stability and overall stability constant and their relationship, Factors affecting the Stability of complexes. Determination of composition of Fe(III)-SSA complex by Mole Ratio and Job's Method.

Unit –III**A) Colorimetry and Spectrophotometry:****7.5 Hrs**

Principles of photometry: Beer-Lamberts Law, derivation and deviation (Numericals). Types of colorimeter and spectrophotometer with simple schematic diagrams. Application of colorimeter and spectrophotometer in quantitative analysis with reference to estimation of Cu(II) as Cu-ammonia complex.

B) Separation Techniques:

- Chromatography: Classification, Principle, Technique and Application of Paper and Column Chromatography.
- Ion-Exchange: Types of ion exchange resins, Equilibria and ion exchange capacity, Application in separation of binary mixtures.
- Solvent Extraction: Principle and Classification, Factors influencing extraction and application in chemistry

Unit- IV Inorganic Polymers:**7.5 Hrs**

Silicones: Introduction, Nomenclature, preparation, properties and uses, General introduction to Silicon oils, Silicone Elastomers and Silicon Resins

Phosphonitrilic halide polymers : Introduction, Preparation, properties and uses. Structure and bonding in $(\text{NPCl}_2)_3$ and $(\text{NPCl}_2)_4$,

CH- 602: Paper- II (Organic Chemistry)**UNIT- I : NMR****7.5 Hrs**

Nuclear Magnetic Resonance (NMR) spectroscopy. Proton Magnetic Resonance spectroscopy. Nuclear shielding and deshielding, Chemical shift, Spin-spin splitting and Coupling constant. Areas of signals. Interpretation of NMR spectra of organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,2 dibromoethane, ethyl acetate, toluene, acetophenone, acetyl acetone. Problem pertaining to the structure elucidation of simple organic molecules by NMR technique.

UNIT- II**7.5 Hrs****A) ORGANIC SYNTHESIS VIA ENOLATES :**

Acidity of α - hydrogens, Reactivity of methylene group. Malonic ester preparation and reaction- Acetoacetic ester - synthesis by Claisen condensation reactions, Keto - enol tautomerism of acetoacetic ester, Preparation of acetic acid, succinic acid, crotonic acid and heterocyclic compounds

- C) **CARBOHYDRATES** : Definition, classification and reaction of glucose. Mechanism of osazone formation. Determination of structure of glucose. Determination of ring size of monosaccharides. Epimerisation, mutarotation, conversion of glucose into fructose and vice-versa. Chain lengthening and shortening of aldoses(Wohl's degradation).Introduction to structures of maltose, sucrose, lactose, starch, cellulose, ribose and deoxyribose without involving structure determination.

UNIT-III

7.5 Hrs

A) AMINO ACIDS, PEPTIDES, PROTEINS & NUCLEIC ACIDS :

Classification, structure and stereochemistry of amino acids. Acids base behavior, isoelectric point and electrophoresis. Structure and nomenclature of peptides and protein. Classification of proteins. Protein denaturation. Structure determination of proteins (primary and secondary).

NUCLEIC ACIDS : Introduction, constituents of nucleic acids. Ribonucleosides and Ribonucleotides. Double helical structure of DNA.

- B) **FATS, OILS AND DETERGENTS** : Natural fats, edible and industrial oils of vegetable origin, Glycerides, hydrogenation of unsaturated oils, Definition of Saponification value. Iodine value. Acid value, Soaps, Synthetic detergents, Alkyl and aryl sulfonates.

UNIT- IV

7.5 Hrs

- A) **SYNTHETIC DYES** : Colour and constitution (Witt theory, electronic concept) Classification of Dyes based on chemical constitution.Synthesis and uses of Congo red, Crystal violet, Phenolphthalein and Alizarin dye.
- B) **SYNTHETIC DRUGS**: Definition,Classification,Preparation,properties and uses of :Aspirin, Paracetamol,Dettol,Chloroquine,Phenobarbitone,Chloramphenicol, Chloramine T.
- C) **SYNTHETIC POLYMERS** : Addition or chain growth polymerisation, free radical. Vinyl polymerisation, Ionic vinyl polymerisation, Ziegler - Natta polymerisation .Condensation or step growth polymerisation. Polyesters, polyamides,

CH-603: Laboratory Course

Practical-I (Inorganic Chemistry):

- A) Preparation of following complexes and Comments on its VBT structure, magnetic properties and colors

a) $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]\text{SO}_4$ b) $[\text{Ni}(\text{NH}_3)_6]\text{SO}_4$ c) Trans $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}$ d) $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3]\cdot\text{H}_2\text{O}$

B) Colorimetry

- Colorimetric or spectrophotometric estimation of copper (II) in commercial copper sulphate sample as ammonia complex.
- Jobs method of determination of composition of Fe- SSA complex
- Mole Ratio Method of determination of composition of Fe- SSA complex

Practical-II (Organic Chemistry):

Separation of an organic mixture containing two solid components using $\text{NaOH} / \text{NaHCO}_3$ for separation, identification of the components and preparation of suitable derivatives (minimum five mixtures)