# FACULTY OF SCIENCES

## SYLLABUS

## FOR

# B.Sc. (Medical & Non Medical)

**(Semester I-VI)**
**Session: 2017-19**

ESTD. 1892

# KHALSA COLLEGE AMRITSAR

*(An Autonomous College)*

*B. Sc. (Medical & Non Medical)* CHEMISTRY
Semester-I
**INORGANIC CHEMISTRY–I**

**Time: 3 Hrs.** **Marks: 30**
**45 Hrs (3 Hrs/week)**

**The question paper shall consist of two parts as detailed below:–**
**Part A :- (Compulsory)**
It shall consist of 6 very short answer type questions (Q. Nos. 1 to 6) from the entire syllabus and the maximum length of each question may not exceed 1/3rd of the page. Each question will be carrying one mark. (**6 x 1 = 6 Marks)**

**Part B:-**
It shall consist of three sections (Section I, II & III) having 9 questions in total (Q. Nos. 7 to 15) from the entire syllabus. Each section will consist of three questions from each unit of the syllabus. The maximum length of each question may not exceed 5 pages. The candidate will attempt two questions from each section. Each question will be carrying four marks. (**6 x 4 = 24 Marks)**

**SECTION–I**

**I. Atomic Structure 15 Hrs.**
Idea of de Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrodinger wave equation, significance of $\psi$ and $\psi^2$, quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s,p,d orbitals. Aufbau and Pauli exclusion principles, Hund's multiplicity rule. Electronic configurations of the elements and ions.
**II. Periodic Properties**
Position of elements in the periodic table; effective nuclear charge and its calculations. Atomic and ionic radii, ionization energy, electron affinity and electronegativity –definition, methods of determination or evaluation, trends in periodic table and applications in predicting and explaining the chemical behaviour.

**SECTION–II**

**III. Chemical Bonding 15 Hrs**
Covalent Bond –Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions. BeF2 , BF3, CH4, PF5, SF6, IF7, SnCI2, XeF4, BF4, SnC16. Valence shell electron pair repulsion (VSEPR) theory to NH3, H3O+, SF4, CIF3, ICl2 and H2O. MO theory, homonuclear (elements and ions of 1st and 2nd row), and heteronuclear (BO, CN–, CO, NO+, CO+, CN), diatomic molecules, multicenter bonding in electron deficient molecule (Boranes). Percentage ionic character from dipole moment and electronegativity difference.

## SECTION–III

**IV**. **Ionic Solids 15 Hrs**

Concept of close packing, Ionic structures, (NaCI type, Zinc blende, Wurtzite, CaF2 and antifluorite, radius ratio rule and coordination number, limitation of radius ratio rule, lattice defects, semiconductors, lattice energy and Born–Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarisability of ions, Fajan's rule. Metallic –b ofnrede electron, valence bond and band theories.

**Weak Interactions** –Hydrogen bonding, Vander Waals forces.

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**SECTION–I**

**I. Structure and Bonding (5 Hrs.)**
Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bond, Vander Waals interactions, resonance, hyperconjugation, aromticity hydrogen bonding and Inductive and electrometric effects.

**II. Mechanism of Organic Reactions (6 Hrs.)**
Curved arrow notation, drawing electron movements with arrows, half–headed and double–headed arrows, homolytic and heterolytic bond breaking. Types of reagents – electrophiles and nucleophiles. Types of organic reactions. Energy considerations.Reactive intermediates – Carbocations, carbanions, free radicals, carbenes, arenes and nitrenes(with examples). Assigning formal charges on intermediates and other ionic species.

**III. Alkanes (4 Hrs.)**
Isomerism in alkanes, sources, methods of formation (with special reference to Wurtz reaction,Kolbe reaction, Corey–House reaction and decarboxylation of carboxylic acids), physicalproperties and chemical reactions of alkanes. Mechanism of free radical halogenation of alkanes:
orientation, reactivity and selectivity.

**SECTION-II**

**IV. Alkenes and Alkynes (8 Hrs.)**
Nomenclature of alkenes, methods of formation, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. The Saytzeff rule, Hofmann elimination, physical properties and relative stabilities of alkenes. Chemical reactions of alkenes-mechanisms involved in hydrogenation, electrophilic and free radical additions,

Markownikoff's rule, hydroboration-oxidation, oxymercuration reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with KMnO4.
Substitution at the allylic and vinylic positions of alkenes.Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions ofalkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions,hydroboration-oxidation, metal-ammonia reductions, oxidation and polymerization.

**V. Alkyl and Aryl Halides (7 Hrs.)**

Nomenclature and classes of alkyl halides, chemical reactions. Mechanisms of nucleophilic substitution reaction of alkyl halides, SN2 and SN1 reactions with energy profile diagrams. Nuclear and side chain reactions. The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions. Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides.

## SECTION–III

**VI. Cycloalkanes: (5 Hrs.)**

Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane andcyclobutane), theory of strainless rings. The case of cyclopropane ring : banana bonds.

**VII. Arenes and Aromaticity (10 Hrs.)**

Nomenclature of benzene derivatives. The aryl group. Aromatic nucleus and side chain.Structure of benzene: Molecular formula and Kekule structure. Stability and carbon carbon bond lengths of benzene, resonance structure, MO picture.Aromaticity : the Huckel's rule, aromatic ions.Aromatic electrophilic substitution–general pattern of the mechanism, role of $\sigma$ and $\pi$ complexes.Mechanism of nitration, halogenation, sulphonation, mercuration and Friedel Crafts reaction.Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/pararatio. Side chain reactions of benzene derivatives. Methods of formation and chemical reactions of alkylbenzenes.

## *B. Sc. (Medical & Non Medical)* CHEMISTRY
Semester-I
**PRACTICAL**

**Duration: 3½ Hrs.** **Marks: 20**
**6 Period/Week**

**Inorganic Chemistry:** Semi Micro analysis. Cation analysis, Separation and identification of ions from groups I, II, III, IV, V, and VI. Anionic analysis. Four ions with no interference.

**Organic Chemistry Laboratory Techniques**

**Determination of Melting Point**
Naphthalene 80–82$^{o}$C Cinnamic acid 132.5–133$^{o}$C
Benzoic acid 121.5–122$^{0}$C Salicylic acid 157.5–158$^{o}$C
Urea 132.5–133$^{o}$C Acetanilide 113.5–114$^{o}$C
Succinic Acid 184.5–185$^{o}$C m–dinitro benzene 90$^{o}$C
P–dichlorobenzene 52$^{o}$C Aspirin 135$^{o}$C

**Determination of Boiling Point**
Ethanol 78$^{o}$C Cyclohexane 81.4$^{o}$C,
Benzene–80$^{o}$C Toluene 110°C

**Practical Examination**

| | |
|---|---|
| 1) Inorganic Mixture | 10 |
| 2) Melting Point/Boiling point of organic substance | 04 |
| 3) Viva–Voce | 04 |
| 4) Note Book | 02 |

*B. Sc. (Medical & Non Medical)* CHEMISTRY
Semester-II
**INORGANIC CHEMISTRY–II**

**Time: 3 Hrs.** **Marks: 30**
**45 Hrs (3 Hrs/week)**

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**Part B:-**
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**SECTION–I** **15 Hrs.**

**I. p–Block Elements–I**
Comparative study (including diagonal relationship) of groups 13–17 elements, compounds like hydrides, oxides, oxyacids and halides of groups 13–16, hydrides of boron–diborane and higher boranes, Borazine, borohydrides, fullerenes.

**SECTION–II** **15 hrs.**

**II. s-Block Elements**
Comparative studies, diagonal relationship, salient features of hydrides, salvation and complexation tendencies.
**III. p–Block Elements-II**
Carbides, fluorocarbons, silicates (structural principle), tetrasulphur tetranitride, basic properties of halogens, interhalogens and polyhalide **,** Silicones and phosphazenes as examples of inorganic polymers, nature of bonding in triphosphazenes.
**IV. Acids and Bases**
Arrhenius, Bronsted-Lowry, the Lux-Flood, solvent system and Lewis concepts of acids and bases.

**SECTION–III** **15 Hrs.**

**V. Chemistry of Transition Elements**
Characteristic properties of *d*–block elements. Properties of the elements of the first transition series, their simple compounds and complexes illustrating relative stability of their oxidation states, coordination number and geometry. General characteristics of elements of Second and Third Transition Series, comparative treatment with their *3*d analogues in respect of ionic radii, oxidation states, magnetic behaviour.

*B. Sc. (Medical & Non Medical)* CHEMISTRY
Semester-II
**PHYSICAL CHEMISTRY–I**

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**45 Hrs (3 Hrs/week)**

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**Part B:-**
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**SECTION–I**

**I. Gaseous States 15 Hrs.**
Postulates of kinetic theory of gases, deviation from ideal behaviour, van der Waal's equation of state.
**Critical Phenomena:** PV isotherms of real gases, continuity of states, the isotherms of van der Waal's equation, relationship between critical constants and van der Waals constants, the law of corresponding states, reduced equation of state.
**Molecular Velocities:** Root mean square, average and most probable velocities. Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter. Liquefaction of gases

**SECTION–II**

**II. Liquid State 10 Hrs.**
Intermolecular forces, structure of liquids (a qualitative description). Structural differences between solids, liquids and gases. Liquid crystals: Difference between liquids crystal, solid and liquid.Classification, structure of nematic and cholestric phases.Thermography and seven segment cell.
**III. Colloidal State 5 Hrs.**
Definition of colloids, classification of colloids. Solids in liquids (Sol): kinetic, optical and electrical, properties, stability of colloids,protective action, Hardy Schulze law, gold number. Liquids in liquids (emulsions): Types of emulsions, preparation. Emulsifiers. general applications of colloids.

## SECTION–III

**IV. Solutions, Dilute Solutions and Colligative Properties 15 Hrs.**

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

*B. Sc. (Medical & Non Medical)* CHEMISTRY
Semester-II
**PRACTICAL**

**Duration: 3½ Hrs.** **Marks: 20**
**6 Period/Week**

**Crystalisation:**
Concept of indication of crystalisation. Phthalic acid from hot water (using fluted filter paper & stem less funnel)
Acetanilide from boiling water.
Naphthalene from Ethanol
Benzoic acid from water

**Physical Chemistry**
1. To determine the specific reaction rate of hydrolysis of ethyl acetate catalysed by Hydrogenions at room temperature.
2. To study the effect of acid strength on hydrolysis of an ester.

**Viscosity, Surface Tension (Pure Liquids)**
3. To study the viscosity and surface tension of CCI glycerine solution in water.
4. To determine the solubility of benzoic acid at different temperatures and to determine H of the dissolution process.
5. To determine the enthalpy of neutralisation of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionisation of the weak acid/weak base.
6. To determine the enthalpy of dissolution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born Haber cycle.

**Practical Examination: Marks**

| | |
|---|---|
| 1) Crystalisation | 04 |
| 2) Physical Experiment | 10 |
| 3) Viva–Voce | 04 |
| 4) Note Book | 02 |

*B. Sc. (Medical & Non Medical)* CHEMISTRY
Semester-III
**ORGANIC CHEMISTRY–II**

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**45 Hrs (3 Hrs/week)**

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**SECTION–I**

**I. Stereochemistry of Organic Compounds (15 Hrs.)**
Concept of isomerism. Types of isomerism. Optical isomerism, elements of symmetry,molecular chirality, enantiomers, stereogenic centre, optical activity, properties of enantiomers,chiral and achiral molecules with two stereogenic centres, diastereomers, threo and erythro diasteremeors, meso compounds, resolution of enantiomers, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometric isomerism–determination of configuration of geometric isomers. E & Z system of nomenclature. Conformational isomerism–conformational analysis of ethane and n–butane; conformation of cyclohexane, axial and equatorial bonds, conformation of mono substituted cyclohexane derivatives. Newman projection and Sawhorse formulae, Fischer and flying wedge formulae. Difference between configuration and conformation.

**SECTION-II**

**II. Alcohols (8 Hrs.)**
Classification and nomenclature. Monohydric alcohols—nomenclature. Acidic nature. Reactions of alcohols. Dihydric alcohols—nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAC)_4$] and [$HIO_4$] and pinacol-pinacolone rearrangement.

**III. Phenols (7 Hrs.)**
Nomenclature, structure and bonding, Preparation of phenols, physical properties and acidiccharacter, Comparative acidic strengths of alcohols and phenols, resonance stabilization ofphenoxide ion. Reactions of phenols—electrophilic aromatic substitution, acylation

andcarboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis,
Reimer Tiemann reaction.

## SECTION-III

### IV. Aldehydes and Ketones (15 Hrs.)

Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones withparticular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and
ketones using 1,3-dithianes, synthesis of ketones from nitriles and from carboxylic acids.
Physical properties. Mechanism of nucleophilic additions to carbonyl group with particularemphasis on benzoin, aldol, Perkin and Knoevenagel condensations. Condensation withammoni a and its derivatives. Witting reaction. Mannich reaction. Use of acetals as protectinggroup. Oxidation of aldehydes, Baeyer-Villiger oxidation of Ketones, Cannizzaro reaction.MPV, Clemmensen, Wolff-Kishner, $LiAlH_4$ and $NaBH_4$ reductions. Halogenation of enolizableketones. Halogenation of enoliable ketones.

*B. Sc. (Medical & Non Medical)* CHEMISTRY
Semester-III
**PHYSICAL CHEMISTRY–II**

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**45 Hrs (3 Hrs/week)**

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## SECTION-I

**1. Thermodynamics-I** **15 Hrs.**

Definition of thermodynamic terms: System, surroundings etc. Types of systems, intensive and extensive properties. State and path functions and their differentials. Thermodynamic process. Concept of heat and work.

***First Law of Thermodynamics:*** Statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law-Joule-Thomson coefficient and inversion temperature, Calculation of w,q,dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.

***Thermochemistry:*** Standard state, standard enthalpy of formation-Hess's Law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization. Bond dissociation energy and its calculation from thermo-chemical data, temperature dependence of enthalpy. Kirchhoff's equation.

## SECTION-II

**II. Thermodynamics-II & III** **15 Hrs.**

*Second Law of Thermodynamics:* Need for 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 & T, entropy as a function of P & T, entropy change in physical change, Clausius inequality, entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases.

*Third Law of Thermodynamics:* Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data. Gibbs and Helmholtz functions; Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, Variation of

G and A with P,V and T.

**SECTION-III**

**Equilibrium**

**III. Chemical Equilibrium** **5 Hrs.**

Equilibrium constant and free energy. Thermodynamic derivation of law of mass action. Determination of Kp, Kc, Ka and their relationship, Clausius-Clapeyron equation, applications.

**IV Introduction to 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 system-water, CO2 and S systems. Phase equilibria of two component systems-solid-liquid equilibria, 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-H2O), FaCl3-H2O) and CuSO4-H2O) system. Freezing mixtures, acetone-dry ice. Liquid-liquid mixtures-Ideal liquid mixtures, Raoult's and Henry's law. Non-ideal system-azeotropes-HCl-H2O and ethanol-water system. Partially miscible liquids Phenol-water, trines-thylamin-water, Nicotine-water System. Lower and upper consulate temperature, Effect of impurity on consolute temperature, immiscible liquids, steam distillation. Nernst distribution law-thermodynamic derivation and applications.

*B. Sc. (Medical & Non Medical)* CHEMISTRY
Semester-III
**PRACTICAL**

**Duration: 3½ Hrs.** **Marks: 20**
**6 Period/Week**

**Quantitative Analysis**
**Volumetric Analysis**
a. Determination of acetic acid in commercial vinegar using NaOH.
b. Determination of alkali content-antacid tablet using HCI.
c. Estimation of calcium content in chalk as calcium oxalate by permanganometry.
d. Estimation of hardness of water by EDTA.
e. Estimation of ferrous and ferric by dichromate method.
f. Estimation of copper using sodiumthiosulphate.

**Gravimetric Analysis**
Analysis of Cu as CuSCN and Ni as Ni (dimethylgloxime)

**Organic Chemistry Laboratory Techniques**
**Thin Layer Chromatography**
Determination of Rf values and identification of organic compounds.
a. Separation of green leaf pigments (spinach leaves may be used).
b. Preparation and separation of 2, 4. dinitrophenylhydrazones of acetone, 2-butone, 2-Butanone, hexan-2 and 3-one using toluene and light petroleum (40 : 60).
c. Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5).

**Practical Examination**

| | |
|---|---|
| 1) Volumetry / Gravimetry | 10 |
| 2) Thin Layer chromatography | 04 |
| 3) Viva-Voce | 04 |
| 4) Note Book | 02 |

*B. Sc. (Medical & Non Medical)* CHEMISTRY
Semester-IV
**INORGANIC CHEMISTRY–III**

**Time: 3 Hrs.** **Marks: 30**
**45 Hrs (3 Hrs/week)**

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**SECTION-I**

**I. Coordination Compounds 10 Hrs.**
Werner's coordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes.
**II. Non-aqueous Solvents 5 Hrs.**
Physical properties of a solvent, types of solvents and their general characteristics, reactions in non-aqueous solvents with reference to liquid NH3 and liquid SO2.

**SECTION-II**

**III. Oxidation and Reduction 8 Hrs.**
Use of redox potential data-analysis of redox cycle, redox stability in water-Frost, Latimer and Pourbaix diagrams.
**IV. Chemistry of Lanthanide Elements 7 Hrs.**
Electronic structure, oxidation states and ionic radii and lanthanide contraction. Electronic absorption and magnetic properties of lanthanides.

**SECTION-III**

**V. Chemistry of Actinides 5 Hrs.**
General features and chemistry of actinides, similarities between the later actinides and the later lanthanides. Electronic and magnetic properties of actinides and their general comparison with the lanthanide elements.
**VI. Bioinorganic Chemistry 10 Hrs.**
Essential and trace elements in biological processes, metalloporphyrins and special reference to haemoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to Ca2+.

*B. Sc. (Medical & Non Medical)* CHEMISTRY
Semester-IV
**ORGANIC CHEMISTRY–III**

**Time: 3 Hrs.** **Marks: 30**
**45 Hrs (3 Hrs/week)**

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**SECTION-I**

**I. Carboxylic Acids (8 Hrs.)**
Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. Mechanism of decarboxylation.
**II. Carboxylic Acids Derivatives (7 Hrs.)**
Structure and nomenclature of acid chlorides, esters, amides and acid anhydrides, Relative stability & reactivity of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution. Preparation of carboxylic acid derivatives, chemical reactions. Mechanisms of esterification and hydrolysis (acidic and basic).

**SECTION-II**

**III. Ethers and Epoxides (5 Hrs.)**
Nomenclature of ethers and methods of their formation, physical properties. Chemical reaction- cleavage and autoxidation, Ziesel's method. Synthesis of epoxides. Acid and basecatalyzed
ring opening of epoxides, orientation of epoxide ring opening, reactions of
Grignard and organolithium reagents with epoxiedes.
**IV. Organic Compounds of Nitrogen (10 Hrs.)**
Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes, Mechanisms of nucleophilc substitution in nitroarenes and their reduction in acidic, neutral and alkaline media. Reactivity, Structure and nomenclature of amines, Methods of preparation of amines by Reductive amination of aldehydic and ketonic compounds, Gabriel-phthalimide reaction and Hofmann bromamide reaction. Physical properties. Stereochemistry of amines. separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines. Amine salts as phase-transfer catalysts.

## SECTION-III

**V. Organometallic Compounds (7 Hrs.)**

Organomagnesium Compounds: The Grignard reagentsformation, structure and chemical reactions.

Organolithium Compounds: Formation and chemical reactions.

Organozinc and Organocoppercompounds: Nomenclature , Structural features, methods of formation, and chemical reactions.

**VI. Heterocyclic Compounds (8 Hrs.)**

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

*B. Sc. (Medical & Non Medical)* CHEMISTRY
Semester-IV
**PRACTICAL**

**Duration: 3½ Hrs.** **Marks: 20**
**6 Period/Week**

**Qualitative Analysis**

**Detection of elements** (N, S and halogens)

**Detection of functional groups** (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide) in simple organic compounds and preparing their derivatives.

**Practical Examination**

| | |
|---|---|
| 1) Detection of Elements | 04 |
| 2) Detection of functional group and derivative preparation | 10 |
| 3) Viva-Voce | 04 |
| 4) Note Book | 02 |

## ***B. Sc. (Medical & Non** Medical)* CHEMISTRY

Semester-V

**INORGANIC CHEMISTRY–IV**

**Time: 3 Hrs.** **Marks: 30**

**45 Hrs (3 Hrs/week)**

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### SECTION-I

**1. Metal-ligand Bonding in Transition Metal Complexes (10 Hrs)**

Limitations of valence bond theory, an elementary idea of crystal-field theory, crystal field splitting in octahedral, tetrahedral and square planar complexes, factors affecting the crystal-field parameters.

**2. Magnetic Properties of Transition Metal Complexes (5 Hrs)**

Types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula. L-S coupling, correlation of μs and μeff values, orbital contribution to magnetic moments, application of magnetic moment data for characterization of 3d-metal complexes.

### SECTION-II

**3. Thermodynamic and Kinetic Aspects of Metal Complexes (5 Hrs.)**

A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, substitution reactions of square planar complexes.

**4. Electronic Spectra of Transition Metal Complexes (10 Hrs)**

Term symbols for $p^2$ and $d^2$ systems, Spectroscopic ground states for d1-d10 electronic configurations.

Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states. Orgel diagram for $d^1$-$d^5$.

### SECTION-III

**5. Organometallic Compounds: (15 Hrs)**

Definition, nomenclature and classification of organometallic compounds. EAN rule, Preparation, properties, and applications of alkyls aryls of lithium and aluminium, Bonding in metal-ethylenic complexes, Mechanism of homogeneous hydrogenation reactions.

*B. Sc. (Medical & Non Medical)* CHEMISTRY
Semester-V
**PHYSICAL CHEMISTRY–III**

**Time: 3 Hrs.** **Marks: 30**
**45 Hrs (3 Hrs/week)**

**The question paper shall consist of two parts as detailed below:–**
**Part A :- (Compulsory)**
It shall consist of 6 very short answer type questions (Q. Nos. 1 to 6) from the entire syllabus and the maximum length of each question may not exceed 1/3rd of the page. Each question will be carrying one mark. (**6 x 1 = 6 Marks)**
**Part B:-**
It shall consist of three sections (Section I, II & III) having 9 questions in total (Q. Nos. 7 to 15) from the entire syllabus. Each section will consist of three questions each unit of the syllabus. The maximum length of each question may not exceed 5 pages. The candidate will attempt two questions from each section. Each question will be carrying four marks. (**6 x 4 = 24 Marks)**

**SECTION-I**

**1. Electrochemistry-I (7 hrs.)**
Electrical transport-conduction in metals and in electrolyte solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution. Migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law, its uses and limitations. Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only). Transport number, definition and determination by Hittorf method and moving boundary method. Applications of conductivity measurements: determination of degree of dissociation, determination of Ka of acids, determination of solubility product of a sparingly soluble salt, conductometric titrations.
**2. Electrochemistry – II (8 hrs.)**
Types of reversible electrodes-gas metal ion, metal ion, metal insolblue salt-anion and redox electrodes. Electrode reactions. Nernst equation, derivation of cell E.M.F. and Single electrode potential, standard hydrogen electrode, reference electrodes, standard electrode potential, sign conventions, electrochemical series and its significance. Electrolytic and Galvanic cellsreversible and irreverisible cells, conventional representation of electrochemi cells.
EMF of a cell and its measurements. Computation of cell. EMF, Calculation of thermodynamic quantities of cell reactions ($\Delta G$ $\Delta H$ and K), polarization, over potential and hydrogen overvoltage. Concentration cells with and without transport, liquid junction potential, application of concentration cells, valency of ions, solubility product and activity coefficient, potentiometric titrations.
Definition of pH and pKa, determination of pH using hydrogen, quinhydrone and glass electrodes, by potentiometric methods. Buffers-mechanism of buffer action, Henderson-Hazel equation, Hydrolysis of salts. Corrosion-types, theories and methods of combating it.

## SECTION-II

**3. Nuclear Chemistry (15 Hrs.)**

Introduction: Radioactivity, Nuclear Structure, Size of Nucleus, Mass Defects and Binding Energy, Nuclear Stability, Nuclear Forces, Nuclear Spin and Moments of Nuclei, Nuclear Models, Nuclear Decay Processes, The Laws of Radioactive Decay, Soddy-Fajans Group Displacement Law, Rate of Nuclear Decay and Half Life Time (Kinetics of Radioactive Decay), Induced Nuclear Reactions, Types of Nuclear Processes, High Energy Nuclear Reactions, Nuclear Reaction Cross-Section, Artificial radioactivity, Detection and Measurement of Radioactivity, Nuclear Fission, Nuclear Fusion, Applications of Radioactivity.

## SECTION-III

**4. Spectroscopy (15 Hrs.)**

Introduction: Electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppenheimer approximation, degrees of freedom.

**5. Rotational Spectrum**

Diatomic molecules. Energy levels of a rigid rotor (semiclassical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotor, isotope effect.

**6. Vibrational Spectrum**

Infrared spectrum: Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups.

Raman Spectrum: Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules.

**7. Electronic Spectrum**

Concept of potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules and Franck-Condon principle.

Qualitative description of s, p, and n M.O., their energy levels and the respective transitions.

*B. Sc. (Medical & Non Medical)* CHEMISTRY
Semester-V
**PRACTICAL**

**Duration: 3½ Hrs.** **Marks: 20**
**6 Period/Week**

**(I) Synthesis and Analysis**
(a) Preparation of Sodium trioxalatoferrate (III)
(b) Preparation of Ni-DMG Complex
(c ) Preparation of Copper tetrammine complex
(d) Preparation of cis-bisoxalatodiaquachromate (III) ion

**(II) Physical Chemistry**

**(a) Conductometric Titrations**
(i) Determine the end point of the following titrations by the conductometric methods.
Strong acid-Strong base
Strong acid-Weak base
Weak acid-Strong base
Weak acid-Weak base
(ii) Determine the composition of a mixture of acetic acid and the hydrochloric acid by conductometric titration.
**(b)** (i) Molecular Weight Determination of acetanilide, napthalane, using camphor as solvent **(Rast's methods).**
(ii) To determine the molecular weight of a polymer by viscosity measurements.
**(c ) Adsorption** (i) To study the adsorption of acetic acid oxalic/acid from aqueous solutions by charcoal.
**(d)** Phase Equilibria to determine the distribution coefficient of iodine between CCI4 and water.
(e) Refractometry
(i) Determination of refractive index of a liquid by Abbe refractometer, and hence the specific and molar refraction.
(ii) To determine the composition of unknown mixture of two liquids by refractive index measurements.

**Practical Examination**

| | |
|---|---|
| 1) Inorganic Synthesis | 06 |
| 2) Physical experiment | 08 |
| 3) Viva- Voce | 04 |
| 4) Note Book | 02 |

*B. Sc. (Medical & Non Medical)* CHEMISTRY
Semester-VI
**ORGANIC CHEMISTRY– IV**

**Time: 3 Hrs.** **Marks: 30**
**45 Hrs (3 Hrs/week)**

**The question paper shall consist of two parts as detailed below:–**
**Part A :- (Compulsory)**
It shall consist of 6 very short answer type questions (Q. Nos. 1 to 6) from the entire syllabus and the maximum length of each question may not exceed 1/3rd of the page. Each question will be carrying one mark. (**6 x 1 = 6 Marks)**
**Part B:-**
It shall consist of three sections (Section I, II & III) having 9 questions in total (Q. Nos. 7 to 15) from the entire syllabus. Each section will consist of three questions from each unit of the syllabus. The maximum length of each question may not exceed 5 pages. The candidate will attempt two questions from each section. Each question will be carrying four marks. (**6 x 4 = 24 Marks)**

**SECTION-I**

**1. Spectroscopy (15 hrs.)**
Nuclear Magnetic Resonance (NMR) spectroscopy.
Proton Magnetic Resonance (1H NMR) spectroscopy,
nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone.
**2. Electromagnetic Spectrum: Absorption Spectroscopy**
Ultraviolet (U.V.) absorption spectroscopy introduction- (Beer-Lambert law), molar absorptivity, analysis of UVspectra, types of electronic transitions effect of conjugation. Concept of chromophores and auxochrome, Bathochrome, hypsochrome, hyperchrome, hypochromic shifts-UV spectra of conjugated compounds, Infrared (IR) Absorption spectroscopy-introduction, Hooke's law, Selection rules, intensity and IR bands, measurement of IR spectrum time characteristic absorption of various fundamental band interpretation of IR spectra of simple organic compounds.

**SECTION-II**

**3. Problems based on spectroscopy (4 Hrs.)**
Problems pertaining to the structure elucidation of simple organic compounds using UV, IR and PMR spectroscopic techniques.
**4. Organosulphur Compounds (3 Hrs.)**
Nomenclature, structural features, Methods of formation and chemical reactions of thiols, thioethers, sulphonic acids, sulphonamides and sulphaguanidine.
**5. Synthetic Polymers (4 Hrs.)**
Addition or chain-growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler-Natta polymerization and vinyl polymers.
Condensation or step growth polymerization. Polyesters, polyamides, phenol formaldehyde

resins, urea formaldehyde resins, epoxy resins and polyurethanes. Natural and synthetic rubbers.

**6. Organic Synthesis *via* Enolates (4 Hrs.)**

Acidity of $\alpha$-hydrogens, alkylation of diethyl malonate and ethyl acetoacetate. Synthesis of ethylacetoacetate: the Claisen condensation. Keto-enol tautomerism of ethyl acetoacetate. Alkylation of 1,3-dithianes. Alkylation and acylation of enamines.

## SECTION-III

**7. Carbohydrates (8 Hrs.)**

Classification and nomenclature. Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threo diastereomers. Conversion of glucose into mannose. Formation of glycosides, ethers and esters. Determination of ring size of monosaccharides. Cyclic structure of D(+)-glucose. Mechanism of mutarotation.

**Structures of ribose and deoxyribose**

An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination.

**8. Amino Acids, Peptides, Proteins and Nucleic Acids (7 Hrs.)**

Classification, structure and stereochemistry of amino acids. Acid-base behaviour, isoelectric point and electrophoresis. Preparation and reactions of $\alpha$-amino acids.

Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, efdsfdfsdfsdsdzz

nd group analysis, selective hydrolysis of peptides. Classical peptide synthesis, solid-phase peptide synthesis. Structures of peptides and proteins. Levels of protein structure. Protein denaturation/renaturation.

Nucleic acids : Introduction. Constituents of nucleic acids. Ribonucleosides and ribonucleotides. The double helical structure of DNA.

*B. Sc. (Medical & Non Medical)* CHEMISTRY
Semester-VI
**PHYSICAL CHEMISTRY–IV**

**Time: 3 Hrs.** **Marks: 30**
**45 Hrs (3 Hrs/week)**

**The question paper shall consist of two parts as detailed below:–**
**Part A :- (Compulsory)**
It shall consist of 6 very short answer type questions (Q. Nos. 1 to 6) from the entire syllabus and the maximum length of each question may not exceed 1/3rd of the page. Each question will be carrying one mark. (**6 x 1 = 6 Marks)**
**Part B:-**
It shall consist of three sections (Section I, II & III) having 9 questions in total (Q. Nos. 7 to 15) from the entire syllabus. Each section will consist of three questions from each unit of the syllabus. The maximum length of each question may not exceed 5 pages. The candidate will attempt two questions from each section. Each question will be carrying four marks. (**6 x 4 = 24 Marks)**

## SECTION-I

**1. Quantum Mechanics-I (15 hrs.)**
Black-body radiation, Planck's radiation law, Photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (no derivation) and its defects, Compton effect.
de Broglie hypothesis, Heisenberg's uncertainty principle, Sinusoidal wave equation, Hamiltonian operator, Schrodinger wave equation and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in a one dimensional box, quantization of energy levels, extension to two and three dimensional boxes, degeneracy.

## SECTION-II

**2. Quantum Mechanics-II (15 hrs.)**
Simple harmonic oscillator model of vibrational motion, setting up Schrodinger equation and discussion of solution and wave functions. Rigid rotator model of rotation of diatomic molecules transformation to spherical polar coordinates spherical harmonics and their discussion.
Qualitative investigation H-atom, setting up Schrodinger equation, radial and angular part, radial distribution functions of 1s, 2s, 2p, 3s, 3p and 3d.

## SECTION-III

**3. Solid State (8 Hrs.)**
Definition of space lattice and unit cell, Law of crystallography- (i) Law of constancy of interfacial angles, (ii) Law of rationality of indices, (iii) Symmetry elements in crystals.
X-ray diffraction by crystals. Derivation of Bragg’s Law in Reciprocal space. Determination of crystal structure of NaCl, KCl by use of Powder method; Laue’s method.

**4. Photochemistry (7 Hrs.)**
Interaction of radiation with matter, difference between thermal and photochemical processes.

Laws of photochemistry: Grothus–Drapper law, Stark–Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of flourescence, phosphorescence, non–radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions–energy transfer processes (simple examples).

*B. Sc. (Medical & Non Medical)* CHEMISTRY
Semester-VI
**PRACTICAL**

**Duration: 3½ Hrs.** **Marks: 20**
**6 Period/Week**

**Organic Chemistry Laboratory Techniques**

**1. Column Chromatography**

Separation of o & p nitrophenol
Separation of Leaf pigments from Spinnach leaves
Separation of o & p nitro aniline
Separation of dyes.

**2. Synthesis of Organic Compounds**

Preparation of p-nitroacetanilide
Preparation of p-bromoacetanilide
Green Chemistry Experiment: Preparation of benzilic acid from Benzyl-using greenapproach.
Preparation of Methyl Orange, Methyl Red
Preparation of benzilic acid from benzyl-using green approach

**Practical Examination**

| | |
|---|---|
| 1) Column Chromatography | 05 |
| 2) Organic Synthesis | 09 |
| 3) Viva-Voce | 04 |
| 4) Note Book | 02 |

**Books Suggested (Theory Courses)**

1. Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson and P.L. Gaus, Wiley.
2. Concise Inorganic Chemistry, J.D. Lee, ELBS.
3. Concepts of Models of Inorganic Chemistry, B. Douglas, D. McDaniel and J. Alexander, John Wiley.
4. Inorganic Chemistry, D.E. Shriver, P.W. Alkins and C.H. Langford, Oxford.
5. Inorganic Chemistry, W.W. Porterfield Addison-Wesley.
6. Inorganic Chemistry, A.G. Sharpe, ELBS.
7. Inorganic Chemistry, G.L. Miessler and D.A. Tarr, Prentice Hall.
8. Organic Chemistry, Morrison and Boyd, Prentice-Hall.
9. Organic Chemistry, L.G. Wade Jr. Prentice-Hall.
10. Fundamentals of Organic Chemistry, Solomons, John Wiley.
11. Organic Chemistry Vol. I, II & III, S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International).
12. Organic Chemistry, F.A. Carey, McGraw-Hill, Inc.
13. Introduction to Organic Chemistry, Sireitwieser, Heathcock and Kosover, Macmilan.
14. Physical Chemistry, G.M. Barrow, International Student Edition, McGraw Hill.
15. Basic Programming with Application, V.K. Jain, Tata McGraw Hill.
16. Computers and Common Sense, R. Hunt and Shelly, Prentice Hall.
17. University General Chemistry, C.N.R. Rao, Macmillan.
18. Physical Chemistry R.A. Alberty, Wiley Eastern Ltd.
19. The Elements of Physical Chemistry, P.W. Atkins, Oxford.
20. Physical Chemistry Through Problems, S.K. Dogra and S. Dogra, Willey Eastern Ltd.

**V ccccccccccc Books Suggested (Laboratory Courses)**

1. Vogel's Qualitative Inorganic Analysis, revised, Svehla, Orient Longman.
2. Vogel's Textbook of Quantitative Inorganic Analysis (revised), J. Bassett, R.C. Denney, G.H. Jeffery and J. Mandham, ELBS.
3. Standard Methods of Chemical. Analysis, W.W. Scott: The Technical Press.
4. Experimental Inorganic Chemistry, W.G. Palmer, Cambridge.
5. Handbook of preparative Inorganic Chemistry, Vol. I & II, Brauer, Academic Press.
6. Inorganic Synthesis, McGraw Hill.
7. Experimental Organic Chemistry, Vol. I & II, P.R. Singh, D.S. Gupta and K.S. Bajpai, Tata McGraw Hill.
8. Laboratory Manual in Organic Chemistry, R.K. Bansal, Wiley Eastern.
9. Vogel's Textbook of Practical Organic Chemistry, B.S. Furniss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, ELBS.
10. Experiments in General Chemistry, C.N.R. Rao and U.C. Aggarwal, East-West Press.
11. Experiments in Physical Chemistry, R.C. Das and B. Behra, Tata McGraw Hill.
12. Advanced Practical Physical Chemistry, J.B. Yadav, Goel Publishing House.
13. Advanced Experimental Chemistry, Vol. I, Physical, J.N. Guru and R. Kapoor, S. Chand & Co.
14. Selected Experiments in Physical Chemistry, N.G. Mukherjee, J.N. Ghosh & Sons.
15. Experiments Physical Chemistry, J.C. Ghosh, Bharati Bhavan.