

3. To determine the refractive indices for ordinary and extraordinary rays using double image prism.
4. To determine the Concentration of sugar solution by half shade polarimeter.
5. To determine the wavelength of monochromatic light by plane diffraction grating.
6. To find the number of lines per centimeter of the given grating.
7. To determine the resolving power of plane diffraction grating.
8. To determine the resolving power of telescope.
9. To determine the wavelength of laser light.
10. Determination of refractive index of a prism by spectrometer.
11. Determination of dispersive power of prism material
12. To determine the resolving power of prism.
13. study of interference of light by bi-prism experiment and find the wavelength of sodium light.
14. To verify the law of Malus of plane polarized light.
15. Polarplots of solarpanel
16. Measurement of direct radiation using Pyrheliometer .
17. Measurement of global & diffuse radiation using pyranometer
18. Determination of solar constant
19. To determine frequency and phase of signal using CRO.
20. To determine capacitance by Scherring bridge method.
21. To determine self inductance by bridge rectifier method.
22. To determine frequency of AC mains by Sonometer.
23. To study and plot I-V characteristics of solar cell.
24. To study time constant of an RC circuit experimentally and verify the result theoretically.
25. Verification of Stefan's law of radiation by using an incandescent lamp as black body Radiator.
26. To study (a) Half-wave Rectifier and (b) Full-wave Bridge Rectifier and investigate the effect of C, L and π filters.

REFERENCE BOOKS:

1. Laser and non-linear optics – B B Laud.
2. Optoelectronics and fiber optics communication – C.K Sarkar, D.C. Sarkar.
3. An introduction to fiber optics – R. Allen Shotwell
4. Optics – Ajoy Ghatak.
5. Optical fiber Communication – John M. Senior
6. Principles of optics – B.K.Mathur
7. Optics and laser – V.K. Sewane
8. Optics and atomic physics – D.P.Khandelwal.
9. Non Conventional Energy Sources, G. D. RAI(4th edition), Khanna Publishers, Delhi.
10. Solar Energy, S.P. Sukhatme (second edition), Tata Mc. Graw Hill Ltd, New Delhi.

11. Solar Energy Utilisation, G. D. RAI (5th edition), Khanna Publishers, Delhi.
12. Principles of Solar Energy - Kreith Kreider.
13. Renewable Energy - BentSarensen.

3. CHEMISTRY

3S Chemistry

The examination in Chemistry of Third semester shall comprise of one theory paper, internal assessment and practical examination. Theory paper will be of 3 Hrs. duration and carry 80 marks. The internal assessment will carry 20 marks. The practical examination will be of 6 to 8 hours duration and carry 50 marks.

The following syllabi is prescribed on the basis of six lectures per week and 6 practical periods per batch per week. Each theory paper has been divided into 6 units. There shall be one question in every unit with internal choice for each of 12 marks & one compulsory question covering all the syllabus of Semester-III (8 marks).

3S Chemistry

Total Lectures: 84

Marks: 80

Note: Figures to the right hand side indicate number of lectures.

Unit I

14L

(A) Covalent Bonding:

Limitations of valence bond theory. Molecular Orbital Theory. Postulates of MO theory. LCAO approximation. Formation of bonding and antibonding MOs. Rules for LCAO. MO energy level diagram. Concept of bond order. MO structure of homonuclear diatomic molecules of namely He₂, H₂, N₂ and O₂. Stability sequence of species of O₂ i.e. O₂, O₂⁺, O₂²⁺, O₂⁻ and O₂²⁻. Paramagnetic nature of O₂. Nonbonding MOs. MO structure of heteronuclear diatomic molecules viz. NO, HF and CO (Coulson's structure). Explanation of important properties of CO viz. - triple bond, almost nonpolar nature, electron donor and acceptor behaviour. Comparison of VB and MO theories. **[6]**

(B) Metallic Bonding:

Free electron theory and properties of metals such as electrical and thermal conduction, malleability, ductility and metallic lustre. VB theory or Resonance theory of metals. Band theory to explain nature of conductors, insulators and semiconductors (both intrinsic and extrinsic). **[3]**

(C) VSEPR Theory:

Various rules under VSEPR theory to explain molecular geometry (following examples may be taken to explain various rules- BeCl₂, BF₃, CH₄, NH₄⁺, PCl₅, SF₆, IF₇, SnCl₂, NH₃, H₂O, SF₄, ClF₃, ICl₂⁺, ICl₄⁻, BrF₃, XeF₆, SOF₄, COF₂, PCl₃, PBr₃, PI₃, F₂O, H₂S). Limitations of VSEPR theory. **[5]**

Unit II - Theory of Quantitative Inorganic Analysis 14L**(A) Volumetric Analysis:**

- (a) **Introduction:**-Volumetric analysis, titrant, titrate, end point, equivalence point, indicator etc. Requirements of volumetric analysis. Definition of standard solution, primary standard substance. Requirements of primary standard substance. Terms to express concentrations namely- molarity, normality, molality, mole fraction and percentage. (Simple numericals expected).
- (b) **Acid-Base titrations:**- Types of acid base titrations. pH variations during acid base titration. Acid base indicators. Modern theory (Quinonoid theory) of acid base indicators. Choice of suitable indicators for different acid base titrations.
- (c) **Redox Titrations:**-General principles involved in redox titrations (redox reactions, redox potentials, oxidant, reductant, oxidation number). Brief idea about use of KMnO_4 , $\text{K}_2\text{Cr}_2\text{O}_7$ as oxidants in acidic medium in redox titrations. Use of I_2 in iodometry and iodimetry. Redox indicators-external and internal indicators. Use of starch as an indicator. Iodometric estimation of Cu (II).

[8]

(B) Gravimetric Analysis:

Definition. Theoretical principles underlying various steps involved in gravimetric analysis with reference to estimation of barium as barium sulphate. Co-precipitation and post precipitation. (Definition, types and factors affecting).

[6]

Unit III

14L

(A) Aldehydes and Ketones:

Aliphatic and Aromatic aldehydes and ketones (Acetaldehyde, Benzaldehyde, Acetone, Acetophenone) Introduction, Structure of carbonyl group, acidity of α -hydrogen in carbonyl compounds. Methods of preparation of aldehydes: From alcohols, Calcium salts of acids, Acid chlorides, Gatterman-Koch synthesis. Reactions of aldehydes: Cannizzaro's, Reformatsky, (Perkin with mechanism), Mannich reaction, (Benzoin and Aldol condensation with mechanism). Methods of preparation of ketones: oxidation, catalytic decomposition of acids, dry distillation of Ca salt, Friedel-Craft's reaction, hydration of alkynes. Reaction of ketones: MPV, Wolff-Kishner, LiAlH_4 reductions.

[9]

(B) Carboxylic acids:

Introduction, Structure and reactivity of carboxylic groups.

Acidity of carboxylic acids, effects of substituents on acids strength. Methods of synthesis and chemical reactions of oxalic, lactic, benzoic and salicylic acid.

Oxalic acid: Preparation from ethylene glycol and cyanogens. Chemical reactions: oxidation, reduction, esterification, reaction with ammonia, glycerol and action of heat.

Lactic acid: Preparation from acetaldehyde, pyruvic acid. Chemical reactions: Ester formation, action of PCl_5 , heat, oxidation and reduction.

Benzoic acid: Preparation from benzene, toluene, benzyl alcohol, phenyl cyanide, benzamide. Chemical reactions : Reaction with PCl_5 , ammonia and ester formation.

Salicylic acid: Preparation by Reimer-Tiemann reaction. Chemical reactions: acetylation and esterification.

[5]

Unit IV - Stereochemistry

14L

- A) Introduction to different types of isomerism, Structural isomerism and Stereoisomerism, conformation, configuration and Geometrical isomerism. [2]
- B) **Optical isomerism:** Element of symmetry, chirality, Assymmetric carbon atom, enantiomers, diastereoisomers, relative and absolute configurations, Fischer projection formula, R-S nomenclature, Inversion and retention, racemisation and resolution of racemic mixture. [3]
- C) **Geometrical isomerism:** Cis-trans nomenclature, E-Z nomenclature, Methods of structure determination. [3]
- D) Bayer's Strain theory and its limitations. Stability of cycloalkanes, conformations and conformational isomers of ethane, n-butane and cyclohexane, their energy level diagrams. Newman, Sawhorse, Fischer and Flying wedge projection formulae. [6]

[6]

Unit V

14L

- (A) **Thermodynamics and Equilibrium:** [10]
- (i) Definition and physical significance of Helmholtz work function (A) and Gibbs free energy. Change in free energy (ΔG) as a criteria of spontaneity and equilibrium. Variation of 'A' with 'V' & 'T'. Change in 'G' due to change in

- 'P' and 'T'. Gibbs-Helmholtz equation and its applications.
- (ii) Chemical potential. Derivation of Gibbs-Duhem equation. Chemical potential of an ideal gas in a gaseous mixture. Derivation of Van't Hoff reaction of isotherm and its application to equilibrium state. Derivation of Van't Hoff equation and its applications.
- (iii) Numericals.
- (B) Phase rule:** [4]
Statement of Phase rule. Explanation of Phase, number of components and degrees of freedom. Application of phase rule to water and sulphur systems.
- Unit VI** [4L]
- (A) Phase Equilibrium:** [6]
- (i) Raoult's Law and its limitations. Ideal and non ideal solution. Classification of binary solutions of completely miscible liquids (I, II and III) on the basis of Raoult's Law.
- (ii) Phase diagrams of Phenol-Water, Triethylamine-Water and Nicotine-Water system.
- (iii) Nerst distribution law and its applications to association and dissociation of solute in one of the immiscible solvents. Process of extraction. Derivation of the formula for the amounts of the solute left unextracted after n^{th} extraction.
- (iv) Numericals.
- (B) Electrochemistry:** [8]
- (i) Conductance of electrolyte solutions. Specific, equivalent and molar conductance. Determination of conductance of electrolyte solution. Variation of specific and equivalent conductance with dilution. Conductometric titrations. Advantages of conductometric titrations.
- (ii) Migration of ions under the influence of electric field. Hittorf's theoretical device (Hittorf's rule). Transport number of ions.
- (iii) Kohlrausch's law of independent migration of ions. Determination of λ_{∞} and the degree of dissociation of a weak electrolyte. Determination of ionization (or dissociation) constant of weak acid. Determination of solubility and solubility product of a sparingly soluble salt.

- (iv) Numericals

Semester- III

3S Chemistry Practicals

Total Laboratory sessions: 21

Marks:50

Unit I : Inorganic Chemistry Practicals 7 Laboratory sessions

- Calibration of volumetric apparatus (Burette, pipette and volumetric flask) and fractional weight box. (Atleast one experiment to be done by using analytical balance and calibrated fractional weight box).
- Following volumetric exercises— (standard solutions to be prepared by students)
 - To determine acid neutralising capacity of an antacid.
 - To determine the strength of oxalic acid by titration with KMnO_4 .
 - To determine percentage purity of Ferrous Ammonium Sulphate by titration with KMnO_4 .
 - To determine strength of FAS by titration with $\text{K}_2\text{Cr}_2\text{O}_7$ using internal indicator.
 - Estimation of copper (II) in commercial copper sulphate sample by iodometric titration.
 - To determine amount of iodine in iodized common salt.

Unit II : Organic Chemistry Practicals 7 Laboratory sessions

- Complete analysis of simple organic compounds containing one or two functional groups and involving following steps:
- Preliminary examinations
 - Detection of the elements
 - Detection of functional groups
 - Determination of m.p./ b.p.
 - Preparation of derivative and its m.p./ b.p.
 - Performance of spot test if any.
- Minimum 7-8 compounds containing different groups should be identified by student.
- Acids : Oxalic acid, Benzoic acid, Salicylic acid, Phthalic acid and Sulphanilic acid.
 - Phenols : Resorcinol, α -naphthol, β -naphthol.
 - Aldehydes : Benzaldehyde, Glucose, Lactose.
 - Base : Aniline, *p*-Toluidine.

- 5) Nitro compounds: Nitrobenzene, *m*-dinitrobenzene.
- 6) Amides : Benzamide, Urea, Thiourea.
- 7) Hydrocarbons: Naphthalene, Anthracene.
- 8) Halogen compounds : Chloroform, Chlorobenzene.

Unit III : Physical Chemistry Practicals 7 Laboratory sessions

- Expt. No.1 : To determine partition coefficient of iodine between water and organic solvents (e.g. CHCl₃/ CCl₄).
- Expt. No.2 : To study distribution of benzoic acid between water and benzene and from this determination of molecular state of benzoic acid in benzene.
- Expt. No.3 : To construct mutual stability curve for phenol-water system and determine the consolute temperature for the system.
- Expt.No.4 : To determine solubility of benzoic acid at different temperature and from that ΔH solution.

Distribution of Marks for Practical Examination.**Time: 6 – 8 hours (One Day Examination) Marks: 50**

Unit – I	: Inorganic Chemistry (Exercise)	.....	12
Unit – II	: Organic Chemistry (Exercise)	.....	12
Unit – III	: Physical Chemistry (Exercise)	.....	12
	Viva-Voce	.....	07
	Record	.....	07

Total:			50

4S Chemistry**Total Lectures: 84****Marks: 80****Note:** Figures to the right hand side indicate number of lectures.**Unit I 14L****(A) Chemistry of elements of transition series:**

Definition of transition elements. General characteristics of transition elements. Comparative study of first transition series elements (3d) with reference to following properties:

- (i) Electronic configuration (ii) Atomic and ionic size
 - (iii) Ionization energy (iv) Metallic nature (v) Oxidation states (vi) Magnetic properties (vii) Color of salts (viii) Catalytic properties (ix) Complex formation behaviour.
- Study of 4d and 5d series elements-Electronic configuration. Comparison of 3d series elements with

4d and 5d series elements with respect to size, oxidation states, magnetic properties and color. [11]

(B) Extraction of elements:

Principles involved in extraction of elements. Major methods of extraction of elements. Factors affecting choice of extraction method. Thermodynamics of reduction processes-Ellingham diagrams for oxides and importance of this diagram (only preliminary ideas). [3]

14L**Unit II****(A) Inner transition elements:**

Definition, Lanthanides and Actinides. Comparative study of Lanthanides with respect to following properties:

- (i) Electronic configuration (ii) Atomic and ionic radii-lanthanide contraction-definition, cause and effect of lanthanide contraction (iii) Oxidation states (iv) Magnetic properties (v) Color of salts (vi) Complex formation behavior.

Occurrence of lanthanides. Isolation of lanthanides by ion exchange method.

Actinides- Electronic configuration and oxidation states. Comparison of lanthanides and actinides. Applications of Lanthanides and Actinides in high technology in brief. [11]

(B) General Principles of Metallurgy:

Definition of metallurgy, steps in metallurgy. Ore dressing by gravity separation, froth floatation and electromagnetic separation. Calcination, roasting, smelting and refining of metals. Meaning of terms-hydrometallurgy and pyrometallurgy. [3]

14L**Unit III****(A) Polynuclear hydrocarbons:**

Introduction, orbital picture of naphthalene. Preparation and reactions of α -naphthol and β - naphthol, α -naphthylamine and β - naphthylamine. [4]

(B) Organic synthesis via enolates:

Definition of reactive methylene group, synthesis and applications of malonic ester and acetoacetic ester, keto-enol tautomerism.

Malonic Ester: Synthetic applications- Synthesis of Acetic acid, Succinic acid, Glutaric acid, Adipic acid, Crotonic acid, Acetone, Malonyl urea.

Acetoacetic ester: Synthetic applications- Synthesis of Acetic acid, Propionic acid, isobutyric acid, Succinic acid, Glutaric acid, Crotonic acid, Acetone, Acetyl acetone, 4-methyl uracil. [6]

(C) **Carbohydrates:**

Introduction, Constitution of glucose, cyclic structure, Pyranose and Furanose structure, Epimerization, Chain lengthening and chain shortening in aldose. Interconversion of glucose and fructose, Introduction to fructose, ribose, 2- deoxyribose, maltose, sucrose. (Their structure only determination not expected) [4]

Unit IV

14L

(A) **Aromatic nitro compounds:**

Nitration and different nitrating agents. Reduction of Nitrobenzene under different conditions. [2]

(B) **Amino Compounds:**

Introduction, Basicity and effect of substituents. Methods of preparation of aniline, Reactions of aniline: Carbylamine reaction, alkylation, reaction with aldehyde, benzoylation, Hoffmann's Exhaustive Methylation and its mechanism. [5]

(C) **Diazonium Salts:**

Diazotization, Preparation and synthetic applications of benzene diazonium chloride. [3]

(D) **Amino acids and Proteins:**

Classification of amino acids, methods of synthesis and reactions of amino acids. Zwitterion structure, Isoelectric point, peptide synthesis, Structure determination of Polypeptides by end group analysis. [4]

Unit V-

Colligative Properties of Dilute Solutions 14L

- Definition and examples of colligative properties. Importance of colligative properties.
- Elevation of boiling point. Thermodynamic derivation of the relationship between elevation of boiling point and the molar mass of non-volatile solute. Cottrell's method for the determination of elevation of boiling point and hence the molar mass of solute.
- Depression of freezing point. Thermodynamic derivation of the relationship between depression of freezing point and the molar mass of non-volatile solute. Rast's method for the determination of molar mass of solute.

(iv) Abnormal behaviour of solution. Van't Hoff's factor 'i'. Determination of degrees of association and degree of dissociation from Van't Hoff's factor.

(v) Numericals.

Unit VI- Physical Properties and Molecular Structure 14L

(A) **Electrical Properties :**

[7]

- Polar and non-polar molecules. Dipole moment.
- Induced polarization and orientation polarization. Clausius-Mossotti equation (only qualitative treatment).
- Measurement of dipole moment by temperature and refractivity methods.
- Applications of dipole moment for the determination of molecular structure. (molecular geometry, % ionic character of a covalent bond, cis-trans isomers and ortho, meta and para isomers of a disubstituted benzene).
- Numericals.

(B) **Magnetic Properties:**

[7]

- Paramagnetic and diamagnetic substances. Origin of paramagnetism and diamagnetism.
- Volume, specific and molar magnetic susceptibility. Relationship between molar magnetic susceptibility and magnetic moment.
- Relationship between magnetic moment (spin only) and the number of unpaired electrons.
- Applications of magnetic moment in the determination of molecular structure.
- Numericals.

4S Chemistry Practicals

Total Laboratory sessions: 21

Marks: 50

Unit I : Inorganic Chemistry Practicals 7 Laboratory sessions

Gravimetric estimation of Ba^{2+} as BaSO_4 , Fe^{3+} as Fe_2O_3 using china or silica crucible and Ni^{2+} as Ni-DMG using sintered glass crucible.

Unit II : Organic Chemistry Practicals 7 Laboratory sessions

- Determination of acetic acid in commercial vinegar using NaOH.
- Estimation of the amino group.
- Estimation of phenol by bromination method.
- Estimation of urea by hypobromide method.
- Estimation of unsaturation.

6. Isolation of Caffeine from tea leaves.
7. Isolation of Casein from milk.
8. Isolation of lactose from milk.

Unit III : Physical Chemistry Practicals 7 Laboratory sessions

- Expt. No. 1: To determine molar mass of non-volatile solute by Rast's method.
- Expt. No. 2: To study conductometric titration of a strong acid against a strong base.
(Standard oxalic acid solution to be prepared by the student).
- Expt. No. 3: To determine rate constant for the saponification of ethyl acetate (second order reaction with equal initial concentration of both the reactants) by Conductometry.
- Expt. No. 4: To study variation of specific and equivalent conductance with dilution for a strong electrolyte.
- Expt. No. 5: To determine equivalent conductance of acetic acid at infinite dilution by Kohlrausch's law.

Distribution of Marks for Practical Examination.

Time: 6 – 8 hours	(One Day Examination)	Marks: 50
Unit – I :	Inorganic Chemistry (Exercise)	12
Unit – II :	Organic Chemistry (Exercise)	12
Unit – III :	Physical Chemistry (Exercise)	12
	Viva-Voce	07
	Record	07
	Total :	50

Books Recommended: (Common for Semester III and Semester IV)

1. Principles of Inorganic Chemistry by Puri, Sharma and Kalia- S. Naginchand & Co., Delhi.
2. Text book of Inorganic Chemistry by A.K. De, Wiley East Ltd.
3. Selected Topics in Inorganic Chemistry by Malik, Tuli and Madan- S. Chand & Co.
4. Modern Inorganic Chemistry by R.C. Agrawal, Kitab Mahal.
5. Instrumental Methods of analysis by Chatwal and Anand, Himalaya Publishing House.
6. Concise Inorganic Chemistry by J.D. Lee, ELBS.
7. Inorganic Chemistry by J.E. Huheey- Harper & Row.
8. Fundamental concepts of Inorganic Chemistry by E.S. Gilreath, McGraw Hill book Co.
9. Modern Inorganic Chemistry by W.L. Jolly, McGraw Hill Int.

10. Chemistry Facts, Patterns & Principles by Kneen, Rogers and Simpson, ELBS.
11. Theoretical Principles of Inorganic Chemistry by G.S. Manku, Tata McGraw Hill.
12. Inorganic complex compounds by Murmann, Chapman & Hall.
13. Text book of Inorganic Chemistry by K.N. Upadhyaya, Vikas Publishing House, Delhi.
14. Advanced Practical Inorganic Chemistry by Gurdeep Raj, Goel Publishing House, Meerut.
15. Co-ordination Chemistry by D. Banerjee, TMH Publication.
16. Text book of Inorganic Chemistry by Nema, Agrawal, Solanki, Morkhade, Meshram, Berad.
17. Text book of Inorganic Chemistry by Bhadange, Pagariya, Deshmukh, Joshi, Bombatkar, Mandlik, Bokey Prakashan, Amravati.
18. Organic Chemistry by R.T. Morrison & R.T. Boyd, 6th edition, PHI.
19. Organic Chemistry by Pine, 5th edition.
20. Organic Chemistry Vol. I, II and III by Mukharjee, Singh and Kapoor- Wiley Eastern.
21. Organic Chemistry by S.K. Ghosh.
22. Reaction Mechanism in Organic Chemistry by S.M. Mukharjee and S.P. Singh.
23. Spectroscopy of Organic Compounds by P.S. Kalsi.
24. Stereochemistry and mechanism through solved problems by P.S. Kalsi.
25. Organic Chemistry by TWG Solomons, 4th edition, John Wiley.
26. Hand Book of Organic Analysis by H.J. Clarke, Arnold Heinmen.
27. Text book of Practical Organic Chemistry by A. I. Vogel.
28. Text book of Organic Chemistry by Wadodkar, Raut, Dighade, Thakare, Kale, Kadu, Chincholkar.
29. Text book of Organic Chemistry by P.S. Kalsi published by Macmillan India Ltd., 1999, Delhi.
30. Practical Organic Chemistry by F.G. Mann, B.C. Saunders, Orient Longman.
31. Comparative Practical Organic Chemistry (Qualitative Analysis) by V.K. Ahluwalia and Sunita Dhingra, Orient Longman.
32. Comprehensive Practical Organic Chemistry (Preparation and Qualitative Analysis) by V.K. Ahluwalia and Renu Agrawal, Orient Longman.