R.T.M NAGPUR UNIVERSITY NAGPUR

SEMISTER PATTERN PROPOSED SYLLABUS

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 $\Psi$ and $\Psi^2$, Quantum numbers, shapes of s, p, and dorbitals, Aufbau principle, Pauli's exclusion principle 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 Mulliken's scale of electronegativity. Effective nuclear charge and Slater's rule with some numericals.

**Unit-II** **(7.5 Hrs)**

(A) Ionic bond :Introduction to Ionic bonding with respect to formation (Kossel Theory), Lattice energy and Born- Habercycle with numericals. Solvation energy and solubility of ionic solids, polarizing power andpolarisability of ions, Fajans rule.

(B)Covalent Bond: Valence Bond Theory, Formation of Hydrogen molecule with Potential energy diagram Limitations of VBT, directional characteristics of covalent bond, overlap criterion and bond strength. Bond energy, bond length, Bond order and Bond angle. Various types of hybridization involving s, p, d orbitals and shape of inorganic molecules.

**Unit – III** **(7.5 Hrs)**

(A) s- block elements- Electronic configuration, Comparative study with respect to atomic andionic radii, Ionization potential, reducing properties. Application of s-block elements(Na, Kand,Ca) in biosystem.Diagonal Relationships (Li-Mg).Hydrogenbonding .Classification and effect of Hydrogen bonding on viscosity, solubility, Melting point and Boiling point.

(B) Chemistry of Noble Gases: Chemical properties of the noble gases, Preparation, chemical

properties, structures, bonding and applications of Xenon fluorides ($XeF_2$, $XeF_4$, $XeF_6$). Structureand bonding in $XeOF_2$ and $XeOF_4$

**Unit- IV** **(7.5 Hrs)**

(A) p-block elements – Introduction to p-block elements with respect to following compounds: Hydrides: Comparative study with respect to structure of $NH_3$, $PH_3$, $AsH_3$ and $SbH_3$.

Oxides: Structure of $P_2O_3$ ,$P_2O_5$

Oxyacids of Phosphorous: Structure of $H_3PO_3$ 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.

(B) Food Adulteration and Detection: Definition, Conditionsof adulteration, Types of adulteration (intentional, unintentional, natural) . Chemical contamination, Simple tests for the detection of food adulteration in tea leaves and coffee, spices(turmeric andchili powder)and,milk..

**WEF Academic Section: 2020-21**

**Proposed Syllabus, RTM Nagpur University, Nagpur**

**Semester Pattern**

**Subject: Chemistry**

**B.Sc. Sem. I CH-102 Paper -II (Physical Chemistry)**

## Unit - I: Thermodynamics 7.5 Hrs

(A) Definitions of some common thermodynamic terms: system, surrounding, types of systems: open, closed, isolated, homogeneous and heterogeneous systems, extensive and intensive properties, thermodynamic processes: isothermal, adiabatic, isochoric, isobaric, cyclic, reversible and irreversible processes, concept of heat and work, Zeroth law of thermodynamics, First law of thermodynamics, internal energy, enthalpy, heat capacity, relationship between $C_p$ and $C_v$. Joule-Thomson effect, Joule-Thomson experiment, Joule-Thomson coefficient and inversion temperature.

(B) Thermochemistry: Standard states, enthalpy of formation, enthalpies of compounds, enthalpy of combustion, enthalpy of solution, enthalpy of dilution, enthalpy of neutralisation, enthalpy of ionisation. Hess's law of constant heat summation and its applications, heat of reaction, relationship between heat of reaction at constant volume and at constant pressure, average bond energy, bond dissociation energy and its calculations from thermochemical data.
Numerical problems.

## Unit-II: Gaseous State 7.5 Hrs

(A) Postulates of kinetic theory of gases, derivation of kinetic gas equation, deductions of various gas laws from kinetic gas equation: Boyle’s law, Charle’s law, Avogadro’s law, Graham’s law, Dalton’s law, Ideal gas equation. Qualitative discussion of Maxwell-Boltzmann distribution of molecular velocities, effect of temperature on molecular velocities, different types of molecular velocities with their expressions and interrelationships: average, root mean square and most probable velocities, collision diameter, collision number and mean free path.

(B) Ideal and real gases, deviation of real gases from ideal behaviour, explanation of the terms: compressibility factor and Boyle temperature, causes of deviation from ideal behaviour, Vander-Waal's equation of state, explanation of behaviour of real gases by Vander-Waal's equation, Andrew's experiment on critical phenomenon: isotherms of $CO_2$ , continuity of state, isotherms of Vander

Waal's equation, relationship between critical constants and Vander Waal's constants, reduced equation of state and law of corresponding states.

Numerical problems.

## Unit-III: Liquid State 7.5 Hrs

(A) Intermolecular forces: dipole-dipole attraction, ion-dipole attraction, dipole- induced dipole attraction and induced dipole-induced dipole attractions, models of liquid state, structural differences between solids, liquids and gases, liquid crystals, types of liquid crystals: nematic, smectic and cholesteric liquid crystals, difference between liquid crystal, solid and liquid, thermography, liquid crystal display and seven segment cells.

(B) Properties of liquid: surface tension, measurement of surface tension by capillary rise method and drop number method, parachor and its applications, viscosity, coefficient of viscosity, effect of temperature on viscosity. Relative viscosity, specific viscosity, reduced viscosity and intrinsic viscosity, determination of viscosity by Ostwald's viscometer, refractive index, determination of refractive index by Abbe's refractometer, specific refraction, molar refraction.

Numerical problems.

## Unit-IV: Surface Chemistry, Catalysis and Colloidal State 7.5 Hrs

(A) Adsorption: Physical and chemical adsorption, difference between physisorption and chemisorption, Freundlich adsorption isotherm, Langmuir adsorption isotherm, applications of adsorption.

Catalysis, characteristics of catalyst, homogeneous and heterogeneous catalysis, promotors and inhibitors, autocatalysis, enzyme catalysis, applications of catalysts.

(B) Colloidal states: Introduction, types of colloidal systems, classification of colloids, true solutions, colloidal solutions and suspensions. General properties of colloidal systems, properties of hydrophobic colloidal systems (a) electrical properties: charge on colloidal particles, coagulation of colloidal sols: Hardy and Schulzer rule, Gold number (b) electrokinetic properties: electrophoresis and electro-osmosis. Surfactants, types of emulsions, emulsifiers, gels, preparation of gels, importance and application of colloids. Numerical problems.

## 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)

1. To detect presence of iron, coal tar and catechu (as adulterants) in Tea powder.
2. To detect presence of brick powder and Rhodamine B (as adulterants)in chili powder.
3. To detect yellow lead salt and chalk powder (as adulterants) in Turmeric powder
4. To detect urea and sugar (as adulterants) in milk.

### Practical-II (Physical Chemistry)

1 .Determination of heat of solution of potassium nitrate calorimetrically.
2. Determination of heat of ionisation of acetic acid calorimetrically.
3. Determination of integral heat of solution of salt at two different concentrations and hence determine integral heat of dilution.
4. Determination of viscosity coefficient of unknown liquid by Ostwald's viscometer.
5. Determination of surface tension of given liquid by drop number method (Stalagmometer method)
6. To compare cleansing power of two samples of detergent.
7. To determine refractometrically specific and molar refractions of given liquids.
8. To study the adsorption of oxalic acid on activated charcoal and verify Freundlich adsorption isotherm.

**Reference Books (Therory):**


1. Barrow G. M; Physical Chemistry, Tata Mc Grow Hills(2007).
2. Castellan G. W; Physical Chemistry, Narosa (2004).
3. Puri B. R; Sharma L. R; Pathania M. S; Principles of Physical Chemistry, Vishal Publishing Company (2018).
4. Gurdeep Raj; Advanced Physical Chemistry, Goel Publishing House (2009).
5. Bajpai D.N; Advanced Physical Chemistry, S. Chand Publishing (2001).
6. Atkins P.W; Paula J.De; Physical Chemistry, 8th Edn. Oxford University Press (2006).
7. Negi A.S., Anand S. C; A Textbook of Physical Chemistry, New Age International Publishers (2007).


**Reference Books (Practical)**


1. Das R. C., Behra B., Experimental Physical Chemistry, Tata McGraw Hill.
2. Yadav J. B., Advanced Practical Physical Chemistry, Goel Publishing House.
3. Alexander Findlay, Levitt B. P., Findlay's Practical Physical Chemistry, Longman, London.

**WEF from the session 2020-21**

# RTM NAGPUR UNIVERSITY NAGPUR
# SEMISTER PATTERN SYLLABUS

**Subject: Chemistry**

B.Sc. Sem. II

**CH-202 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, Carnot theorem, thermodynamic scale of temperature, concept of entropy, entropy change in reversible and irreversible processes, entropy change of the universe, entropy changefor an ideal gas with change in P, V and T, entropy change during physical changes,
Free energy functions: work function (A) and Gibb's free energy function (G), variation of work function with T and V, variation of Gibb's free energy with T and P, A and G as criteria for spontaneity and equilibrium of a process, Gibb's-Helmholtz equation and its applications.

(B) Partial molar properties, chemical potential, Gibb's-Duhem equation, Clapeyron equation, Clapeyron-Clausius equation, chemical equilibrium: law of mass action, law of chemical equilibrium, relation between $k_p$ and $k_c$, Van't- Hoff reaction isotherm, relation between standard free energy change and equilibrium constant, effect of temperature on equilibrium constant, integrated form of Van't Hoff equation.
Numerical problems.

## Unit-II: Phase Equilibria and Solutions of Liquids in Liquids 7.5 Hrs

(A) Phase rule, definitions and explanation of the terms: phase, components and degree of freedom, derivation of Gibb's phase rule, application of Phase rule to one component systems (i) water system and (ii) sulphur system, need of reduced phase rule equation, application of Phase rule to two component system: lead-silver system, Pattinson process for de-silverization of lead, Potassium iodide-water system.

(B) Solutions of liquids in liquids, Raoult's law, positive deviation from Raoult's law, negative deviation from Raoult's law, Henry's law, partially miscible liquids: lower and upper consolute temperature (examples of phenol-water, trimethylamine-water system, nicotine-water systems), effect of impurity on consolute temperature, Nernst distribution law, conditions for the validity of the distribution law, Applications of Nernst distribution law: association, dissociation and in the process of extraction,
Numerical problems.

## Unit-III: Chemical Kinetics and Theories of Reaction Rates 7.5 Hrs

(A) Rate of reaction, factors affecting the rate of reaction (concentration, temperature, pressure, solvent light and catalyst), order and molecularity of reaction, reactions of zero order, expression of the rate constant for the zero order reaction, derivation of integrated rate equation for first and second order reactions (both for equal and unequal concentration of reactants), characteristics of first and second order reactions, pseudo-unimolecular reactions, methods for determination of order of reactions: integration, differential, graphical, half life period, isolation methods.

(B) Theories of reaction rate: concept of energy of activation, Arrhenius equation, effect of temperature on rate of reaction, collision theory of bimolecular reactions (hard sphere model), transition state theory (equilibrium hypothesis), expression of rate constant based on equilibrium constant and thermodynamic aspects, Lindemann theory of unimolecular reactions.
Numerical problems.

## Unit-IV: Nuclear Chemistry and Pollution and its Control 7.5 Hrs

(A) Nuclear chemistry: Radioactivity, stability of nucleus, rate of radioactive decay, mass defect and binding energy, average binding energy, explanation of nuclear stability on the basis of graph between binding energy per nucleon and atomic mass number, Nuclear reactions: fission and fusion, nuclear models: shell model and liquid drop model, comparison between shell model and liquid drop model, Bohr-Wheeler theory, radioisotopes, applications of radioisotopes in medicine, agriculture, industry and Carbon dating.

(B) Pollution and it's control: Introduction, pollution, causes of pollution, segments of environment: lithosphere, hydrosphere, biosphere and atmosphere, composition of atmosphere, atmospheric structure, air pollution, air pollutants like $SO_2$, $SO_3$, $H_2S$, NO, $NO_2$, CO, $CO_2$, and $O_3$, Acid rain, Greenhouse effect/Global warming, Particulates: dust, smoke, fly ash and smog: London smog and photochemical smog, Air pollution control, methods used to control gaseous pollutants: combustion, absorption and adsorption.
Numerical problems.

## 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 -$NH_2$, -$CONH_2$). 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 solubility of benzoic acid at different temperatures and hence determination of heat of solution of benzoic acid.
2. 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.
3. To construct phase diagram of three- component system (acetic acid-chloroform-water)
4. To determine critical solution temperature of two partially miscible liquids (phenol-water system).
5. To study the distribution coefficient of iodine between water and carbon- tetra chloride/kerosene.
6. To determine molecular state of benzoic acid in benzene by distribution method.
7. To determine rate constant of hydrolysis of methyl acetate in the presence of acid.
8. To determine the velocity constant of hydrolysis of ethyl acetate by NaOH (Saponification of an ester).

**Reference Books (Theory)**


1. Barrow G. M; Physical Chemistry, Tata Mc Grow Hills (2007).
2. Castellan G. W; Physical Chemistry, Narosa (2004).
3. Puri B. R; Sharma L. R; Pathania M. S; Principles of Physical Chemistry, Vishal Publishing Company (2018).
4. Gurdeep Raj, Advanced Physical Chemistry, Goel Publishing House (2009).
5. Bajpai D.N; Advanced Physical Chemistry, S. Chand and Compony Ltd. (2001).
6. Atkins P.W, and Paula J. De ; Physical Chemistry, 8th Edn. Oxford University Press (2006).
7. Negi A. S., Anand S. C., A Textbook of Physical Chemistry, New Age International Publishers (2007).
8. Dey A. K., Environmental Chemistry, New Age International Publishers (2019).
9. Dara S.S., A Text Book of Engineering Chemistry, S. Chand and Company Ltd.(2002).


**Reference Books (Practical)**


1. Das R. C., Behra B., Experimental Physical Chemistry, Tata McGraw Hill.
2. Yadav J. B., Advanced Practical Physical Chemistry, Goel Publishing House.
3. Alexander Findlay, Levitt B. P., Findlay's Practical Physical Chemistry, Longman, London.

**WEF from the session 2020-21**

**RTM NAGPUR UNIVERSITY NAGPUR**
**SEMISTER PATTERN SYLLABUS**
**SUBJECT CHEMISTRY**
**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 carboxylic acid) and its consequences.

**(B) Mechanism of Organic Reactions:** Homolytic and heterolytic bond fission with examples. Electrophiles and nucleophiles: Definition and example both neutral and charged. Types of organic reactions: Addition, substitution, elimination and rearrangement(Definition and examples). Reactive intermediates: Carbocations, carbanions, free radicals and carbenes (Defination, formation, geometry, stability).

**Unit - II** **(7.5Hrs)**

**(A) Stereochemistry of Organic Compounds:**Concept of isomerism. Types of isomerism with 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 acidas example), diastereo-isomers, meso-compound. Resolution of enantiomers: Biological and chemical methods. Inversion, retention, racemisation and asymmetric synthesis. Relative and absolute configuration.Sequence rules - D & L and R & S system of nomenclature.

**(B) Geometrical isomerism:**E and Z system of nomenclature, geometric isomerism in maleic acid, 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 ofalkanes (branched and unbranched). Alkyl group(definition and examples), methods of formation (Ethane and Propane): Wurtz reaction, Kolbe's reaction and decarboxylation of carboxylic acid. Physical properties andChemical reactions of alkanes (Ethane and Propane): Halogenation, nitration, sulphonation,isomerization, cyclization,aromatization,and pyrolysis, cracking and oxidation.L. P. G., Octane number. Mechanism of free radical chlorination of methane.

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

**(B) Alkenes:** IUPAC nomenclature of alkenes, methods of formation (ethylene and propylene): Dehydrogenation of alkanes, dehydrohalogenation of alkyl halides, dehydration of alcohols and 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 and dehydrohalogenation of dihalides. Chemical reaction: Hydroboration,oxidation, metal ammonia reduction and polymerization. Oxyacetylene flame and Acidity of alkynes.

**(B) Aromatic Compounds and Aromaticity:**Nomenclature of Benzene derivatives.Introduction,Structure of benzene - Molecular formula, Kekule structure, Resonance structure, MO picture, Huckel rule and aromaticity.Aromatic ions (cyclopentadienyl anion and cycloheptatrienyl cation). Aromatic electrophillic substitution mechanism with energy profile diagram (e.g. nitration and sulphonation).

**Fuel Chemistry:** LPG, CNG, LNG, and Bio-Gas (definition, calorific value, composition, properties and uses). Octane number.Lubricants:Definition, classification (solid, semisolid, liquidwith example), properties (viscosity index, cloud point, pour point,acid value,saponification value) and applications of lubricants.

# - SYLLABUS -

## B.Sc. Semester - III

### CH - 301: Paper- I (Inorganic Chemistry)

**Unit - I :** **(7.5 Hrs)**

A) **Valence Shell Electron Pair Repulsion (VSEPR) Theory** : Structure with respect to $H_2O$, $NH_3$, $NH_4^+$, $ClF_3$, $SF_4$, $ICl_4^-$. Preparation properties and structure of Interhalogen compounds. Polyhalides (Structure of $I_3^-$, $I_5^-$, $ICl_4^-$)

B) **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.

**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) **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 behaviour.

**Unit- III :**

A) **Chemistry of Lanthanides :** Chemistry 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. Actinide contraction.

**Unit IV :** **(7.5 Hrs)**

A) **Errors in Chemical Ana lysis :**

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.

B) **Soil Chemistry:** Types of soil, Components of soil, Introduction to soil analysis. Analysis of moisture, pH, salinity, nutrients (N, P, K) and micronutrients.

## CH-302: Paper- II (Organic Chemistry)

**Unit - I :** (7.5 Hrs)

A) **Orientation** : Activating (-OH, $-NH_2$) and 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.

B) **Alkyl and Aryl halides** : Nomenclature, classification, methods of formation, chemical reactions. Mechanism of nucleophilic substitution reactions of alkyl halides $S_N1$ and $S_N2$ with energy profile diagrams. Chlorobenzene and benzyl chloride: Method of formations and chemical reactions. Polyhalogen compounds: Chloroform and carbon tetrachloride: formation and chemical reactions.

**Unit - II :** (7.5 Hrs)

A) **Alcohols** : Classification and nomenclature. Dihydric Alcohols: Nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage ($Pb(OAc)_4$ and $HIO_4$) and Pinacol-pinacolone rearrangement with mechanism. Trihydric Alcohols: Nomenclature and methods of formation of Glycerol from (i) Propene and (ii) Hydrolysis of oils and fats, chemical reactions of glycerol - with oxalic acid at two different temperatures, HI, $HNO_3$, dehydration.

B) **Phenols** : Nomenclature, structure and bonding. Preparation of phenols from cumene, Chlorobenzene (Dows and Raschig process) and diazonium salts. 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)

A) Aldehydes **and Ketones:** Nomenclature, 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. Oxidation of aldehydes by $KMnO_4$, Tollen's reagent and Fehlings solution. Reduction by $LiAlH_4$ and $NaBH_4$.

B) Mechanism of nucleophilic additions to carbonyl group with particular emphasis on Benzoin, Aldol, Perkin and Knoevenagel condensation. Wittig reaction, Mannich reaction, Baeyer-Villiger oxidation of ketones, Cannizaro reaction, (with mechanism), MPV, Clemmensen and Wolf- Kishner reaction.

**Unit - IV** (7.5 Hrs)

A) Carboxylic **Acids:** Nomenclature, structure and bonding. Acidity of carboxylic acids, effect of substituent's on acid strengths, preparation of carboxylic acids from Grignard Reagent and cyanides. Chemical reactions of carboxylic acids, Hell-Volhard-Zelinsky reactions, Mechanism of decarboxylation with soda lime.

**Dicarboxylic Acids** : Methods of formation of succinic acid from ethylene dibromide and Phthalic acid from o-xylene. Effect of heat and dehydrating agents (Succinic acid, Phthalic acid).

**Carboxylic Acid Derivatives** : Structure, preparation and chemical reactions of acid chlorides, esters, amides and acid anhydrides.

B) Agrochemicals : Introduction and examples of insecticides, herbicides, fungicide, rodenticides. Advantages and disadvantages of agrochemicals. Synthesis and applications of DDT, BHC, Aldrin, Endosul phan, Atrazine

**Bio pesticides:** Neem oil and Karanj oil.

## CH - 303: Laboratory Course

**Practical - I (Inorganic Chemistry) :**

A) Volumetric Analysis (All Experiments 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

B) Short experiments on soil analysis.

1. Determination of percentage of moisture in a given soil sample.
2. Determination of pH of a given soil sample.
3. Determination of electrical conductivity of a given soil sample.
4. Determination of free lime ($CaCO_3$) in a given soil sample.

**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

*****

# - SYLLABUS -

## B.Sc. 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. Sidgwiek's electronic interpretation. EAN rule with examples. Nomenclature of coordination compounds. Chelates: Classification and their applications. Valence Bond Theory of transition metal complexes.

**Unit - II :** **7.5 Hrs**

A) **Isomerism in Coordination Compounds:** Structural isomerism and stereoisomerism in coordination compounds with respect to C. N. 4 and 6.

B) **Oxidation and Reduction:** Concept of oxidation and reduction. Methods of balancing redox reactions by Ion-Electron method and oxidation number method, (numericals). EMF series and its applications. Use of redox potential data : Analysis of redox cycle, redox stability in water. Latimer diagram of chlorine and oxygen, construction and explanation of Frost diagram. Frost diagram of nitrogen and oxygen. Pourbaix diagram of iron.

**Unit - III :** **7.5 Hrs**

A) **Colorimetry and Spectrophotometry:** 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:** a) Chromatography: Classification, principle, technique and application of paper and column chromatography, b) Ion-Exchange: Types of ion exchange resins, equilibria and ion exchange capacity. Application in separation of binary mixtures. c) Solvent Extraction: Principle and classification. Factors influencing extraction and application in chemistry.

**Unit - IV :** **7.5 Hrs**

A) **Inorganic Polymers:** Silicones : Introductions, Nomenclature, preparation, properties and uses. Phosphonitrilic halide polymers: Introduction, preparation, properties and uses. Structure and bonding in $(NPCl_2)_3$

B) **Water Analysis:** Water and its quality parameters. Physical and chemical quality parameters of drinking water. Analysis of water quality parameters (pH, conductance, TDS, turbidity, temporary and permanent hardness, BOD, COD, DO, alkalinity, chloride, fluoride, sulphate)

## CH-402 : Chemistry - II (Physical Chemistry)

**Unit - I : Solid State:** **(7.5 Hrs)**

A) Solid and their classification, difference between crystalline and amorphous solids, crystallography: some terms used in crystallography, laws of crystallography: Law of constancy of interfacial angles, law of rationality of indices, law of symmetry, elements of symmetry of a crystal, space lattice and unit cell, Bravais lattice, crystal systems, identification of crystal planes, Weiss indices and Miller indices, interplanar distances in cubic systems.

B) X-ray diffraction by crystal, derivation of Bragg's equation, experimental methods of determination of crystal structure: Powder method, Laue's method, determination of crystal structure of NaCl, KCl and CsCl, types of crystals, characteristics of various types of crystals, characteristics structures of ionic crystals, zinc blende structure and Rutile structure, numerical problems.

**Unit - II : Electrochemistry:** **(7.5 Hrs)**

A) Electrical transport: Electrolytic and metallic conductance, difference between metallic and electrolytic conductors, electrical resistance and conductance, specific, equivalent and molar conductance, measurement of electrolytic conductance, variation of conductance, specific, equivalent and molar conductance with concentration. Kohrausch's law, Arrhenius theory of electrolytic dissociation, limitations of Arrhenius theory, Ostwald's dilutions law, validity and importance of Ostwald's dillution law, Debye-Huckel theory (elementary treatment), relaxation effect, electrophoretic effect, Debye-Huckel-Onsagar equation.

B) Transport number, determination of transport number: Hittorf's method, moving boundary method, relation between ionic conductance and transport number, applications of Kohlrausch's law, applications of conductance measurement : determination of equivalent conductance at infinite dilution ($\lambda_\infty$) for weak electrolytes, determination of degree of dissociation, determination of solubility and solubility product of sparingly soluble salts, conductometric titrations: Acid-base and precipitation titration, numerical problems.

**Unit - III : Molecular Spectroscopy:** **(7.5 Hrs)**

A) Rotational spectra: Introduction, electromagnetic radiation, regions of electromagnetic spectrum, types of molecular spectra, rotational spectra of diatomic molecules energy level of rigid rotors, selection rules, expression for wave numbers of spectral lines in terms of rotational constant and rotational, quantum number, intensity of spectral lines, types of molecules showing rotational spectra. Applications of rotational spectra for determination of moment of inertia and bond length, introduction to non-rigid rotor.

B) Vibrational spectra: Vibrational energy levels of simple harmonic oscillator, selection rules, types of molecules showing vibrational spectra, vibrational energy levels of anharmonic oscillator, selection rules, idea of overtones, vibrational-rotational spectra, P, Q and R branches of vibrational - rotational spectra, structural information from infrared spectra moment of inertia and bond length, force constant, normal modes of vibrations in polyatomic molecules, numerical problems.

**Unit - IV : Quantum Chemistry:** **(7.5 Hrs.)**

A) Failure of classical mechanics, explanation of black body radiation, photoelectric effect, heat capacity of solids, de-Broglie's hypothesis (derivation and experimental proof), Heisenberg uncertainty principle (explanation and experimental proof ), Schrodinger wave equation. Eigen value and Eigen functions, normalised and orthogonal wave functions, operators, algebra of operators, Laplacian operator, Hermitian operator, postulates of quantum mechanics, derivation of Schrodinger wave equation on the basis of postulates of quantum mechanics.

B) Dielectric and Magnetic properties of molecules: Polarization of molecules in an electric field, Clausius-Mosotti equation, effect of temperature on polarization, dipole moment and chemical constitution (application of dipole moment). Magnetic permeability, diamegnetic paramagnetic and ferromagnetic substances, magnetic susceptibility, measurement of magnetic susceptibility (Gouy's method), applications of magnetic susceptibility, numberical problems.

## CH-403: Laboratory Course

**Practical - I (Inorganic Chemistry):**

A) Preparation of following complexes and comments on its VBT structure, magnetic properties and colours : a) $[(Cu\,NH_3)_4(H_2O)_2]SO_4$ b) $[Ni(NH_3)_6]SO_4$
c) Trans $[Co(NH_3)_4Cl_2]Cl$ d) $K_3[Fe(C_2O_4)_3].H_2O$

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

C) Determination of Zn by complexometric titration with EDTA

D) Determination of total hardness of water (permanent and temporary) by EDTA

E) Determination of following parameters of drinking water;
a) pH b) Conductance c) Turbidity d) Alkalinity and e) TDS

**Practical - II (Physical Chemistry):**

1. To construct various crystal lattices.
2. To determine the strength of given acid (HCl or $CH_3COOH$) conductometrically by using standard alkali (NaOH) solution.
3. To determine the strength of strong acid and weak acid in a mixture conductometrically by using standard alkali (NaOH) solution.
4. To determine solubility and solubility product of a sparingly soluble salt conductometrically.
5. To determine ionization constant of weak acid conductometrically.
6. To determine electron polarization and electron polarizability of a liquid refractometrically.
7. To determine the molar volume of ethanol and its partial molal volume at room temperature in dilute solution.
8. To determine the equilibrium constant of the reaction, $KI + I_2 \rightarrow KI_3$ by the distribution method.

**B.Sc. –III, Semester – V**
**CH- 501:Paper- I (Organic Chemistry)**
**(2019-2020)**

**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 by Hoffmann's method, 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 - HETEROCYCLIC COMPOUNDS:** **(7.5 Hrs)**

Molecular orbital picture and aromaticity of furan, thiophene, pyrrole and pyridine. Methods of synthesis of pyridine (i) from hexamethylene diamine and (ii) Picoline. 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 :** **(7.5 Hrs)**

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 Electrochemistry (7.5 Hrs)**

**(A)** Galvanic cells, irreversible & reversible cells, emf of cell & its measurement, relation between electrical energy and chemical energy, calculation of thermodynamic quantities of a cell reactions ($\Delta G$, $\Delta H$ & $\Delta S$ & equilibrium constant)

**(B)** Types of reversible electrodes : metal-metal ion electrode, gas electrode, metal insoluble salt-anion electrode, redox electrodes, amalgam electrode, 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). Numericals Problems.

**Unit II : Quantum Chemistry and Molecular Orbital Theory: (7.5 Hrs)**

A) **Quantum Chemistry** Schrodinger wave equation for H-atom, separation in to three equations (without derivation), quantum numbers and their importance,. Hydrogen like wave functions, radial wave functions and angular wave functions. Concept of orbital, shapes of orbital. Radial probability distribution curves for 1s, 2s, 2p, 3p and 3d orbitals.

**B) Molecular orbital theory :** Born-Oppenheimer approximation, Criteria for forming M. O. from A. O., LCAO-MO method for $H^{2+}$ ion, Physical pictures of bonding and antibonding wave functions. Calculation of energy from wave functions. Comparison of bonding and antibonding molecular orbitals. Introduction to M. O. theory for $H_2$ molecule. Introduction to Valance bond theory for $H_2$ molecule. Similarities and differences of valence bond and molecular orbital models.

**Unit III:Photochemistry and Raman Spectroscopy (7.5 Hrs)**

**A) Photochemistry :**

Interaction of radiation with matter, difference between thermal and photochemical reactions, Laws governing absorption of light. Laws of photochemistry. Jablonski diagram depicting various processes, quantum yield, determination of quantum yield of reactions, reasons 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 HCI from $H_2$ and $Cl_2$) Photosensitization, Photosensitized reactions. Numericals Problems.

**B) Raman Spectroscopy :**

Raman Effect, explanation of Rayleigh's lines, Stoke's lines and antistoke's lines, Experimental set up of Raman spectrometer. Pure rotational Raman spectra of diatomic molecules, rotational-vibration Raman spectra of diatomic molecules. Advantages of Raman spectroscopy over Inrfra red spectroscopy.

**UNIT-IV: Colligative properties and Macromolecules (7.5 Hrs)**

**A) Colligative properties:** Methods of expressing concentration of solutions, Raoults law, Relative lowering of vapour pressure, determination of molecular mass from relative lowering of vapour pressure. Osmosis and osmotic pressure of solution. Measurement of osmotic pressure by Barkeley and Hartley method. Determination of molecular mass from osmotic pressure. Elevation of boiling point of solvent, determination of molecular mass from elevation of boiling point. Depression of freezing point of the solvent. Determination of molecular mass from depression of freezing point. Van't Hoff factor, degree of dissociation and association of solute.

**B) Macromolecules:** Macromolecules, classification of polymers, molar masses of polymers: nuber average and weight average molar masses, determination of molar masses of macromolecules: viscometry, Osmometryand light scattering method. Kinetics of polymerization, addition and condensation polymerization. Electronically conducting polymers: poly(acetylene) poly(sulphyrnitride), poly(para-phenylene, poly(aniline). Numericals Problems.

## 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 determine the strength of given acid (HCL or $CH_3COOH$) potentiometrically using standard alkali solution
2. To determine the dissociation constant of weak acid potentiometrically by titrating it against alkali.
3. To titrate potentiometrically ferrous ammonium sulphate against potassium dichromate and calculate redox potential of $Fe^{2+}/Fe^{3+}$ system.
4. To verify Beer-Lambert law using calorimeter and determine the concentration of given solution.
5. To determine molecular mass of a non-volatile solute by Rast method.
6. To determine the molecular weight of polymer by Viscometric method.

7. .To determine the specific rotation of a given optically active compound and the concentration of an unknown solution polarimetrically.

8. To study the rate of acid catalysed iodination of acetone.

(At least six experiments to be performed)

## 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 Valence bond theory, Crystal field theory: Splitting of d-orbital in octahedral, tetrahedral and square planar complexes. Factors affecting the Magnitude of 10 Dq . Concept of Crystal field Stabilisatation Energy of octahedral and tetrahedral complexes. High spin low spin complexes on the basis of $\Delta$ o and pairing energy in octahedral complexes. (Numericals)

**B) Electronic spectra of Transition Metal Complexes:**

Jahn-Teller Effect, Conditions of distortion with respect to CFT configuration. Selection Rules (Laporte and Spin selection Rules). Hole Formalism Principle with respect to $d^1$ and $d^9$ ions. Electronic spectrum of $[Ti(H_2O)_6]^{3+}$ and $[Cu(H_2O)_6]^{2+}$ complex ions with respect to position of the band, intensity of the band, symmetry of the band and bandwidth.

**Unit-II: (7.5 Hrs)**

**A) Magnetic Properties of Transition Metal Complexes:**

Method of determination 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: (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 $Cr(CO)_6$ with respect to back $\pi$ -bonding.

**Unit –IV: (7.5 Hrs)**

**A) Bioinorganic Chemistry**: Essential and Trace elements in biological processes, Metalloporphyrins with special reference to structure and role of Haemoglobin and Myoglobin in transport of Oxygen. Biological role of $Na^+$ and $K^+$ and $Ca^{2+}$ metal ions. Sodium and potassium pump. Hypo and hyper calcimia. Calcium triggering and calcium pump.

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

## CH- 602: Paper- II (Organic Chemistry)

**UNIT- I : NMR Spectroscopy: (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.

B) **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, aracetamol, Dettol, Chloroquine, Phenobarbitone, Chloramphenicol, Chloramine T.

**C) SYNTHETIC POLYMERS:** Addition or chain growth polymerization, free radical. Vinyl polymerization, Ionic vinyl polymerization, Ziegler - Natta polymerization .Condensation or step growth polymerization. Polyesters, polyamides,

## CH-603: 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)** Colorimetery

i) Colorimetric or spectrophotometric estimation of copper (II) in commercial copper sulphate sample as ammonia complex.

ii) Jobs method of determination of composition of Fe- SSA complex

iii) 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 NaOH /NaHCO3 for separation , identification of the components and preparation of suitable derivatives (minimum five mixtures)