B.Sc. PART-III

CHEMISTRY

PAPER I-INORGANIC CHEMISTRY

Max. Marks : 75 — 60 hrs (2hrs/week)
Time Allowed : 3 hours — 3 Periods/Week
Pass Marks : 35%

SECTION-A

I. **Metal-ligand Bonding in Transition Metal Complexes.** 10 Hrs.

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

II. **Magnetic Properties of Transition Metal Complexes** 7 Hrs.

Types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, Correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moment, application of magnetic moment data for 3d-metal complexes.

III. **Thermodynamic and Kinetic Aspects of Metal Complexes** 3Hrs.

A brief outline of thermodynamic stability of meta1 complexes and factors affecting the stability, substitution reactions of square planar complexes.

SECTION-B

IV. **Hard and Soft acids and Bases (HSAB)** 5 Hrs.

Classification of acids and bases as a hard and soft, Pearson's HSAB concept, acid-base strength and hardness and softness. Symbiosis, theoretical basis of hardness and softness, electronegativity and hardness and softness.

V. **Bioinorganic Chemistry** 10 Hrs.

Essential and trace elements in biological processes, metalloporphyrins with special reference to haemoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to Ca^{+2} Nitrogen fixation.

VI. **Silicones and Phosphazenes** 5 Hrs.

Silicones and Phosphazenes as examples of inorganic polymers, nature of bonding in triphosphazenes.

SECTION- C

VII. **Electronic Spectra of Transition Metal Complexes.** 8 Hrs.

Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series. Orgel-energy level diagram for d^1 and d^9 states, discussion of electronic spectrum of complexion.

VIII. **Organometallic Chemistry** 12 Hrs.

Definition, Nomenclature and classification of organometallic compounds. Preparation, properties, bonding and applications of alkyls, of Li, AI, Hg, Sn and Ti, a brief account of metal-ethylenic complexes and homogeneous hydrogenation, mononuclear carbonyls and the nature of bonding in metal carbonyls.

INSTRUCTIONS FOR PAPER-SETTER AND CANDIDATES

Question paper will have three sections : A, B, C and an additional section D. The paper-setter will set eight questions from sections A, B and C in such a way that not less than two and not more than three questions are set from any section. Section D will have only one question, which will consist of 8 or 10 objective/ very short answer type parts uniformly covering the whole syllabus. All the questions from Sections A, B, C and D will carry the same marks.

Candidates will attempt five questions, taking at least one but not more than two from each section.

PAPER II-ORGANIC CHEMISTRY

Max. Marks : 75 60 hrs (2hrs/week)
Time Allowed : 3 hrs 3 Periods/Week
Pass Marks : 35%

SECTION-A

I. **Spectroscopy** 20 Hrs.

Nuclear magnetic resonance (NMR) spectroscopy.

Proton magnetic resonance (^{1}H NMR) spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde 1,1,2 tribromoethane, ethyl acetate, toluene and acetophennone.

II. **Electromagnetic spectrum: Absorption Spectra**

Ultraviolet (UV) absorption spectroscopy—absorption laws (Beer-Lambert's 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.

Infared (IR) absorption spectroscopy-molecular vibrations, Hooke's law, Selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorption of various functional groups and interpretation of IR spectra of simple organic compounds.

Problems pertaining to the structure elucidation of simple organic compounds using UV, IR, and PMR spectroscopic techniques.

SECTION-B 20 Hrs.

III. **Organometallic Compounds**

Organomagnesium Compounds : The Grignard reagents formation, structure and chemical reactions.

Organozinc compounds: formation and chemical reactions.

Organolithium compounds: formation and chemical reactions.

IV. **Organosulphur Compounds**

Nomenclature, structural features, methods of formation and chemical reactions of thiols, thioethers, sulphonic acids, and sulphonamides.

V. **Heterocyclic Compounds**

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

Introduction to condensed five and six membered heterocycles. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fischer indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis. Mechanism of electrophlic substitution reactions of indole, quinoline and isoquinoline.

VI. **Synthesis Polymers**

Ziegler-Natta polymerziation and vinyl polymers. Condensation or step growth polymerziation. Urea formaldhehyde resins, epoxy resins and polyurethanes. Natural and synthetic rubbers.

20 Hrs.

SECTION-C

VII. **Organic Synthesis Via Enolates**

Acidity of α-hydrogens, alkylation of diethyl malonate and ethyl acetoacetate. Synthesis of ethyl acetoacetate: the Claisen condensation. Keto-enol tautomerism of ethyl acetoacetate. Alkylation and acylation of enamines.

VIII. **Carbohydrates**

Classification and nomenclature, Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses.

Configuration of monosaccharides. Erythro and threodiastereomers. Conversion of glucose into mannose. Formation of glycosides, ethers, and esters. Determination of ring size of monosaccharides. Cyclic structure of D (+)-glucose. Mechanism of mutarotation.

Structures of ribose and deoxyribose.

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

IX. **Amino Acids, Peptides, Proteins and Nucleic Acids**

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

Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical levels of protein structure. Protein denaturation/renaturation.

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

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PAPER-III–PHYSICAL CHEMISTRY

Max. Marks : 75 — 60 hrs (2hrs/week)

Time Allowed : 3 hours — 3 Periods/Week

Pass Marks : 35%

SECTION-A

I. **Elementary Quantum Mechanics** 20 Hrs.

Black-body radiations, Planck's radiation law, photoelectric effect, heat capacity of solids.

Sinusoidal wave equation Hamiltonian operator, Schrodinger wave equation and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in a one dimensional box.

Schrodinger wave equation for H-atom, separation into three equations (without derivation), quantum numbers and their importance, hydrogen like wave functions, radial wave functions, angular wave functions. Molecular orbital theory, basic ideas—criteria for forming M.O. from A.O., construction of M.O. 's by LCAO H_2^+ ion, calculation of energy levels from wave functions, physical picture of bonding and antibonding wave functions, concept of $\sigma,\sigma^*,\pi\ \pi^*$, orbitals and their characteristics. Hybrid orbitals- sp, sp^2, sp^3;calculation of coefficients of A.O 's used in these hybrid orbitals.

Introduction to valence bond model of H_2, comparison of M.O. and V.B. models.

20 Hrs.

SECTION-B

Spectroscopy

Introduction :

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

Rotational Spectrum :

Diatomic molecules. Energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, determination of bond length, qualitative description of non-rigid rotor, isotope effect.

Vibrational Spectrum :

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

Raman Spectrum :

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

Electronic Spectrum :

Concept of potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules and Franck-Condon principle. Qualitative description of σ, π and n M.O. their energy levels and their respective transitions. 20 Hrs.

SECTION-C

III. **Photochemistry**

Interaction of radiation with matter, difference between thermal and photochemical process. Laws of photochemistry: Grothus-Drapper law, Stark-Einstein law, Jablonski diagram depiciting various processes occurring in the excited state, qualitative description of fluorescence, non- radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions- energy transfer processes (simple examples).

IV. **Solid State** 12 Hrs.

Definition of space lattice and unit cell.

Laws of crystallography—(i) Law of constancy of interfacial angles. (ii) Law of rationality of indices (iii) Law of symmetry elements in crystals.

X-ray diffraction by crystals. Derivation of Bragg's equation. Determination of crystal structure of NaCI, KCI and CsCI (Laue's method and powder method).

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PRACTICALS

Max. Marks : 75 6 Periods/Week

Synthesis and Analysis

(a) Preparation of sodium trioxalatoferrate(III), $Na_3[Fe(C_2O_4)_3]$ and determination of its composition by permagnometry.

(b) Preparation of Ni-DMG complex, $[Ni(DMG)_2]$

(c) Preparation of copper tetra-ammine complex.$[Cu(NH_3)_4]SO_4$.

(d) Preparation of cis-and trans-bisoxalatodiaquachromate(III) ion.

ORGANIC CHEMISTRY

Laboratory Techniques
Column Chromatography
Separation of fluorescein and methylene blue.
Separation of leaf pigments from spinach leaves.

Synthesis or Organic Compounds

Iodoform from ethanol and acetone,

(b) Aromatic electrophlic substitution

1. m-dinitrobenzene
2. p-nitroacetanilide
3. p-bromoacetanilide
   2,4,6-tribromophenol
   Diazotization/Coupling
4. methyl orange and methyl red
5. Preparation of benzoic acid from toluene
   Reduction
   Preparation of aniline from nitrobenzene
   Preparation of m-nitroaniline from m-dinitrobenzene
   Stereochemical Study of Organic Compounds via Models
   R and S configuration of optical isomers.

E, Z configuration of geometrical isomers.
Conformational analysis of cyclohexanes and substituted cyclohexanes.

Physical Chemistry

(a) To determine the strength of the given acid conductometrically using standard alkali solution.
(b) To determine the solubility and solubility product of a given sparingly soluble electrolyte conductometrically.
(c) To study the saponification of ethyl acetate conductometrically.
(d) To determine the ionisation constant of a weak acid conductometrically.
(e) To determine the strength of the given acid solution pH- metrically by using standard alkali solution.
(f) To determine the molar refrection of methanol, ethanol and propanol.
(g) To study the distribution of iodine between water and CCl_4.
(h) To study the distribution of benzoic acid between benzene and water.

PRACTICALS—CHEMISTRY

8 Hrs. (Two session each of 4 hours duration
First Session in the evening and
Second in the morning of the next day)

INSTRUCTIONS FOR EXAMINERS AND CANDIDATES

During first day, candidate are required to prepare inorganic complex, perform column Chromatography experiment and synthesise organic compound. On the second day teacher will check the note books, models and conduct the viva voce. The candidate will perform experiments from physical, chemistry. Distribution of marks will be as under :

1.	Viva-Voce	=	10	(five each day)
2.	Note Books	=	10	(five each day)
3.	Inorganic Complex	=	10	(3 for initial write up)
4.	Column Chromatography	=	7	(Performance and result)
5.	Organic Synthesis	=	10	(3 for initial write up)
6.	Models	=	8	
7.	Physical experiments Two	=	20*	(5 for initial write up of both experiment)
	Total	=	75	

*Full credit may be given for error upto 10% and one mark may be deducted for additional 5% error.

BOOKS SUGGESTED (THEORY COURSES)

1. *Basic Inorganic Chemistry*, F.A. Cotton, G. Willdson and P.L. Gaus, Wiley.
2. *Concise Inorganic Chemistry*, J.D. Leee, ELBS.
3. *Concept of models of Inorganic Chemistry*, B. Douglas, D. McDaniel, and J. Alexander, Jolin Wiley.
4. *Inorganic Chemistry*, D. E. Shriver, P. W. Atkins and C.H. Langford, Oxford.
5. *Inorganic Chemistry*, W. W. Porterfield Addison-Welsey.
6. *Inorganic Chemistry*, A. G. Sharpe, ELBS
7. *Inorganic Chemistry*, G. L. Miessler and D. A. Tarr, Prentice Hall.
8. *Inorganic Chemistry*, Morrison and Boyd, Prentice-Hall.
9. *Inorganic Chemistry*, L.G. Wade Jr. Prentice-Hall.
10. *Fundamentals of Organic Chemistry*, Solomons, John Wiley.
11. *Organic Chemistry*, Vol. I, II & III, S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International).
12. *Organic Chemistry*, F.A. Carey, McGraw-Hill, Inc.
13. *Introduction to Organic Chemistry*, Streitwieser, Healthcock and Kosover and Kosover, Macmilan.
14. *Physical Chemistry*, G.M. Barrow, International Student Edition, McGraw Hill.
15. *University General Chemistry*, C.N.R. Rao. Macmillan.
16. *Physical Chemistry*, R.A. Alberty, Wiley Eastern Ltd.
17. *The Elements of Physical Chemistry*, P. W. Atkins, Oxford.
18. *Physical Chemistry Through Problems*, S.K. Dogra and S. Dogra, Willey Eastern Ltd.

BOOKS SUGGESTED (LABORATORY COURSES)

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