

**Syllabus
for B.Sc (Chemistry)
to be started from
June-2013**

First Semester
PAPER B. Sc. - CHEM-101
INORGANIC CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

- 1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one parts. Section E will be of 18 marks and consists of TEN objective type questions (in MCQ/true and false / fill in the blanks) of **one** mark each and FOUR short answer questions of **two** marks each covering the entire paper.*
- 2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION –A (11 Hrs)

Atomic Structure:

Dual nature of electron, Heisenberg's uncertainty principle, orbitals, Schrödinger wave equation, quantum numbers, orbital wave function, probability distribution curves, shapes of s, p, d and f orbital, Pauli's exclusion principle, Hund's rule of maximum multiplicity. Effective nuclear charge and screening effect, Slater's rule and its applications, energy level diagrams of multi electron system

SECTION –B (11 Hrs)

Periodic Table and Periodic Properties:

Long form of periodic table and classification based on electronic configuration.. Definitions and determination of Atomic and ionic radius, ionization energy, electron affinity and electron negativity and their trends in periodic table. Application of electronegativity.

SECTION-C (12 Hrs)

Chemical Bonding-I:

Covalent bond- valence bond theory and its limitations, various types of hybridization and shapes of simple molecules and ions (BeF_2 , BF_3 , CH_4 , PF_5 , SF_6 , IF_7 , SnCl_2 , XeF_4 , BF_4^- , PF_6^- , SnCl_6^{2-} . Molecular orbital approach of bonding (LCAO method) symmetry and overlap symmetry of molecular orbital, bonding in homonuclear molecules (H_2 , Be_2 , N_2 , N_2^+ , O_2 , O_2^- , O_2^{2-} , O_2^+ and Ne_2) and hetero nuclear molecules (NO , CO , CN and their ions, HF & HCl) .

SECTION-D (11 Hrs)**Chemical Bonding-II:**

Ionic solids- concept of close packing, radius ratio rule and coordination numbers, limitation of radius ratio rule, lattice defects, Structures of NaCl, CsCl, ZnS. Lattice energy, Born Haber cycle. Polarising power, polarisability and Fajan's rules, percent ionic character of polar covalent bond, dipole moment and structure of molecules.

Hydrogen Bonding and Vander Waals forces:

Hydrogen bonding – definition, types, effects of hydrogen bonding on properties of substance, applications. Brief discussion of various types of Vander Waals forces.

Books Recommended:

1. Concise inorganic Chemistry 4th Edn. By J.D.Lee.ELBS
- 2 . Huheey, J.E. *Inorganic Chemistry*, Prentice Hall 1993.
3. Cotton, F.A. and Wilkinson, G, *Advanced Inorganic Chemistry*, Wiley, VCH, 1999.
4. Greenwood, N.N. and Earnshaw, *Chemistry of the Elements*, Butterworth-Heinemann. 1997.
5. Day, M.C. and Selbin, J. *Theoretical Inorganic Chemistry*, ACS Publications 1962
6. Douglas, B.E. and Mc Daniel, D.H., *Concepts & Models of Inorganic Chemistry*, Oxford 1970
7. Shriver & Atkins, *Inorganic Chemistry*, Third Edition, Oxford Press 1994.
8. H.W. Porterfield, *Inorganic Chemistry*, Second Edition, Academic Press, 2005.

First Semester
PAPER B. Sc. - CHEM-102
ORGANIC CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

- The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one parts. Section E will be of 18 marks and consists of TEN objective type questions (in MCQ/true and false / fill in the blanks) of **one** mark each and FOUR short answer questions of **two** marks each covering the entire paper.*
- The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION- A (11 Hrs)

Structure and bonding:

Hybridization, bond length, bond energy, bond angle, localized and delocalized chemical bond, resonance, conditions of resonance, resonance effect and its applications, Electronic displacements: inductive effect, electrometric effect, mesomeric effect & hyperconjugation, cross conjugation, tautomerism.

Basic Concepts in Organic reactions:

Nature of fission of covalent bond, type of reagents: nucleophiles and electrophiles, reaction intermediates: carbocations, carbanions, free radicals, carbenes, nitrenes, and benzynes. Types of organic reactions: addition, elimination, substitution and rearrangement reactions. Methods of determination of reaction mechanism (product analysis, intermediates, isotope effects, kinetic and stereochemical studies).

SECTION- B (11 Hrs)

Stereochemistry of Organic Compounds:

Optical isomerism – Elements of symmetry, molecular chirality, enantiomers, stereogenic centre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diastereomers, meso compounds & racemic mixture and resolution of enantiomers. Relative and absolute configuration, sequence rules, D & L and R & S system of nomenclature.

Geometrical isomerism—Determination of configuration of geometrical isomers. E and Z system of nomenclature. Geometric isomerism in oximes and alicyclic compounds.

Conformational isomerism--Newman projections and sawhorse formulae, Fischer and flying wedge formulae, Conformational analysis of ethane, n- butane and cyclohexane, axial and equatorial bonds, difference between configuration and conformation.

SECTION- C (11 Hrs)

Alkanes:

IUPAC nomenclature of branched and unbranched alkanes, the alkyl groups, classification of carbon atoms in alkanes. Methods of formations with reference to Wurtz reaction, Kolbe reaction, Corey house reaction and decarboxylation of carboxylic acids, physical properties and chemical reaction of alkanes, mechanism of free radical halogenations of alkanes, orientation, reactivity and selectivity.

Cycloalkanes:

Nomenclature, methods of formation including photochemical [2+2] cycloaddition reaction, dehalogenation of α , β -dihalides, pyrolysis of calcium or barium salt of carboxylic acids, chemical reactions, Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings. Banana bond in case of cyclopropane.

SECTION-D (12 Hrs)

Alkenes and cycloalkenes:

Nomenclature of alkenes, methods of preparation of alkenes, mechanism of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. The Saytzeff rule, Hofmann elimination, physical properties and relative stability of alkenes.

Chemical reactions of alkenes:

Mechanism involved in hydrogenation, electrophilic and free radical additions Markownikoff's rule, hydroboration-oxidation, oxymercuration-reduction, ozonolysis and its applications, hydration, hydroxylation and oxidation with KMnO_4 , polymerization of alkenes, Substitution at the allylic and vinylic positions of alkenes, methods of formation, conformation and chemical reactions of cycloalkenes.

Dienes:

Nomenclature and classification of dienes, isolated, conjugated and cumulated dienes. Structure of allenes and butadiene, methods of formation. Chemical reactions-1, 2 and 1, 4 additions and their mechanism, Diels-Alder reaction, polymerization.

Books Recommended:

1. Stereo Chemistry by P.S. Kalsi
2. Organic Chemistry by Paula Yurkanis Bruice.
3. Reaction Mechanism by O. P. Aggarwal.
4. Organic Chemistry by F. A. Carey, Tata McGraw Hill.
5. Organic Chemistry by Robert T. Morrison & Robert N. Boyd, Prentice Hall of India Pvt. Ltd.
6. Stereo Chemistry of Organic Compounds by Ernest L Eliel, Tata McGraw-Hill
7. Advance Organic Chemistry Reaction Mechanism and Structure by Jerry March, Wiley International Pub.
8. Organic Chemistry by SM Mukherji, SP Singh and RP Kapoor, Vol. I, II & III, New Age International Publishers
9. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
10. Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Second Semester
PAPER B. Sc. - CHEM-203
PHYSICAL CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

1. *The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one parts. Section E will be of 18 marks and consists of TEN objective type questions (in MCQ/true and false / fill in the blanks) of one mark each and FOUR short answer questions of two marks each covering the entire paper.*
2. *The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION-A (13 Hrs)

Gaseous state:

Molecular velocities: Root mean square, average and most probable velocities. Derivation of Maxwell's distribution law of velocities, collision number, collision frequency, mean free path and collision diameter. Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waal's equation of state.

Critical Phenomenon: P-V isotherm of real gases, continuity of state, the isotherm of van der Waal's equation, relation between critical constants and van der Waal's constants, the law of corresponding states, reduced equation of state. Liquefaction of gases.

SECTION-B (10 Hrs)

States of Matter:

Liquid State: Intermolecular forces, structure of liquids (a qualitative description) structural difference between solids, liquids and gases. Surface tension and viscosity: Determination, properties, Parachor, Rheochor and refractive index

Liquid Crystals: An introduction to liquid crystals. Classification and properties of liquid crystals.

SECTION-C (10 Hrs)

Solid state:

Definition of unit cell and space lattice. Laws of crystallography: (i) Law of constancy of Interfacial angles. (ii) Law of rationality of indices. Kinds of symmetry elements and symmetry operations. X-ray diffraction by crystals. Bragg's equation (only qualitative analysis). Determination of crystal structures of NaCl, CsCl and CaF₂.

SECTION-D (12Hrs)

Colloidal State: Classification of colloids, solids in liquids (sols): Preparation and Properties of colloidal solutions, kinetic, optical and electrical properties. Stability of colloids, protective action, Hardy-Schulze rule and gold number.

Emulsions: Types of emulsions and their preparations, oils, soaps and detergents, cleansing action of soaps, CMC and its determination

Gels: Classification, preparation and properties, Imbibition and General applications of colloids.

Books recommended:

1. Physical Chemistry by S.C.Khetarpal, G.S, Sharma and R.K. Kalia.
2. A text Book of Physical Chemistry by K.K.Sharma and I.K. Sharma
3. Physical Chemistry by P.N.Kapil and S.K.Guglani.
4. A text book of Biophysical Chemistry by U.N.Das
5. Surface Chemistry by Adison, L.I. Osipow.
6. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 8th Ed., Oxford University Press (2006).
7. Ball, D. W. *Physical Chemistry* Thomson Press, India (2007).
8. Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa (2004).
9. Mortimer, R. G. *Physical Chemistry* 3rd Ed. Elsevier: NOIDA, UP (2009).

Second Semester
PAPER B. Sc. - CHEM-204
INORGANIC CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

- The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one parts. Section E will be of 18 marks and consists of TEN objective type questions (in MCQ/true and false / fill in the blanks) of one mark each and FOUR short answer questions of two marks each covering the entire paper.*
- The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION –A (14 Hrs)

Hydrogen:

Unique position of Hydrogen in the periodic table, isotopes, ortho and para hydrogen, Industrial production, Hydrides and their chemistry, Heavy water, Hydrogen bonding, Hydrates.

S-Block Elements:

Periodic discussion and Comparative study of elements, diagonal relationship of lithium and magnesium, Lithium hydride, Lithium aluminum hydride, sodamide, alkyl and aryls of alkali metals, solvation and complexation tendencies. Role of Na^+ , K^+ , Mg^{2+} and Ca^{2+} ions in biological system, behavior of solutions in liquid ammonia.

SECTION-B (12 Hrs)

P- Block Elements:

Comparative studies including diagonal relationship of group 13 and 14 elements. Borohydrides, Hydrides, oxide and oxy-acids and halides of boron, borax, Borazine, allotropic forms of carbon, fullerenes, carbides of calcium and silicon, silanes, structure of silicate minerals and silicones. Hydrides, oxides, oxoacids and halides of nitrogen. Allotropic forms of phosphorous. Hydrides, halides, oxides and oxyacids of phosphorous. Basic properties of halogens and inter halogen compounds, pseudohalogens and poly halides.

SECTION –C (11 Hrs)**Noble Gases:**

Occurrence of noble gases, History of discovery of noble gases and isolation of noble gases from air. Preparation properties and structure of important compounds of noble gases-fluorides, oxides, oxyfluorides of xenon (valence bond structure only). Krypton difluoride and clathrate compounds of noble gases.

Analytical Chemistry:

Theory of volumetric and gravimetric analysis, equivalent points, standard solutions, primary and secondary standards, end point detections, theory of titrimetry, redox and complexometric titration. Indicators, theories of indicators and their selection for volumetric analysis, important organic precipitants.

SECTION –D (8 Hrs)**Nuclear Chemistry:**

Nuclear binding energy and stability, nuclear shell model, nuclear reactions – fission and fusion. Q-value, natural and artificial radioactivity.

Metallic bond and semiconductors:

Metallic bond – Brief introduction of metallic bond, band theory of metallic bond.
Semiconductors – Introduction, types and applications.

Books Recommended:

1. Concise inorganic Chemistry 4th Edn. By J.D.Lee.
2. Inorganic Chemistry by J.E.Huheey.
3. Advanced Inorganic Chemistry by Cotton And Wilkinson.
4. Chemistry of Elements by Greenwood & Earnshaw.
5. Theoretical Inorganic Chemistry By Day & Selbin.
6. Vogel's Text Book of Qualitative Inorganic Analysis (revised) J.Bassett, R.C. Cdenney, G.H.Jettory and J.Mendham, ELBS.
7. Standard methods of Chemical Analysis, W.W.Scott.
8. Experimental Inorganic Chemistry, by W.G.Paimer.
9. Laboratory Manual in Organic Chemistry, R.K.Bansal
10. Principle of Inorganic Chemistry by Puri, Sharma and Kalia
11. Essential of nuclear chemistry by H J Arnikaar
12. Nuclear Chemistry by B G Harvey
13. Nuclear Chemistry by U C Dash
14. Canham, G.R. & Overton, T. Descriptive inorganic chemistry. Freeman & Co. 2006.

Third Semester
PAPER B. Sc. - CHEM-305
ORGANIC CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

- The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one parts. Section E will be of 18 marks and consists of TEN objective type questions (in MCQ/true and false / fill in the blanks) of one mark each and FOUR short answer questions of two marks each covering the entire paper.*
- The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION-A (12 Hrs.)

Alkynes:

Nomenclature, structure and bonding in alkynes, methods of formation, chemical reactions and acidity of alkynes, mechanism of nucleophilic and electrophilic addition reactions. Hydroboration-oxidation of alkynes, metal-ammonia reductions, oxidation and polymerization.

Aromaticity:

Aromaticity, Huckel rule, , aromatic, antiaromatic and non aromatic compounds, aromatic ions, homoaromaticity, antiaromaticity. Annulenes .

SECTION-B (11 Hrs.)

Arenes:

Structure of benzene: molecular formula and Kekule structure. Stability and carbon-carbon bond lengths of benzene, resonance structure, MO picture. Nomenclature of benzene derivatives, aromatic nucleus and side chain. Aromatic electrophilic substitution – general pattern of the mechanism of halogenations, nitration, sulphonation and Friedal-crafts reaction. Role of σ - and π - complexes. Energy profile diagrams. Activating-deactivating substituents and orientation of reactions and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction. Methods of formation and chemical reactions of biphenyl.

SECTION-C (11 Hrs.)

Alkyl and Aryl halides:

Nomenclature and classification of alkyl halides, methods of formation, chemical reactions, mechanism of nucleophilic substitution reaction, S_N1 and S_N2 reactions with energy profile diagram. Methods of formation of aryl halides, addition-elimination and elimination-addition mechanism of nucleophilic aromatic substitution reactions. Relative reactivities of alkyl, aryl, vinyl and allyl halides. Synthesis and uses of chloroform, carbon tetrachloride, DDT and BHC.

SECTION-D (11 Hrs.)**Alcohols: Monohydric alcohols:**

Classification and nomenclature, Preparation of monohydric alcohols- methods of formation by reduction of compounds containing carbonyl group, carboxylic acids and esters. Hydrogen bonding, reactions of alcohols – showing acidic nature, reactions involving C--OH and CO--H, cleavage, reactions involving both alkyl and hydroxyl groups. Distinction and inter conversion of primary, secondary and tertiary alcohols.

Dihydric alcohols:

Ethylene Glycol: preparation from alkenes, vicinal dihaloalkanes, carbonyl compounds and epoxides. Chemical reactions of vicinal glycol, oxidative cleavage by $\text{Pb}[\text{OAc}]_4$ and HIO_4 , Pinacol- Pinacolone rearrangement .

Trihydric Alcohols:

Glycerol- preparation by saponification of oils and fats and from propylene, Chemical reactions of glycerol.

Books Recommended:

1. Reaction and Mechanism by Singh & Mukherjee.
2. Organic Chemistry (Reaction and Mechanism) by P.S. Kalsi.
3. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Organic Chemistry by Paula Yurkanis Bruice.
6. Organic Chemistry by Baeyer and Walter.
7. Organic Chemistry by Singh and Mukherjee [Vol. I, II& III] .
8. Morrison R.T. & Boyd R.N. Organic Chemistry Dorling kindersley(India Pvt. Ltd) Pearson education

Third Semester
PAPER B. Sc. - CHEM-306
PHYSICAL CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

- 1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one parts. Section E will be of 18 marks and consists of TEN objective type questions (in MCQ/true and false / fill in the blanks) of one mark each and FOUR short answer questions of two marks each covering the entire paper.*
- 2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION-A (12 Hrs)

Chemical kinetics:

Chemical kinetics and its scope. Rates of reaction and factors influencing the rate of reaction (concentration, temperature, pressure, solvent, light and catalyst). Classification of reactions on the basis of molecularity and order. Mathematical derivation of rate equation for first order reaction, second order reaction, third order reaction and pseudo order reaction. Experimental methods for the study of chemical kinetics: conductometric, potentiometric, optical and polarimetric.

SECTION-B (11 Hrs)

Theories of Chemical Kinetics:

Effect of temperature on the rate of reaction (Arrhenius equation). Activation energy and activated complex. Collision theory and activated complex theory of reaction rate. Reaction rates and chemical equilibria: dissociation constant and principle of microscopic reversibility.

Catalysis:

Characteristics of catalysed reactions, classification of catalysts, catalytic poisoning, miscellaneous examples.

Heterogeneous and homogeneous catalysis, enzyme catalysis, Michaelis–Menten equation.

SECTION-C (11 Hrs)

Thermodynamics:

Definition of thermodynamic terms: System, surrounding, reversible and irreversible processes. Types of systems, intensive and extensive properties, state and path functions and their differentials, thermodynamic processes, concept of heat and work.

Thermochemistry:

Standard state, standard enthalpy of formation. Hess's law of heat summation and its applications. Bond dissociation energy and its calculation from thermo-chemical data. Temperature dependence of enthalpy (Kirchhoff's equation).

SECTION-D(11 Hrs)**First Law of thermodynamics:**

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

Books Recommended:

1. Physical Chemistry by S.C.Khetarpal, G.S, Sharma and R.K. Kalia.
2. A text Book of Physical Chemistry by K.K.Sharma and I.K. Sharma
3. Thermodynamics, by R.C. Shrivastva, S.K. Saha and A.K.Jain.
4. Fundamentals of Chemical Thermodynamics by M.L.Lakhanpal.
5. Physical Chemistry by P.N.Kapil and S.K.Guglani.
6. Chemical Kinetics by K.J.Laidler.
7. Elements of Physical Chemistry by Samuel Glasstone and David Lewis.
8. Thermodynamics for students of chemistry by Rajaram and J.C.Kuriacose.
9. Ball, D. W. *Physical Chemistry* Thomson Press, India (2007).
10. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 8th Ed., Oxford University Press (2006).
11. Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa (2004).
12. Engel, T. & Reid, P. *Thermodynamics, Statistical Thermodynamics, & Kinetics* Pearson Education, Inc: New Delhi (2007).
13. McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi (2004)

Fourth Semester
PAPER B. Sc. CHEM-407
INORGANIC CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

- 1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one parts. Section E will be of 18 marks and consists of TEN objective type questions (in MCQ/true and false / fill in the blanks) of one mark each and FOUR short answer questions of two marks each covering the entire paper.*
- 2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION-A (13 Hrs)

Chemistry of d-Block Elements:

Transition elements, definition, position in periodic table, electronic configuration of atoms and ions. General characteristics such as oxidation state, size, melting and boiling points, reactivity, ionization energies, magnetic behavior, colour, tendency to form complexes, comparison of properties of first transition series with second and third transition series. Brief chemistry and extraction of elements Ti and Co. Preparation, properties and structure of following compounds: TiCl_4 , TiO_2 , Ziegler Natta Catalyst, CrO_2Cl_2 , Prussian blue.

SECTION-B (12 Hrs)

Chemistry of Lanthanide Elements:

Electronic structure, oxidation state, ionic radii and lanthanide contraction, complex formation, occurrence of lanthanides, separation of lanthanides by ion exchange method.

Chemistry of actinides:

General features and chemistry of actinides, chemistry of extraction of Thorium and Uranium from their ores. Similarities between actinides and lanthanides.

SECTION-C (12 Hrs)

Chemistry of Coordination Compounds:

Werner's coordination theory and its experimental verification. Effective atomic number concept, chelates, nomenclature of coordination compounds, thermodynamic and kinetic stability of coordination compounds, isomerism (structural, stereo and geometrical isomerism in 4 and 6 coordination number compounds.) Optical isomerism in four and six coordination number compounds. Valence bond theory of transition metal complexes. Properties of coordination compounds i.e. magnetic and colors properties.

SECTION-D (08 Hrs)**Acids and Bases:**

Arrhenius, Bronsted and Lowry, Lewis, Lux flood and solvent system concepts of acids and bases. Classification of acids and bases as hard and soft. Pearson's HSAB concept, application of HSAB principle. Relative strength of acids and bases and effect of substituents and solvent on their strength.

Books Recommended:

1. Concise inorganic Chemistry 4th Edn. By J. D.Lee.
2. Inorganic Chemistry by T. Moeller.
3. Advanced Inorganic Chemistry by Cotton And Wilkinson.
4. Chemistry of Lanthanides by T. Moeller.
5. Theoretical Inorganic Chemistry by Day & Selbin.
6. Coordination Chemistry by S.F.A. Kettle
7. Purecell, K.F. & Kotz J.C. Inorganic Chemistry. W.B. Saunders & Co. 1977.
8. Basolo, F. & Pearson, R.C. Mechanisms of Inorganic chemistry. John Wiley & Sons, NY, 1967.
9. Chemistry of Elements by Greenwood, N.N. & Earnshaw. Butterworth – Heinemann 1997.

Fourth Semester
PAPER B. Sc. CHEM-408
ORGANIC CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

- The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one parts. Section E will be of 18 marks and consists of TEN objective type questions (in MCQ/true and false / fill in the blanks) of one mark each and FOUR short answer questions of two marks each covering the entire paper.*
- The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION-A (12 Hrs.)

Phenols:

Preparation by Dow's process, from diazonium salt, from cumene & from sulphonic acid. Acidic nature of Phenols and their comparative strength with alcohols and acids.

Electrophilic aromatic substitution reactions, acylation reaction and carboxylation reaction of phenols, Fries rearrangement, Claisen rearrangement, Reimer-Tiemann reaction, Kolbes reaction, Schotten-Baumann reaction, Lederer and Manasse reaction and Hauben - Hoesch reaction.

Ethers and Epoxides:

Nomenclature of ethers and methods of their formation, physical properties. Chemical reactions – cleavage and autoxidation, Ziesel's method. Synthesis of epoxides. Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.

SECTION-B (11 Hrs.)

Aldehydes and ketones:

Nomenclature, structure and nature of reactions of carbonyl group: synthesis of aldehydes and ketones from alcohols, carboxylic acids and nitriles. Etard reaction, Reimer -Tiemann reaction, Friedal crafts reaction. Physical properties, nucleophilic addition reactions with mechanism, aldol condensation, Perkin condensation, benzoin and Knoevengel condensation. Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction, oxidation of aldehydes, Baeyer Villiger oxidation of ketones, Cannizzaro reaction, MPV and Clemmensen reductions, Wolff Kishner reduction LiAlH_4 and NaBH_4 reduction. An introduction to α , β -unsaturated aldehydes and ketones.

SECTION-C (11 Hrs.)**Carboxylic Acids:**

Nomenclature, structure and bonding, synthesis from primary alcohols, from aldehydes, from alkyl benzene and alkenes, from nitriles, from carbonation of organometallics, Baeyer Villiger oxidation. Physical properties, acidic nature, effect of substituents on acidic strength. Chemical reactions – reactions showing acidic character, reactions involving –OH group and –COOH group, Hell Volhard Zelinsky reaction, synthesis of acid chlorides, esters amides and anhydrides . Inter conversion of acid derivatives by nucleophilic acyl substitution. Mechanism of esterification, acidic and basic hydrolysis of acid derivatives. Preparation and chemical reactions of halo acids, hydroxy acids: malic, tartaric, citric acid. IUPAC and common names of unsaturated monocarboxylic acids and dicarboxylic acids. Action of heat on dicarboxylic acids.

SECTION-D (11 Hrs.)**Compounds of Nitrogen****Amines:**

Structure and nomenclature of amines, physical properties, stereochemistry of amines, methods of separation of mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amines, amine salts as phase transfer catalysts. Preparation of alkyl and aryl amines, reduction of nitro compounds, nitriles. Reductive amination of carbonyl compounds. Gabriel phthalimide reaction, Hofmann bromamide reaction. Reactions of amines, electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acids.

Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanism of nucleophilic substitution in nitroarenes and their reduction in acidic, neutral and alkaline medium.

Halonitroarenes: reactivity.

Diazonium Salts:

Mechanism of diazotisation, structure of benzene diazonium chloride. Replacement of diazo group by H, OH, F, Cl, Br, I, NO₂ and CN groups, reduction of diazonium salts to hydrazines, coupling reaction and its synthetic application.

Books Recommended:

1. Reaction and Mechanism by Singh & Mukherjee.
2. Organic Chemistry (Reaction and Mechanism) by P.S. Kalsi.
3. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Organic Chemistry by Paula Yurkanis Bruice.
5. Organic Chemistry by Baeyer and Walter.
6. Organic Chemistry by Robert T. Morrison & Robert N. Boyd, Prentice Hall of India Pvt. Ltd.

Fourth Semester
PAPER B. Sc. CHEM-409
PHYSICAL CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

- The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one parts. Section E will be of 18 marks and consists of TEN objective type questions (in MCQ/true and false / fill in the blanks) of one mark each and FOUR short answer questions of two marks each covering the entire paper.*
- The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION -A (11Hrs)

Thermodynamics:

The second law of Thermodynamics: Second law of thermodynamics and its necessity. Carnot cycle and its efficiency; Carnot theorem, thermodynamic scale of temperature.

Concept of Entropy: The evaluation of entropy and changes in reversible and irreversible processes for ideal gases. Variation of entropy with T and V, T and P & P and V. Entropy change during phase changes. Clausius inequality. Entropy as a criterion for thermodynamic equilibrium. Thermodynamics of mixing of gases.

SECTION-B (11 Hours)

Free energy and work function:

Gibb's function (G) and Helmholtz function(A) as thermodynamic state functions. Variation in A and G with volume, temperature and pressure. A and G as criteria for thermodynamic equilibrium and spontaneity. Maxwell relations. Gibbs - Helmholtz equation and its applications.

Third law of thermodynamics:

The Nernst heat theorem. Evaluation of absolute entropy from heat capacity data and application of third law of thermodynamics.

SECTION –C (11Hrs)

Partial molar properties:

Systems of variable composition, relationship among molarity molality and mole fraction, partial molar quantities, chemical potential (μ) and Gibbs- Duhem equations. Variation of chemical potential with T and P.

Phase equilibria: Chemical potential and phase equilibria. The Clausius - Clapeyron equation

SECTION-D (12 Hours)

Phase Rule:

Meaning of terms: phase, component and degree of freedom. Thermodynamic derivation of phase rule and its applications. Phase equilibria for one component system: water and sulphur. Phase equilibria for two component system: solid liquid equilibria, simple Pb-Ag system, desilverisation of lead.

Solid Solutions:

Compound formation with congruent melting point (Mg-Zn) and incongruent melting (NaCl-H₂O, CuSO₄-H₂O) systems, freezing mixture, acetone-dry ice.

Books Recommended:

1. Thermodynamics for students of Chemistry, by Rajaram & J.C.Kuriacose.
2. An Introduction of Physical Chemistry, by Ishwar Dass, Archana Sharma and Namita Rani Aggarwal.
3. Thermodynamics, by S. Glasstone.
4. Thermodynamics, by S. Glasstone.
5. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 8th Ed., Oxford University Press (2006).
6. Elements of Physical Chemistry by Samuel Glasstone and David Lewis.
7. Physical Chemistry by J. Walter Moore.
8. Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa (2004).
9. Engel, T. & Reid, P. *Thermodynamics, Statistical Thermodynamics, & Kinetics* Pearson Education, Inc: New Delhi (2007).
10. McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi (2004).

Fifth Semester
PAPER B. Sc. CHEM-510
INORGANIC CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

- 1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one parts. Section E will be of 18 marks and consists of TEN objective type questions (in MCQ/true and false / fill in the blanks) of one mark each and FOUR short answer questions of two marks each covering the entire paper.*
- 2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION-A (12 Hrs)

Metal- Ligand bonding in transition metal complexes (CFT):

Limitations of valence bond theory, Splitting of d-orbitals in different fields (Octahedral, tetrahedral, tetragonal distorted octahedral, square planar, trigonal bipyramidal), Consequences and applications of orbital splitting, crystal field stabilization energy, magnetic properties, factor affecting extent of splitting, spectrochemical series, colour of transition metal complexes in terms of d-orbital splitting.

SECTION-B (11 Hrs)

Magneto-chemistry:

Origin and type of magnetic behavior shown by transition elements and compounds. Magnetic susceptibility, Gouy's methods for measuring magnetic susceptibility. Application of magnetic susceptibility measurement to first row metal complexes. Qualitative idea of orbital contribution and abnormal magnetic moments.

SECTION-C (11Hrs)

Thermodynamic and Kinetic Aspect of Metal Complexes:

Definition of stability, step wise formation constants and overall formation constants. Kinetic vs Thermodynamic stability, labile and inert octahedral complexes according to valence bond and crystal field theory. Factors affecting stability of complexes in aqueous solutions, nucleophilic substitution reactions and mechanism in square planar complexes. Trans effect and its theories.

SECTION-D (11Hrs)**Electron Spectra of transition metal complexes:**

Types of electronic transition, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series, Orgel-energy level diagrams for d^1 and d^9 states, discussion of electronic spectrum of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$.

Books Recommended:

1. Inorganic Chemistry Silver, Atkin and Longford.
2. Inorganic Chemistry by J.E.Huheey. Prentice Hall, 1993.
3. Advanced Inorganic Chemistry by Cotton And Wilkinson.
4. Mechanisms of Inorganic Chemistry by Basolo and Pearson
5. Theoretical Inorganic Chemistry by Day & Selbin.
6. Coordination Chemistry by S.F.A. Kettle

Fifth Semester
PAPER B. Sc. CHEM-511
ORGANIC CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

- The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one parts. Section E will be of 18 marks and consists of TEN objective type questions (in MCQ/true and false / fill in the blanks) of one mark each and FOUR short answer questions of two marks each covering the entire paper.*
- The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION-A (11 Hrs.)

Ultra violet absorption spectroscopy:

Absorption laws [Beer –Lambert law], molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation, concept of chromophore and auxochrome. Bathochromic, hypsochromic hyperchromic and hypochromic shifts. UV spectra of conjugated enes and enones, Woodward- Fieser rules, calculation of max. of simple conjugated dienes and α,β -unsaturated ketones. Applications of UV Spectroscopy in structure elucidation of simple organic compounds.

SECTION-B (10 Hrs.)

Infrared absorption spectroscopy:

Molecular vibrations Hook's law, selection rules intensity and position of IR bands measurement of IR spectrum, fingerprint region, characteristic absorption of various functional groups. Interpretation of IR spectra of simple organic compounds. Applications of IR spectroscopy in structure elucidation of simple organic compounds.

SECTION-C (12 Hrs.)

Nuclear Magnetic Resonance Spectroscopy:

Principle of nuclear magnetic resonance, number of signals, peak areas equivalent & non-equivalent protons, positions of signals, chemical shift. Shielding & deshielding of protons, proton counting, splitting of signals & coupling constants, magnetic equivalence of protons. Discussion of PMR spectra of molecules : ethyl bromide, n –propyl bromide, isopropyl bromide 1,1-dibromoethane 1,1,2- tribromo

ethane, ethanol, toluene, acetaldehyde, acetophenone. Simple problems on PMR spectroscopy for structure determination of organic compounds.

SECTION-D (12 Hrs.)

Mass Spectroscopy:

Introduction, Basic theory, Mass Spectrum, Base peak, Molecular ion and parent ion, Mass to charge ratio, Relative intensity, Fragmentation of ions, Meta stable ions, Even electron rule, Nitrogen rule, McLafferty rearrangement and ortho effect. General modes of fragmentation of simple molecules, homolytic cleavage, heterolytic cleavage, β -Cleavage, allylic cleavage, benzylic cleavage, Retro Diels - Alder Reaction and simple characteristic features of fragmentation in acetone, anisole, benzaldehyde, ethyl acetate, ethyl amine, ethyl bromide, toluene and isopropyl benzene

Books Recommended:

1. Spectroscopy by Dyer
2. Kemp, W. *Organic Spectroscopy*, Palgrave.
3. Elementary Organic Spectroscopy by Y.R.Sharma
4. Organic Spectroscopy by Jagmohan, Narosa Publication House
5. Spectroscopy by R. M. Silverstein, Sixth edition.
6. Carey F.A., Organic Chemistry, Pubs: McGraw-Hill, Inc, 2003.
7. Solomons G., Fundamentals of Organic Chemistry, Pubs: John Wiley, 2002

Fifth Semester
PAPER B. Sc. CHEM-512
PHYSICAL CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

1. *The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one parts. Section E will be of 18 marks and consists of TEN objective type questions (in MCQ/true and false / fill in the blanks) of **one** mark each and FOUR short answer questions of **two** marks each covering the entire paper.*
2. *The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION -A (12Hrs)

Ideal solutions and Raoult's Law:

Thermodynamics of mixing of dilute solutions Derivation from Raoult's law, Henry's law and solubility of gases. Nernst distribution Law and its applications.

Fugacity and activity:

Determination of activity and activity coefficients of non-electrolytes. Fugacity and method of determination of fugacity of real gases. Variation of fugacity with temperature and pressure.

SECTION -B (09Hrs)

Chemical equilibria:

Equilibrium constant and free energy, thermodynamic derivation of law of mass action and its application. Le Chatellier's principle, Van't Hoff reaction isotherms and reaction isochors.

SECTION-C (12 Hrs)

Colligative Properties:

Dilute Solutions, Colligative properties. Raoult's Law. Relative lowering of vapour pressure, molecular weight determination Osmosis and law of osmotic pressure and its measurement. Determination of molecular weight from osmotic pressure measurements. Elevation of boiling point and depression in 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.

SECTION -D (12Hrs)

Electrochemistry:

Types of reversible electrodes: Nernst equation. Derivation of cell EMF and single electrode potential, standard hydrogen electrode, reference electrode, standard electrode potential, sign conventions.

Electrolytic and Galvanic Cells: Reversible and irreversible cells, conventional representation of electrochemical cells, EMF of a cell and its measurements, calculation of thermodynamic quantities of cell reactions (ΔG , ΔH and ΔS). pH and pK_a values and their determination using hydrogen, and glass electrodes by potentiometric methods using quinhydrone. Buffer solutions and mechanism of buffer action. Henderson-Hassel equation. Hydrolysis of salts.

Books Recommended:

1. Thermodynamics for students of Chemistry, by Rajaram & J.C.Kuriacose.
2. An Introduction of Physical Chemistry, by Ishwar Dass, Archana Sharma and Namita Rani Aggarwal.
3. Electrochemistry, by B.K. Sharma.
4. Electrochemistry, by S. Glasstone.
5. Thermodynamics, by S. Glasstone.
6. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 8th Ed., Oxford University Press (2006).
7. Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa (2004).
8. Engel, T. & Reid, P. *Thermodynamics, Statistical Thermodynamics, & Kinetics* Pearson Education, Inc: New Delhi (2007).
9. McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi (2004).
10. Ball, D. W. *Physical Chemistry* Thomson Press, India (2007).
11. Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa (2004).
12. Mortimer, R. G. *Physical Chemistry* 3rd Ed. Elsevier: NOIDA, UP (2009)
13. Elements of Physical Chemistry by Samuel Glasstone and David Lewis

Sixth Semester
PAPER B. Sc. CHEM-613
INORGANIC CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

- The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of **8** marks each and may contain more than one parts. Section E will be of **18** marks and consists of **TEN** objective type questions (in MCQ/true and false / fill in the blanks) of **one** mark each and **FOUR** short answer questions of **two** marks each covering the entire paper.*
- The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION-A (12 Hrs)

Organometallic Compounds:

Definition, types of organometallic compounds, classification, EAN and nomenclature. Bonding: metal carbon bonding, metal carbon multiple bonding. Metal alkyl complexes of group 1, 2 and 13. Metal olefin complexes and nature of bonding in these complexes. Preparation and reactions of ferrocene, structure of ferrocene. Preparation and reaction of carbonyl compound of transition elements, bonding in linear carbonyls, structure of mono and poly nuclear carbonyls.

SECTION-B (11 Hrs)

Bioinorganic Chemistry:

Essential and trace elements in biological process, metalloporphyrin with special reference to haemoglobin and myoglobin. Biological role of alkali and alkaline earth metals ion with reference to K^+ & Ca^{2+} and nitrogen fixation.

Inorganic polymers:

Silicones, preparation and properties of silicones, nomenclature preparation of silicone products, elastomers and their types, ring opening reactions of cyclosiloxanes, polyphosphazenes.

SECTION-C (11 Hrs)

Environmental Chemistry:

Environment segments, composition of atmosphere, chemical composition of water bodies (lake, streams, rivers etc.), hydrological cycle, soil composition. Air, water, thermal and soil pollution(source, types and effect of pollutants)Analytical methods of measuring DO, BOD, COD. Analytical examination of sewage and sewage purification.Pollution due to pesticides, its bio-chemical effects and control.

SECTION-D (11 Hrs)**Non Aqueous solvents**

Introduction to non aqueous solvents. Effect of the physical properties of the solvent on the role of solvent in chemical reaction. Solvent system concept of acids and base. Elementary study of ammonia and sulphur dioxide as non aqueous solvent.

Perfumes: Introduction to perfumes. Fixatives, synthesis and application of following Perfumes- Musk xylene and Vaniline.

Books Recommended:

1. Inorganic Chemistry by Silver,Atkin & Longford
2. Inorganic Chemistry by J.E.Huheey. Prentice hall, 1993
3. Advanced Inorganic Chemistry by Cotton And Wilkinson.
4. Mechanisms of Inorganic Reactions by Basolo & Pearson
5. Theoretical Inorganic Chemistry By Day & Selbin.
6. Environmental Chemistry by A.K.De
7. Non-aqueous Solvents by H. Sisler.
8. Non-aqueous Solvents by T.C. Wadington.
9. Industrial Chemistry, (9th Edition) B. K. Sharma.
10. Lippard, S.J. 7 Berg, J.M. Principles of Bioinorganic Chemistry. Panima publishing Company 1994.
11. Miller, G.T.(2006) Environmental Science. 11th Ed. Books/Cole
12. Manahan, S.E.(2005) Environmental Chemistry, CRC Press

Sixth Semester
PAPER B. Sc. CHEM-614
ORGANIC CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

- The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of **8** marks each and may contain more than one parts. Section E will be of **18** marks and consists of **TEN** objective type questions (in MCQ/true and false / fill in the blanks) of **one** mark each and **FOUR** short answer questions of **two** marks each covering the entire paper.*
- The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION-A (12 Hrs.)

Carbohydrates:

Classification & nomenclature monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening & chain shortening of aldoses configuration of monosaccharides, erythro & threo diastereomers, conversion of glucose into mannose formation of glycosides, ethers & esters. Determination of ring size of glucose, open chain & cyclic structure of D (+) glucose & D (-) fructose. Mechanism of mutarotation.

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

SECTION-B (11 Hrs.)

Photochemistry:

General principles about light absorption, electronic transition, introduction scope & importance of photochemistry, comparison between photochemical & thermal reactions, Jablonski diagram (singlet & triplet states, internal conversion, ISC, fluorescence and phosphorescence), photochemical inhibitors, Norrish type I & type II reactions, Paterno- Buchi reaction, photochemical reduction of benzophenone, photochemical reactions of simple alkenes , carbonyl compounds and aromatic compounds, Barton reaction.

Organometallic compounds:

Organomagnesium compounds: the Grignard reagent – formation, structure, and chemical reactions

Organozinc compounds: formation and chemical reactions.

Organolithium compounds: formation and chemical reactions.

SECTION-C (10 Hrs.)**Polynuclear Hydrocarbons:**

Synthesis & reactions of Naphthalene, Anthracene & Phenanthrene. Relative reactivity of these compounds at different positions.

Synthetic dyes:

Colour and constitution [electronic concept], classification of dyes. Chemistry and synthesis of methyl orange, congo red, malachite green, crystal violet, phenolphthalein, fluorescein, alizarin and indigo.

SECTION-D (12 Hrs.)**Heterocyclic compounds:**

Introduction: Classification and nomenclature, Molecular orbital picture & aromatic characteristics of pyrrole, furan, thiophene & pyridine. Methods of synthesis, chemical reactions with emphasis on mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine. comparison of basicity of pyridine, piperidine and pyrrole.

Introduction to condensed five & six-membered heterocyclic compounds, preparation & reactions of indole quinoline & isoquinoline with special reference to Fisher indole synthesis Skraup synthesis & Bischler – Napieralski synthesis. Mechanism of electrophilic substitution reactions of indole, quinoline, & isoquinoline.

Books Recommended:

1. Finar I.L. (Vol.II).Stereochemistry & The chemistry of Natural Products.Dorling kindersley(India Pvt. Ltd) Pearson education
2. Natural Products Vol.I & II, by O. P. Aggarwal.
3. Photochemistry by Robert O Cahn
4. Morrison R.T. & Boyd R.N. Organic Chemistry Dorling kindersley(India Pvt. Ltd) Pearson education
5. Photochemistry by Cox & Kamp
6. Organic Photochemistry James Morriss Coxon, [HYPERLINK "http://www.google.co.in/search?tbo=p&tbm=bks&q=inauthor:%22Brian+Halton%22"](http://www.google.co.in/search?tbo=p&tbm=bks&q=inauthor:%22Brian+Halton%22) Brian Halton, Cambridge University Press
7. Heterocyclic Chemistry, John A. Joule, Keith Mills, 5th Edition
8. Heterocyclic Chemistry by Raj K Bansal, New Age International(P) Ltd Publishers.
9. Kalsi P.S. Text book of Organic chemistry Ist Ed. New Age International(P) Ltd. Publishers.

Sixth Semester
PAPER B. Sc. CHEM-615
PHYSICAL CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

- 1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one parts. Section E will be of 18 marks and consists of TEN objective type questions (in MCQ/true and false / fill in the blanks) of one mark each and FOUR short answer questions of two marks each covering the entire paper.*
- 2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION -A (11Hrs)

Elementary Quantum Mechanics:

Black body radiation (Plank radiation law). Photoelectric effect. Heat capacity of solids. Bohr's model of Hydrogen atom (without derivation) and its effects. Compton Effect. Complete derivation of Schrodinger wave equation for H-atom and determination of quantum numbers.

SECTION -B (11Hrs)

Spectroscopy:

Rotational Spectrum: Rotational spectra of rigid diatomic molecules. Energy level of rigid rotor; selection rules spectral intensity, distribution using population distribution law (Maxwell-Boltzmann distribution). Determination of bond length, qualitative description of non-rigid rotor, isotope effect.

SECTION –C (11 Hours)

Vibrational spectrum:

Infra-red 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 isotope on the vibrational spectrum of a diatomic molecule.

Electronic Spectrum:

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

SECTION -D (12Hrs)

Photochemistry:

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 fluorescence, phosphorescence, non-radiative processes (Internal conversion, inter system crossing), quantum yield, photosensitized reactions-energy transfer processes(simple processes)

Physical Properties and Molecular Structure:

Optical activity, polarization- (Clausius Mossoutti equation). Orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment- temperature method and refractivity method, dipole moment and structure of molecules.

Books Recommended:

1. Banwell, C. N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. Tata McGraw-Hill: New Delhi (2006).
2. Chandra, A. K. *Introductory Quantum Chemistry* Tata McGraw-Hill (2001).
3. House, J. E. *Fundamentals of Quantum Chemistry* 2nd Ed. Elsevier: USA (2004).
4. Lowe, J. P. & Peterson, K. *Quantum Chemistry* Academic Press (2005).
5. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 8th Ed., Oxford University Press (2006).
6. Ball, D. W. *Physical Chemistry* Thomson Press, India (2007).
7. Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa (2004).
8. An Introduction of Physical Chemistry, by Ishwar Dass, Archana Sharma and Namita Rani Aggarwal.
9. Physical Chemistry by Puri, Sharma and Pathania.
10. Quantum Mechanics by G. Aruldas
11. Advance Physical Chemistry by Gurdeep and Harish.
12. A text book of Physical Chemistry by P L Soni, O P Dharmarha and U N Das.
13. Physical Chemistry by S C Khetarpal.
14. Physical Chemistry by S Glastone.
15. Elements of Physical Chemistry by Samuel Glastone and David Lewis.

Additional Elective Course
Fifth/ Sixth Semester
PAPER B. Sc. CHEM-616
INORGANIC CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

- 1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one parts. Section E will be of 18 marks and consists of TEN objective type questions (in MCQ/true and false / fill in the blanks) of **one** mark each and FOUR short answer questions of **two** marks each covering the entire paper.*
- 2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION -A (11Hrs)

Fertilizers:

Classification of fertilizers. Study of raw materials for nitrogenous, Phosphate and potash fertilizers. Manufacture of calcium ammonium nitrate, urea and ammonium phosphate.

Solid Fuel:

Coal, Different kinds, its formation, origin of coal, analysis of coal (ultimate and proximate analysis).

Explosives:

Introduction, classification, synthesis application of Pentaerythritol tetranitrate and RDX.

SECTION -B (12Hrs)

Cement Industry:

Classification of cement, study of raw material and their availability. Manufacture of Portland cement with construction and working of rotary kiln. Role of gypsum in cement. Setting, hardening and strength characteristics of cement compounds. ISI specification of Portland cement. Study of special cement like high alumina cement. Early high strength cement and white Portland cement. Decay of cement concrete and its protection.

Glass:

Introduction, physical and chemical properties of glass, characteristics of glass, raw materials, chemical reactions, methods of manufacture, Shaping of plate glass, annealing, finishing.

SECTION -C (11Hrs)**Water and Hydrogen peroxide:**

Water and its properties, hard and soft water, analysis of hard water (EDTA method), removal of hardness of water (ion exchange method), portable water, heavy water.

Hydrogen peroxide, strength of hydrogen peroxide solution, properties of hydrogen peroxide, structure, uses, tests and estimation of hydrogen peroxide.

SECTION -D (11Hrs)**Chromatography:**

Introduction, classification of chromatographic techniques

Paper Chromatography- introduction, principle, migration parameters, types of paper chromatography, experimental details.

Thin Layer Chromatography-Introduction, superiority of TLC over other chromatographic techniques, general applications.

Column Chromatography- principle and applications.

Books Recommended:

1. Text book of Inorganic Chemistry by P. L. Soni and Mohan Katyal
2. Industrial Chemistry, (9th Edition) B. K. Sharma
3. A Text Book of Engineering Chemistry by M. M. Uppal.
4. Analytical chemistry by Alka Gupta, Pragati Prakashan.
6. Vogel's Text Book of Qualitative Inorganic Analysis (revised) J.Bassett,R.C, Cdenney, G.H.Jettery and J.Mendham,ELBS.
8. Experimental Inorganic Chemistry, by W.G.Paimer.
9. Laboratory Manual in Organic Chemistry, R.K.Bansal

Additional Elective Course**Fifth/ Sixth Semester****PAPER B. Sc. CHEM-616(Project)****PROJECT- INORGANIC CHEMISTRY & VIVA****Max.Marks: 25****Credit - 1**

The candidate will have to submit a project related to the course content of **PAPER B. Sc. CHEM-616 INORGANIC CHEMISTRY(Theory)** during the semester. The project will be evaluated by the examiner including viva-voce examination in the area of the project.

Additional Elective Course
Fifth/ Sixth Semester
PAPER B. Sc. CHEM-617
ORGANIC CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

- The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one parts. Section E will be of 18 marks and consists of TEN objective type questions (in MCQ/true and false / fill in the blanks) of one mark each and FOUR short answer questions of two marks each covering the entire paper.*
- The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION - A (11 Hrs.)

Fats Oils and Detergents:

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

Organic Synthesis via enolates:

Acidity of α - hydrogens . Alkylation of diethyl malonate & ethyl acetoacetate. Synthesis of ethyl acetoacetate : the Claisen condensation, keto - enol tautomerism of ethyl acetoacetate, alkylation of 1, 3-dithianes & acylation of enamines

SECTION- B (11 Hrs.)

Polymers:

Polymerisation, definition, Classification of polymers on the basis of composition, mechanism of ionic & free radical polymerization. Addition & chain growth polymerisation, free radical polymerisation vinyl polymerisation, ionic vinyl polymerization, Ziegler –Natta polymerisation, vinyl polymers. Condensation & step growth polymerisation. Polyesters ,polyamides, phenol formaldehyde resins urea formaldehyde resins, epoxy resins, urea formaldehyde resins, epoxy resins, poly urethanes natural and synthetic rubber .

SECTION- C (11 Hrs.)

Amino acids, Peptides & Proteins:

Classification, acid base behavior, isoelectric point & electrophoresis. Preparation and reactions of amino acids.

Structure and nomenclature of peptides and proteins. Classification of proteins, peptide structure determination, end group analysis, selective hydrolysis of peptides, solid – phase peptide synthesis. Structure of proteins: primary, secondary & tertiary structure(elementary structure only), denaturation.

SECTION-D (12 Hrs.)

Pharmaceutical Chemistry:

Pharmacokinetics & pharmacodynamics of the drugs, synthesis & therapeutic importance of Sulphanilamide, Aspirin, phenacetin, chloroquin, chloramphenicol. Chemotherapy of sexually transmitted diseases.

Green Chemistry:

Basic concept of waste generation, pollution, atom economy, use of renewable resources, twelve principles of green chemistry. Designing a green synthesis: choice of starting materials, reagents, catalysts and solvents, choice of water as a solvent, microwave & ultrasonic assisted synthesis, biocatalysis. Natural renewable resources such as forest wastes, agro based & polysaccharides as chemical and biodegradable polymers. Examples of green synthesis, recyclization & poly(ethylene terephthalate), synthesis of methyl methacrylate, synthesis of adipic acid & catechol from biomass.

Books Recommended:

1. Organic Chemistry by I.L.Finar (Vol.II).
2. Natural Products Vol. I & II ,by O.P.Aggarwal.
3. Polymer Chemistry by Willmaeyer.
4. A new trends in Green Chemistry by V K Ahluwalia.

Additional Elective Course

Fifth/ Sixth Semester

PAPER B. Sc. CHEM-617(Project)

PROJECT- ORGANIC CHEMISTRY & VIVA

Max.Marks: 25

Credit - 1

The candidate will have to submit a project related to the course content of **PAPER B. Sc. CHEM-617 ORGANIC CHEMISTRY(Theory)** during the semester. The project will be evaluated by the examiner including viva-voce examination in the area of the project.

Additional Elective Course
Fifth/ Sixth Semester
PAPER B. Sc. CHEM-618
PHYSICAL CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

- 1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one parts. Section E will be of 18 marks and consists of TEN objective type questions (in MCQ/true and false / fill in the blanks) of **one** mark each and FOUR short answer questions of **two** marks each covering the entire paper.*
- 2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION-A(13 Hrs.)

Electrochemistry:

Electric conduction in electrolytic solution. Specific and equivalent conductances. Measurement of equivalent conductance and variation of equivalent and specific conductance with dilution. Kohlrausch law. Arrhenius theory of electrolytic dissociation and its limitations. Weak and strong electrolytes. Ostwald dilution law and its application and limitations. Debye-Huckel-Onsager equation for strong electrolytes (elementary treatment only). Transport number and its determination by Hittorf method and moving boundary method. Degree of dissociation of weak acids and bases and determination of dissociation constant. Solubility product of sparingly soluble salts and its determination by conductometric titrations.

SECTION – B(11 Hrs.)

Interphase Chemistry:

Adsorption and types of adsorption. Adsorption Isotherm, Freundlich and Langmuir adsorption isotherm and their applications. Catalysis; homogenous, heterogeneous and enzyme catalysis, Michilis and Menton Equation. Adsorption from the solutions: Gibb's adsorption isotherm. Study of surface films and surface area. Applications of adsorption; adsorption indicators. Surfactants; surfactants and detergents. Micelles, critical micelle concentration and its applications.

SECTION- C(11 Hrs.)

Basic concepts of polymer chemistry:

Classification of polymers on the basis of composition, degree of polymerization and molecular weight. Homopolymers, co-polymers, graft copolymers, crystalline polymers, amorphous polymers. Classification of polymers on the basis of structure of polymer, i.e., linear, branched, and cross linked

polymers. Biopolymers, condensation polymers, addition polymers, photopolymerization, mechanism of polymerization, mechanism, of polymerization, polymer degradation, (chemical and photochemical). Dilute polymer solutions, molecular weight of polymers; number average and weight average molecular weights.

SECTION- D (10 Hrs.)

Biophysical Chemistry:

Chemical constituents of living cells. Cell as the smallest biological entity, cell membrane, its structure and function, the plasma membrane, cytoplasm, and organelles. The endoplasmic reticulum, the mitochondria, the Golgi, apparatus, ribosome, lysosomes, centriol and microtubules, the interphase nucleus.

Books Recommended:

1. Physical Chemistry Puri ,Sharma and Pathania
2. Quantum Mechanics by G.Aruldas
3. Adv Physical Chemistry by Gurdeep and Harish
4. A Text Book of Physical Chemistry by P.L.Soni, O.P.Dharmarha & U.N.Das
5. Physical Chemistry by S.C.Khetarpal

Additional Elective Course

Fifth/ Sixth Semester

PAPER B. Sc. CHEM-618(Project)

PROJECT- PHYSICAL CHEMISTRY & VIVA

Max.Marks: 25

Credit - 1

The candidate will have to submit a project related to the course content of **PAPER B. Sc. CHEM-618 PHYSICAL CHEMISTRY(Theory)** during the semester. The project will be evaluated by the examiner including viva-voce examination in the area of the project.

Additional Elective Course
Fifth/Sixth Semester
PAPER B. Sc. CHEM-619
INORGANIC CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

- The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one parts. Section E will be of 18 marks and consists of TEN objective type questions (in MCQ/true and false / fill in the blanks) of one mark each and FOUR short answer questions of two marks each covering the entire paper.*
- The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION -A (11Hrs)

Analytical chemistry:

Data analysis- idea of significant figures- its importance- accuracy- methods of expressing accuracy- error analysis- types of errors- minimizing errors- precision- methods of expressing precision-mean, median, mean deviation, standard deviation and confidence limits. 1.2 Chemical and single pan balance- precautions in using balance- sources of error in weighing-correction for buoyancy, temperature effects - calibration of weights.

SECTION -B (12Hrs)

Gravimetric Analysis:

Principle- theories of precipitation- solubility product and precipitation - factors affecting solubility. Conditions of precipitation- co-precipitation & post precipitation, reduction of errors. Precipitation from homogeneous solution- washing and drying of precipitate.

Choice of the precipitant- Specific and Selective precipitants-, Anthranilic acid, Cupferon, Dimethylglyoxime, Ethylenediamine, 8-Hydroxyquinoline, Salicylaldehyde, - Use of masking agent. Crucibles- types, care and uses. Calculations in gravimetric analysis- use of gravimetric factor.

SECTION -C (11Hrs)

Electro Analytical Method :

Polarography- principle, concentration polarization, dropping mercury electrode (DME)- advantages and disadvantages- migration, residual, limiting and diffusion currents- Use of supporting electrolytes-Ilkovic equation (derivation not required) and significance- experimental assembly- current voltage curve-oxygen wave-influence of temperature and agitation on diffusion layer. Half wave potential ($E_{1/2}$)-

Polarography as an analytical tool in quantitative and qualitative analysis. 5.2 Amperometric titrations
Basic principle – titrations- advantages, disadvantages – applications.

SECTION -D (11Hrs)

Symmetry Elements and Symmetry operations:

Groups-point groups of simple molecules like H_2 , HCl , CO_2 , H_2O & NH_3 . some general rules for multiplication of Symmetry operations. Multiplication tables for H_2O & NH_3 . Matrix representation (for C_{2V} and C_{3V} point groups). A brief idea of applications of group theory in chemical bonding (hybridisation), Raman and IR spectroscopy (Selection rules).

Books Recommended

1. Douglas A, Skoog and Donal M. West Hort, Fundamentals of analytical Chemistry Rinechan and Winston Inc., New York.
2. Bassett.J, Denney.R.C, Jaffery.G.H and Mendhan.J, Vogel's Hand Book of Quantitative Inorganic Analysis ELBS – Longman.
3. Ramachandra Sastry.A, Analytical Chemistry – K.C.S. Desikan & Co.
4. Principles of Inorganic Chemistry by Puri, Sharma & Kalia.
5. F. A. Cotton. Chemical applications of Group Theory, Wiley India Pvt. Ltd.
6. Group theory and its chemical application By P. K. Bhattacharya, Himalaya Pub. House.

Additional Elective Course

Fifth/ Sixth Semester

PAPER B. Sc. CHEM-619(Project)

PROJECT- INORGANIC CHEMISTRY & VIVA

Max.Marks: 25

Credit - 1

The candidate will have to submit a project related to the course content of **PAPER B. Sc. CHEM-619 INORGANIC CHEMISTRY(Theory)** during the semester. The project will be evaluated by the examiner including viva-voce examination in the area of the project.

Additional Elective Course
Fifth/Sixth Semester
PAPER B. Sc. CHEM-620
ORGANIC CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

- 1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one parts. Section E will be of 18 marks and consists of TEN objective type questions (in MCQ/true and false / fill in the blanks) of one mark each and FOUR short answer questions of two marks each covering the entire paper.*
- 2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION –A (12 Hrs)

Pericyclic reactions:

Definition & classification; Concerted reactions, electrocyclic reactions(including Woodward-Hofmann selection rules), cycloaddition reactions [4+2] thermal with special reference to Diels-alder reaction - general features, dienophiles, dienes' (2+2) cycloadditions. Correlation diagrams and FMO theory: Sigmatropic reactions: [1,j] and [i,j] shifts. Simple examples for [1, 5] H shift. [3, 3] sigmatropic shifts with reference to Cope and Claisen rearrangement.

SECTION –B (11 Hrs)

Natural products:

Alkaloids

Natural occurrence, General structural features, Isolation and their physiological action
 Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Quinine or Morphine.

Terpenes

Occurrence, classification, isoprene rule; Elucidation of structure and synthesis of α -terpineol.

SECTION –C (10 Hrs)

Petroleum Industry:

Composition and classification of crude petroleum. Refining of petroleum and brief introduction regarding each refining product. Thermal and catalytic cracking of petroleum products. Significance of octane number and cetane number.

Paints and Varnishes :

Classification, constituents and manufacture of paints a varnishes. enamels & lacquers.

SECTION –D (12 hrs)

Molecular Rearrangements:

Classification - anionotropic, cationotropic, intermolecular and intramolecular. Mechanism and applications of following rearrangements:

Rearrangement to electron-deficient carbon

(Wagner-Meerwein rearrangement, benzil-benzilic acid rearrangement).

Electron-deficient nitrogen

(Beckmann rearrangement, Schmidt rearrangement, Hofmann rearrangement, Lossen rearrangement, Curtius rearrangement).

Electron-deficient oxygen

(Dakin reaction).

Aromatic rearrangements –

migration from oxygen to ring carbon (Claisen rearrangement); migration from nitrogen to ring carbon (Hofmann-Martius rearrangement, Bamberger rearrangement, Orton rearrangement, benzidine rearrangement).

Books Recommended:

1. Advance Organic Chemistry, part A and part B by Carey F.A. and Sundoerg R.J., 2nd Ed. Pubs: Plenum Press, New York, 1984.
2. Organic Chemistry, 5th Ed. by Morrison R.T. and Boyd P.S., Pubs: Allyn and Bacon Inc., Boston (1992).
3. Advanced Organic Chemistry, 3rd Ed. by March J.,,Pubs: Wiely Interscience ,1985.
4. Introduction to Organic Chemistry 3rd Ed. By Streitwischer A., Jr. and Heathcock C.H., MacMillan Pub. Co., N.Y,1992.
5. Physical Organic Chemistry by Isaccs N.S., , Pubs:Longman
6. A text book of Chemical Technology, Vol. I & II. by Pandey G. M., Pubs: Vikas Publishing House Pvt. Ltd., New Delhi, 1993.
7. Chemical Process Industries by Shreve R.N. and Brink J.A., , Pubs: McGraw Hill Book Company, 1977.
8. Reigel's Hand Book of Industrial Chemistry by Kent Jemes A,(Ed.), , Pubs: Van Nostrand Rein Hold Company, London,1992.
9. Outlines of Chemical Technology by Dryden Charles E., , Pubs: Affiliated East West Press Pvt. Ltd., New Delhi,1973.

- 10 . Organic Chemistry (Volume 1) by Finar, I. L. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
11. Stereochemistry and the Chemistry of Natural Products by Finar, I. L. Organic Chemistry (Volume 2) Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Additional Elective Course
Fifth/ Sixth Semester
PAPER B. Sc. CHEM-620(Project)
PROJECT- ORGANIC CHEMISTRY & VIVA

Max.Marks: 25

Credit - 1

The candidate will have to submit a project related to the course content of **PAPER B. Sc. CHEM-620 ORGANIC CHEMISTRY(Theory)** during the semester. The project will be evaluated by the examiner including viva-voce examination in the area of the project.

Additional Elective Course
Fifth/Sixth Semester
PAPER B. Sc. CHEM-621
PHYSICAL CHEMISTRY

Max.Marks: 50

Credit - 3

Note for Examiners and Students:

- 1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one parts. Section E will be of 18 marks and consists of TEN objective type questions (in MCQ/true and false / fill in the blanks) of **one** mark each and FOUR short answer questions of **two** marks each covering the entire paper.*
- 2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION-A (12 Hrs)

Electrochemistry:

Qualitative idea of Debye-Huckel theory of strong electrolytes: ion-ion interactions, Debye-Huckel limiting law for activity coefficient of ions in solution and its modification for concentrated solutions. Debye-Huckel-Onsager (D-H-O) theory of electrolytic solutions: qualitative idea of electrophoretic and relaxation effects. Effect of high frequency and high field on conductance.

SECTION-B (12 Hrs)

Thermodynamics and Statistical Mechanics:

Fundamentals of statistical mechanics: the distribution of molecular states, configuration and weights, ensembles and microcanonical ensembles. The Boltzmann distribution. The molecular and canonical partition functions. The thermodynamic information in the partition and canonical partition functions.

SECTION-C (12 Hrs)

Quantum Mechanics:

Eigen functions and Eigen values, quantum mechanical operators and expectation value of a physical quantity. Orthogonality of wave functions. Quantum Mechanics of Simple Systems: free particle, particle in a one and three dimensional box problems and Harmonic Oscillator.

SECTION-D (12 Hrs)***Reaction Kinetics:***

Collision theory of bimolecular reactions; unimolecular reactions: Lindemann-Hinshelwood mechanism. Transition state theory and its thermodynamic formulation. Primary kinetic salt effect. Catalytic activities at the surfaces: adsorption and catalysis the Langmuir – Hinshelwood mechanism and the Eley-Redeal mechanism (qualitative interpretation only). Examples of catalysis: catalytic activity, hydrogenation, oxidation and cracking and reforming.

Books Recommended:

1. Physical Chemistry: P.W. Atkins
2. Quantum Chemistry: A.K. Prasad
3. Thermodynamics and Statistical Mechanics: P.V. Panat
4. An Introduction to Statistical Mechanics: P.B. Bal
5. Statistical Thermodynamics: S. Glasstone
6. Quantum Chemistry: A.K. Chandra

Additional Elective Course**Fifth/ Sixth Semester****PAPER B. Sc. CHEM-621(Project)****PROJECT- PHYSICAL CHEMISTRY & VIVA****Max.Marks: 25****Credit - 1**

The candidate will have to submit a project related to the course content of **PAPER B. Sc. CHEM-621 PHYSICAL CHEMISTRY (Theory)** during the semester. The project will be evaluated by the examiner including viva-voce examination in the area of the project.

**Open Elective Course
General Chemistry
CHEM – 622**

Max.Marks: 50

Credit – 3

Note for Examiners and Students:

- 1. The question paper will consist of five sections A, B, C, D and E. Section E will be compulsory. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one parts. Section E will be of 18 marks and consists of TEN objective type questions (in MCQ/true and false / fill in the blanks) of one mark each and FOUR short answer questions of two marks each covering the entire paper.*
- 2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

SECTION-A (12 Hrs.)

Atoms and Molecules:

Mole concept, electronegativity of atoms and polarity of bonds, its variation with position in the periodic table, ionization potential, electron affinity, bond lengths, bond angles, hybridization and shapes of some simple molecules like CO_2 , H_2O , NH_3 , CH_4 .

Atomic Structure:

Bohr's theory: energy and radius calculations for H-like atoms, quantum numbers, Pauli exclusion Principle, qualitative introduction of orbitals, shapes of orbitals, electron distribution of elements - Aufbau principle and Hund's rule.

SECTION-B(12Hrs.)

Reaction Intermediates and Reagent :

Homolytic and heterolytic cleavage, carbocation, carbanion, free radical, nucleophile, electrophile, types of reactions and types of reagents. Simple concept of inductive effect, electromeric effect and resonance. Alkanes – free radical substitution reaction, alkenes – electrophilic addition reaction.

Elementary Stereochemistry :

Optical isomerism, concept of chirality, enantiomers and diastereomers, geometrical isomerism, examples from organic molecules and inorganic complexes.

SECTION-C (12 Hrs)

Laws in Chemistry:

Law of constant proportion, law of multiple proportion and law of reciprocal proportion, Gas laws- Boyle's law, Charles's law, Avagadro's law, Graham's law of diffusion, Dalton's law of Partial Pressure, First, second and third law of thermodynamics, and terms in thermodynamics- state functions, state variables, extensive and intensive properties. Types of processes- isothermal, isobaric, isochoric, adiabatic, reversible and irreversible . Law of mass action.

Kinetic theory of gases, states of matter, types of solids- amorphous and crystalline solids, simple structure of NaCl, oxidation and reduction- electronic concept, oxidation number, types of chemical bonds.

SECTION-D(12 Hrs)

Minerals:

Mineral elements in food-Principal mineral elements-source. Function-Deficiency and daily requirements-Na, K, Mg, Fe, S and P

Vitamins :

Sources, requirement, deficiency diseases of A, C, D, E and K and B₁, B₂, B₆ B₁₂.

Soil Chemistry :

The composition of soil, sandy clay, shalky, loamy soils, common plant food like nitrate, phosphate and potash and their analysis, pest and its control by neutral and synthetic using pesticides.

Additional Elective Course

Fifth/ Sixth Semester

PAPER B. Sc. CHEM-622(Project)

PROJECT- GENERAL CHEMISTRY & VIVA

Max.Marks: 25

Credit - 1

The candidate will have to submit a project related to the course content of **PAPER B. Sc. CHEM-622 GENERAL CHEMISTRY(Theory)** during the semester. The project will be evaluated by the examiner including viva-voce examination in the area of the project.

General Interest Course (Offered by Chemistry Department)
First/Second/Third Semester
PAPER B. Sc. - CHEM-23

Total Max.Marks: 50

Credit – 1

(L=1, T=0, P=0)

English shall be the medium of instructions and Examinations.

Examinations shall be conducted at the end of each semester as per the academic calendar notified by H.P. University Shimla-5.

This course will carry 50 marks (Theory Paper Only) and will have following components.

Theory Paper	50 marks
Continuous Comprehensive Assessment (Internal Assessment)	25 marks
Assignment/Class Test/Quiz/Seminar	
Minor Tests (2)	20 marks
Attendance	05 marks
End- Semester Examination	25 marks

Note for Examiners and Students:

1. *The question paper will consist of four sections A, B, C and D. Examiner will set eight questions in all, selecting two questions from section A, B, C, and D of 5 marks each.*
2. *The candidate will be required to attempt five questions in all selecting at least one question from each section. The duration of the examination will be 3 Hours.*

SECTION –A (3 Hrs)

Evolution of Chemistry :

Evolution of Chemistry - ancient speculations on the nature of matter, early form of chemistry-alchemy, origin of modern chemistry. Structure of chemical science: scope of chemical science, theory and experiment, branches of chemistry.

SECTION –B (4 Hrs)**Chemistry as a central science:**

Role of Chemistry as a central science connecting Physics, Biology and other branches of science.
Interdisciplinary areas involving Chemistry - Nanotechnology, Biotechnology. Artificial rain and Global warming.

SECTION-C (4 Hrs)**Chemical Science in the Service of Man:**

Chemical science in the service of man: Drugs, food, flavouring agents, sweeteners, cosmetics, soaps and detergents, paints, varnishes, textiles, dyes, fertilizers, insecticides, fuels and propellants.

SECTION-D (4 Hrs)**Some important chemical compounds used in our daily life:**

Laboratory and daily life uses of KMnO_4 , Na_2CO_3 , NaHCO_3 , acetic acid (CH_3COOH), sucrose, sodium hypochlorite, hydrogen peroxide, acetone.

Adulterants and Food Additives:

Adulterants in milk, ghee, oil, coffee powder, tea, chilli powder, pulses and turmeric powder – identification.

Book:

J. A Lee, Scientific Endeavor, Addison Wesley Logman, C. N. R. Rao, University General Chemistry Mc Millan (Indian Ltd.), Physical Chemistry by Paul Monk

PRACTICAL COURSES

First Semester PAPER- B. Sc. CHEM-101(P) Inorganic Chemistry(lab)

Max. Marks: 25

Credit - 1

Each Practical examination shall be of three hours duration.

The contents of practicals shall consist of the following:

1. Preparation of standard solutions:

- i) Preparation of N/10 NaOH solution and its standardization with HCl.
- ii) Preparation of N/20 $K_2Cr_2O_7$ solution and its standardization with Mohr's salt.
- iii) Preparation of N/2 $KMnO_4$ solution and its standardization with $FeSO_4$.

2. Volumetric analysis:

i). Iodometry and Iodimetry titrations:

- i) Standardization of sodium thiosulphate with potassium dichromate
- ii) Determination of Cu (II) (Double Titrations)
- iii) Determination of available chlorine in bleaching powder.
- iv) Standardization of I_2 with $Na_2S_2O_3$.
- v) Determination of Sb (III) in tartaremetic

ii). $K_2Cr_2O_7$ titrations:

- i) Standardization with Fe (II).
- ii) Determination of Ferric ions (Double Titrations)
- iii) Determination of Chemical Oxygen Demand (COD) in the waste water.

Books Recommended:

1. Vogel's Text Book of Quantative Inorganic analysis (revised) J. Bassett, R.C Cdenney, G H Jettery and J Mendhan, ELBS.
2. Standard Methods of Chemical Analysis by W W Scott.
3. Experimental inorganic Chemistry by W G Paimer.

First Semester
PAPER- B. Sc. CHEM-102(P)
Organic Chemistry (lab)

Max. Marks: 25

Credit - 1

Practical examination shall be of three hours duration.

The contents of practicals shall consist of the following:

1. Qualitative organic analysis:

Detection of elements (N, S and halogens) and functional groups –Phenol(α - & β - naphthols), carboxylic acid(benzoic and cinnamic acid), , carbohydrates(Glucose & fructose) , amides(urea and benzaamide), m- dinitrobenzene and naphthalene. Determination of melting point.

2. Purification of organic compounds by crystallization:

Oxalic acid, Urea, Glucose, Acetamide.

Recommended Books:

1. Vogel's Text Book of Qualitative Organic analysis (revised) J. Bassett, R.C Cdenney, G H Jettery and J Mendhan, ELBS.
2. Laboratory Manual in Organic Chemistry , R K Bansal.
3. Experimental Organic Chemistry Vol. I & II, P R Singh, D S Gupta and K S Bajpai.

Second Semester
PAPER- B. Sc. CHEM-203(P)
Physical Chemistry (lab)

Max. Marks: 25

Credit - 1

Practical examination shall be of three hours duration.

The contents of practicals shall consist of the following:

1. (i). Determination of surface tension of pure liquids.
(ii) Determination of viscosity of pure liquids.
(iii) Determination of % age composition of the given mixtures from surface tension and viscosity measurements.
2. **Preparation of colloidal solutions:** As_2S_3 , $\text{Fe}(\text{OH})_3$

Recommended Books:

1. Experiments in Physical Chemistry, R C Dass and B Bhera.
2. Selected experimental Chemistry Vol I, Physical J N Gurtu and R Kapoor.
3. Experimental Physical Chemistry by J C Ghose.
4. Experimental Physical Chemistry: B.D Khosla

Second Semester
PAPER- B. Sc. CHEM-204(P)
Inorganic Chemistry(lab)

Max. Marks: 25

Credit - 1

Practical examination shall be of three hours duration.

The contents of practicals shall consist of the following:

1. **Paper chromatography:** Qualitative analysis of anyone of the following inorganic cations or anions by paper chromatography (Cu^{2+} , Ni^{2+} , NO_3^- , Cl^-)
2. Qualitative inorganic analysis of mixture containing four radicals(two acidic and two basic) & may contain one interfering radical.

Recommended Books:

1. Vogel's Text Book of Qualitative Inorganic analysis (revised) J. Bassett, R.C. Cdenney, G. H. Jettery and J. Mendhan, ELBS.
2. Standard Methods of Chemical Analysis by W. W. Scott.
3. Experimental inorganic Chemistry by W. G. Paimer.

Third Semester
PAPER- B. Sc. CHEM-305(P)
Organic Chemistry (lab)

Max. Marks: 25

Credit - 1

Practical examination shall be of three hours duration.

The contents of practicals shall consist of the following:

1. Organic Synthesis:

- i) Preparation of Iodoform.
- ii) Preparation of p-bromoacetanilide from acetanilide.
- iii) Preparation of glucosazone.
- iv) Preparation of aspirin.

2. Thin Layer and Column Chromatography:

- i) Determination of R_f value and purity of organic compounds by use of thin layer chromatography.
- ii) To analyze the analgesic drug APC by thin layer chromatography.
- iii) Separation of mixture of *o*-nitro aniline and *p*-nitro aniline by Column Chromatography.

Recommended books:

1. Vogel's Text Book of Quantitative organic analysis (revised) J. Bassett, R.C Cdenney, G H Jetter and J Mendhan, ELBS.
2. Laboratory Manual in Organic Chemistry , R K Bansal.
3. Experimental Organic Chemistry Vol. I & II, P R Singh, D S Gupta and K S Bajpai.

Third Semester
PAPER- B. Sc. CHEM-306(P)
Physical Chemistry (lab)

Max. Marks: 25

Credit - 1

Practical examination shall be of three hours duration.

The contents of practicals shall consist of the following:

1. Thermochemistry:

- i) Determination of Water Equivalent of a thermoflask.
- ii) Determination of heat of solution of KNO₃ and KCl.
- iii) Determine the enthalpy of neutralization between strong acid and strong base.
- iv) Determine the enthalpy of hydration of CuSO₄.

2. Chemical Kinetics:

- i) Determine the order of reaction of hydrolysis of ethyl acetate in acidic medium.
- ii) Determination of kinetics of reaction between sodium thiosulphate and hydrochloric acid by initial rate method.

Recommended Books:

1. Experiments in Physical Chemistry, R C Dass and B Bhera.
2. Selected experimental Chemistry Vol I, Physical J N Gurtu and R Kapoor.
3. Experimental Physical Chemistry by J C Ghose.

Fourth Semester
PAPER- B. Sc. CHEM-407(P)
Inorganic Chemistry (lab)

Max. Marks: 25

Credit - 1

Practical examination shall be of three hours duration.

The contents of practicals shall consist of the following:

1. Qualitative inorganic analysis

Qualitative inorganic analysis of mixture containing six radicals including interfering radicals (PO_4^{3-} , $\text{C}_2\text{O}_4^{2-}$, BO_3^{3-}).

- 2. EDTA titrations:** Estimation calcium, magnesium and zinc, determination of permanent hardness of water by EDTA titrations.

Books Recommended:

1. Vogel's Text Book of Qualitative Inorganic analysis (revised) J. Bassett, R.C Cdenney, G H Jettery and J Mendhan, ELBS.
2. Standard Methods of Chemical Analysis by W W Scott.
3. Experimental inorganic Chemistry by W G Paimer.

Fourth Semester
PAPER- B. Sc. CHEM-408(P)
Organic Chemistry (lab)

Max. Marks: 25

Credit - 1

Practical examination shall be of three hours duration.

The contents of practicals shall consist of the following:

1. Qualitative Organic analysis:

Qualitative analysis of the following organic compounds for

- i) Detection of extra elements (N, S and Halogens)
- ii) Determination of functional groups
- iii) Determination of melting point
- iv) Specific tests
- v) Preparation of solid derivative(Benzoic acid, cinnamic acid, oxalic acid, α - & β - naphthol, glucose, fructose, sucrose, urea, thiourea, acetamide, benzamide, m- dinitrobenzene, β - naphthyl amine and naphthalene).

- 2. Determination of boiling points:** Ethanol 78^0 , Cyclohexane 81.4^0 , Toluene 110.6^0 , Benzene 80^0 .

Books Recommended:

1. Vogel's Text Book of Qualitative organic analysis (revised) J. Bassett, R.C Cdenney, G H Jettery and J Mendhan, ELBS.
2. Laboratory Manual in Organic Chemistry , R K Bansal.
3. Experimental Organic Chemistry Vol. I & II, P R Singh, D S Gupta and K S Bajpai.

Fourth Semester
PAPER- B. Sc. CHEM-409(P)
Physical Chemistry (lab)

Max. Marks: 25

Credit - 1

Practical examination shall be of three hours duration.

The contents of practicals shall consist of the following:

Physical Chemistry:

1. **Photocolorimetry:** Estimation of Co^{2+} , Ni^{2+} , Cu^{2+}
2. i) Determination of molecular weight of naphthalene by Rast method
 ii) Determination of CST of Phenol – Water system

Recommended Books:

1. Experiments in Physical Chemistry, R C Dass and B Bhera.
2. Selected experimental Chemistry Vol I, Physical J N Gurtu and R Kapoor.
3. Experimental Physical Chemistry by J C Ghose.

Fifth Semester
PAPER- B. Sc. CHEM-510(P)
Inorganic Chemistry (lab)

Max. Marks: 25

Credit - 1

Practical examination shall be of three hours duration.

The contents of practicals shall consist of the following:

1. **Inorganic preparations:**
 - 1) Preparation of cuprous chloride.
 - 2) Preparation of Tetrammine copper (II) Sulfate.
 - 3) Preparation of Potassium trioxalatoaluminate(III)
2. Ceric sulfate titration: Estimation of nitrite and oxalate.
3. Estimation of calcium content of chalk as calcium oxalate by permanganometry

Books Recommended:

1. Hand Book of preparative inorganic Chemistry vol I&II, A P Brauer.
2. Vogel's Text Book of Quantitative Inorganic analysis (revised) J. Bassett, R.C Cdenney, G H Jetter and J Mendhan, ELBS.

Fifth Semester
PAPER- B. Sc. CHEM-511(P)
Organic Chemistry (lab)

Max. Marks: 25

Credit - 1

Practical examination shall be of three hours duration.

1. i) Estimation of acid value, iodine value and saponification value of a given oil and fat.
 ii) Preparation of Nylon-66
2. Distillation:
 - i) Simple distillation of ethanol-water mixture using water condenser.
 - ii) Distillation of nitrobenzene and aniline using air condenser.

Recommended Books:

1. Vogel's Text Book of Quantitative organic analysis (revised) J. Bassett, R.C Cdenney,
 G H Jettery and J Mendhan, ELBS.
2. Laboratory Manual in Organic Chemistry , R K Bansal.

Fifth Semester
PAPER- B. Sc. CHEM-512(P)
Physical Chemistry (lab)

Max. Marks: 25

Credit - 1

Practical examination shall be of three hours duration.

The contents of practicals shall consist of the following:

Experiments Physical Chemistry

1. Conductometric Titrations:

Titration of i) Mixture of strong acid and weak acid with NaOH

ii) KCl with AgNO₃

2. i) Study of adsorption of acetic acid on activated charcoal – Langmuir adsorption isotherm.

iii) Separation of a mixture of Benzoic acid and 2- Naphthol by solvent extraction and identification of their functional groups.

Books recommended:

1. Experiments in Physical Chemistry, R C Dass and B Bhera.
2. Selected experimental Chemistry Vol I, Physical J N Gurtu and R Kapoor.
3. Experimental Physical Chemistry by J C Ghose.

Sixth Semester
PAPER- B. Sc. CHEM-613(P)
Inorganic Chemistry (lab)

Max. Marks: 25

Credit - 1

Practical examination shall be of three hours duration.

The contents of practicals shall consist of the following:

1. Gravimetric analysis:

- i) Estimate Barium/ SO_4^{2-} as Barium sulfate by gravimetric method
- ii) Quantitative estimation of Cu^{2+} as copper thiocyanate and Ni^{2+} as Nickel DMG.
- iii) Estimation of iron as ferric oxide from a solution of Mohr' salt.
- iv) Estimation of aluminium as aluminium oxide
- v) Estimate chromium (III) as lead chromate.

2. Inorganic Preparations:

- i) Preparation of Prussian blue.
- ii) Preparation of potassium trioxalato ferrate (III).
- iii) Preparation of Hexamine Nickel (II) chloride.

Books recommended:

1. Hand Book of preparative inorganic Chemistry vol. I &II, A P Brauer.
2. Vogel's Text Book of Quantative Inorganic analysis (revised) J. Bassett, R.C Cdenney, G H Jettery and J Mendhan, ELBS.

Sixth Semester
PAPER- B. Sc. CHEM-614(P)
Organic Chemistry (lab)

Max. Marks: 25

Credit - 1

Practical examination shall be of three hours duration.

The contents of practicals shall consist of the following:

1. Extraction:

- i) Lycopene from tomato
- ii) Casein from milk
- iii) Preparation of benzpinacolone from benzpinacol (pinacol-pinacolone rearrangement).

2. Preparation and Estimation:

- i) Preparation of methyl orange and its use as azo dye
- ii) Preparation of *m*-dinitrobenzene from nitrobenzene.
- iii) To estimate the strength of given glucose solution (Fehling method).

Books Recommended:

1. Vogel's Text Book of Quantitative organic analysis (revised) J. Bassett, R.C Cdenney, G H Jettery and J Mendhan, ELBS.
2. Laboratory Manual in Organic Chemistry, R K Bansal.

Sixth Semester
PAPER- B. Sc. CHEM-615(P)
Physical Chemistry (lab)

Max. Marks: 25

Credit - 1

Practical examination shall be of three hours duration.

The contents of practicals shall consist of the following:

1. **Partition coefficient:** i) Determination of distribution coefficient of Iodine between water and carbon tetrachloride.

ii) Determination of distribution coefficient of benzoic acid between benzoic acid and water
2. i) To determine the strength of the given acid solution (monobasic and dibasic) conductometrically.
ii) To determine the solubility and solubility product of a sparingly soluble electrolyte conductometrically.

Books Recommended:

1. Experiments in Physical Chemistry, R C Dass and B Bhera.
2. Selected experimental Chemistry Vol I, Physical J N Gurtu and R Kapoor.
3. Experimental Physical Chemistry by J C Ghose.

**SCHEME OF CREDIT FOR B.SC. (CHEMISTRY) COURSE IN DIFFERENT SEMESTERS FOR H P
UNIVERSITY UNDERGRADUATE CLASSES FROM ACADEMIC SESSION -2013-14. (B. Sc) I, II, III Year Chemistry**

Semester	Subject Code	Subject Title	Credit		Hours Per Week	Evaluation Scheme					EE	Subject total Marks
			Th	Pr		As/CT/S	MT ₁	MT ₂	At	Pr		
B Sc I Year												
Semester – I												
	CHEM 101	Inorganic Chemistry	3	1	3 hours(theory)+2 hours(practical)	15	15	15	5	25	50	125
	CHEM 102	Organic Chemistry	3	1	3 hours(theory)+2 hours(practical)	15	15	15	5	25	50	125
Semester – II												
	CHEM 203	Physical Chemistry	3	1	3 hours(theory)+2 hours(practical)	15	15	15	5	25	50	125
	CHEM 204	Inorganic Chemistry	3	1	3 hours(theory)+2 hours(practical)	15	15	15	5	25	50	125
			16									500
B Sc II Year												
Semester – III												
	CHEM 305	Organic Chemistry	3	1	3 hours(theory)+2 hours(practical)	15	15	15	5	25	50	125
	CHEM 306	Physical Chemistry	3	1	3 hours(theory)+2 hours(practical)	15	15	15	5	25	50	125
Semester – IV												
	CHEM 407	Inorganic Chemistry	3	1	3 hours(theory)+2 hours(practical)	15	15	15	5	25	50	125
	CHEM 408	Organic Chemistry	3	1	3 hours(theory)+2 hours(practical)	15	15	15	5	25	50	125
	CHEM 409	Physical Chemistry	3	1	3 hours(theory)+2 hours(practical)	15	15	15	5	25	50	125
			20									625
B Sc III Year												
Semester – V												
	CHEM 510	Inorganic Chemistry	3	1	3 hours(theory)+2 hours(practical)	15	15	15	5	25	50	125
	CHEM 511	Organic Chemistry	3	1	3 hours(theory)+2 hours(practical)	15	15	15	5	25	50	125
	CHEM 512	Physical Chemistry	3	1	3 hours(theory)+2 hours(practical)	15	15	15	5	25	50	125
Semester – VI												
Any two	CHEM 613, CHEM 614, CHEM 615		3	1	3 hours(theory)+2 hours(practical)	15	15	15	5	25	50	125
			3	1	3 hours(theory)+2 hours(practical)	15	15	15	5	25	50	125
			20									625
		Grand Total	56									1750

**Th = Theory, Pr = Practical, As = Assignment, CT = Class Test, S= Seminar, MT= minor test, At = Attendance,
EE = End Term Exams.**