JIWAJI UNIVERSITY, GWALIOR

B.Sc. Honor's Chemistry – 2019-22

Subject – Chemistry

Year – 2019-2022

Year	Type of Paper	Paper Code	Name of the Paper	Marks		
				CCE	Yearly Exam	Total
I Year	Pass Course I	Chem-108	Inorganic Chemistry-I	7.5	25.5	**33**
	Pass Course II	Chem-109	Organic Chemistry-I	7.5	25.5	**33**
	Pass Course III	Chem-110	Physical Chemistry-I	7.5	26.5	**34**
	Honor's Course-I	Chem-111	Honors Chemistry-I	10	40	**50**
	Practical-Pass Course	Chem-112	Practical –I (Practical based on Chem-108, 109 & Chem110)	-	50	**50**
	Practical-Honors Course	Chem-113	Practical-II (Practical based on Chem-111)	-	25	**25**
II Year	Pass Course I	Chem-204	Inorganic Chemistry-II	7.5	25.5	**33**
	Pass Course II	Chem-205	Organic Chemistry-II	7.5	25.5	**33**
	Pass Course III	Chem-206	Physical Chemistry-II	7.5	26.5	**34**
	Honor's Course-I	Chem-210	Honors Chemistry-II	10	40	50
	Honor's Course-I	Chem-211	Honors Chemistry-III	10	40	50
	Practical-Pass Course	Chem-212	Practical –I (Practical based on Chem-204, 205 & Chem-206)	-	50	**50**
	Practical-Honors Course	Chem-213	Practical-II (Practical based on Chem-207 & 208)	-	50	**50**
III Year	Pass Course I	Chem-304	Inorganic Chemistry-III	7.5	25.5	**33**
	Pass Course II	Chem-305	Organic Chemistry-III	7.5	25.5	**33**
	Pass Course-III	Chem-306	Physical Chemistry-III	7.5	26.5	**34**
	Honor's Course-I	Chem-310	Honors Chemistry-IV	10	40	50
	Honor's Course-I	Chem-311	Honors Chemistry-V	10	40	**50**
	Practical-Pass Course	Chem-312	Practical –I (Practical based on Chem-304, 305 & Chem-306)	-	50	**50**
	Practical-Honors Course	Chem-313	Practical-II (Practical based on Chem-307 & 308)	-	50	**50**

JIWAJI UNIVERSITY, GWALIOR

B.Sc. Honor's Chemistry : 2019-22

Class	**B.Sc. I Year**
Paper	**Chem 108 : Inorganic Chemistry-I**
Type of Paper	**Pass Course I**
Maximum Marks	**7.5 + 25.5 = 33**

Unit - I	**Atomic Structure & Elementary Quantum Mechanics:** **(A) Quantum Numbers Shapes of s, p, d, f orbitals**. Aufbau principle and Pauli exclusion principles, Hund's multiplicity rule. Electronic configurations of the elements, effective nuclear charge. Dual nature of Electron, Photo Electric Effect, Compton effect, Idea of the de-Broglie matter waves, Heisenberg Uncertainty principle, Bohr's Model of Hydrogen atom (no derivation) and its defects. **(B) Molecular orbital theory, basic ideas**: Criteria for forming M.O, construction M.O's by LCAO-$H2^+$ ion calculation of energy levels from wave functions, concept of σ, σ *, π, π* & n orbitals and their characteristics. Hybrid orbitals – (sp, sp^2, sp^3), calculation of co-efficient of A.O.'s used in these hybrid orbitals. Schrödinger wave equation, Significance of ψ and ψ2.
Unit – II	**Periodic Properties:** Atomic and ionic radii, ionization energy, electron affinity and electro negativity definition, methods of determination, trends in periodic table and applications in predicting and explaining the chemical behaviour. **Oxidation and Reduction:** Use of Redox Potential Data – Analysis of Redox Cycle, Redox Stability in Water, Frost, Latimer and Pourbiax diagram, Principle involved in extraction of two elements.
Unit – III	**Covalent Bond:** Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions. Valence Shell Electron Pair Repulsion (VSEPR) theory to NH_3, H_3O^+, SF_4, ClF_3, ICl_2 and H_2O. MO theory, homonuclear and heteronuclear (CO and NO) diatomic molecules, multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electro negativity difference. **Ionic Solids:** Ionic structures, radius ratio effect and coordination number, limitation of radius ratio rule, Lattice defects, Semiconductors, Lattice energy and Born-Haber cycle, Solvation energy and Solubility of Ionic solids, polarizing power and polarisability of ions, Fajan's rule. Metallic bond: free electron, valence bond and bond theories. **Weak Interactions –:** Hydrogen bonding, Vander Waals forces.

Unit – IV	**S – Block Elements:** Comparative Study, Diagonal Relationships, Salient Feature of Hydrides, Solvation and Complexation Tendencies including their functions in bio-system, biological role of s-block elements. **P- Block Elements:** Comparative Study (Including Diagonal Relationship) of group 13 to 17 elements, Compounds like Hydrides, Oxides, Oxyacids and Halides of group 13 to 16, Hydrides of Boron, Diboranes and Higher Boranes, Borazines, Fullarenes, Carbides, Fluorocarbons, Silicates (structural principle), Silicones and Phosphazenes, Tetrasulphur Tetranitrides, Basic Properties of Halogens, Interhalogens and Polyhalides. Biological role of p-block elements.
Unit – V	**Chemistry of Noble Gases:** Chemical Properties of Noble Gases, Chemistry of Xenon, Structure and Bonding of Xenon Compounds. **Acid and Bases:** Arrhenius, Bronsted and Lowry, Lux-Flood Solvent System and Lewis Concept of Acid and Bases, Pearson's Classification of Acid and Bases as Hard and Soft, Acid-Base strength and Hardness and Softness, Symbiosis, Theoretical bases of Hardness and Softness, Electronegativity and Hardness and Softness.

Suggested Books:

1. Gurdeep Raj, Inorganic Chemistry, Krishna Publications.
2. Malik Wahid, Inorganic Chemistry, S. Chand Publications.
3. Lee J.D, Concise Inorganic Chemistry, Blackwell Publications.
4. Madan R.D, Modern Inorganic Chemistry, S. Chand Publications.
5. Satya Prakash, Advanced Inorganic Chemistry, S. Chand Publication.
6. Huheey James, Inorganic Chemistry, Addison Wesley publication.

JIWAJI UNIVERSITY, GWALIOR

B.Sc. Honor's Chemistry : 2019-22

Class	**B.Sc. I Year**
Paper	**Chem 109 : Organic Chemistry-I**
Type of Paper	**Pass Course II**
Maximum Marks	**7.5 + 25.5 = 33**

Unit - I	**Basics of Organic Chemistry:** *Organic Compounds:* Classification, Hybridization, Shapes of molecules. **Electronic Displacements**: Inductive, electromeric, resonance mesomeric effects and hyperconjugation. Homolytic and Heterolytic fission with suitable examples. Electrophiles and Nucleophiles.
Unit – II	**Stereochemistry:** Fischer Projection and Newmann Projection formulae Geometrical isomerism: cis–trans and, syn-anti isomerism. **Optical Isomerism***: Criteria for* Optical Activity, Enantiomers and Distereoisomers, meso structures, Threo and Erythro isomers.
Unit – III	**Chemistry of Aliphatic Hydrocarbons** **Carbon-Carbon sigma bonds** **Chemistry of alkanes:** Formation of alkanes, Wurtz Reaction **Carbon-Carbon pi bonds:** Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. **Reactions of alkenes:** Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition) and Diels-Alder reaction. **Reactions of alkynes:** Electrophilic and Nucleophilic additions.
Unit – IV	**Cycloalkanes and Conformational Analysis:** Types of cycloalkanes and their relative stability, Conformation analysis of alkanes: Chair, Boat and Twist boat forms; Relative stability with the help of energy diagrams
Unit – V	**Aromatic Hydrocarbons** **Electrophilic aromatic substitution**: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism.

Suggested Books:

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling

Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
5. Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

JIWAJI UNIVERSITY, GWALIOR

B.Sc. Honor's Chemistry : 2019-22

Class	**B.Sc. I Year**
Paper	**Chem 110 : Physical Chemistry-I**
Type of Paper	**Pass Course III**
Maximum Marks	**7.5 + 26.5 = 34**

Unit - I	**Chemical Thermodynamics:** Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics. **First law:** Concept of heat, *q*, work, *w*, internal energy, *U*, and statement of first law; enthalpy, *H*, relation between heat capacities, calculations of *q*, *w*, *U* and *H* for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. **Second Law:** Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. **Third Law:** Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. **Thermochemistry:** Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.
Unit – II	**Chemical Kinetics:** Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction – concentration, temperature, pressure, solvent, light catalyst, concentration dependence of rates, mathematical characteristics of simple chemical reactions – zero order, first order, second order, pseudo order, half life and mean life, Determination of the order of reaction – differential method, method of integration, method of half life period and isolation method. **Radioactive decay as a first order phenomenon;** Experimental methods of chemical kinetics: conductometric, potentiometric, optical methods, polarimetry and spectrophotometer. Theories of chemical kinetics
Unit – III	**Gaseous States:** Postulates of kinetic theory of gases, deviation from ideal behavior, Vander Waals equation of state; **Critical Phenomena** : PV isotherms of real gases, continuity of states, the isotherms of vander Waals equation, relationship between critical constants and vander Waals constants, the law of corresponding states, reduced equation of state.

	Molecular velocities : Root mean square, average and most probable velocities, Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter, Liquification of gases (based on Joule – Thomson effect). **Liquid State:** Intermolecular forces, Qualitative treatment of the structure of liquid state, Structural differences between solids, liquids and gases
Unit – IV	**Solid States:** Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals.
Unit – V	**Colloidal States:** Definition of colloids, classification of colloids **Solids in liquids (sols):** properties – kinetic, optical and electrical; stability of colloids, protective action, Hardy-Schulze law, gold number. **Liquids in liquids (emulsions) :** types of emulsions, preparation, Emulsifier, **Liquids in solids (gels) :** classification, preparation and properties, inhibition, general application of colloids, colloidal electrolytes

Suggested Books:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press (2006).
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
5. Peter, A. & Paula, J. de. *Physical Chemistry 9th Ed.,* Oxford University Press (2011).
6. Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa (2004).
7. Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).
8. McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi (2004).
9. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S *Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).
10. Levine, I .N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill (2010).
11. Metz, C.R. *2000 solved problems in chemistry,* Schaum Series (2006).

JIWAJI UNIVERSITY, GWALIOR

B.Sc. Honor's Chemistry : 2019-22

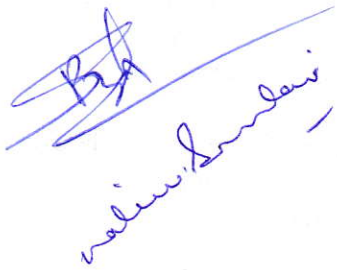
Class	**B.Sc. I Year**
Paper	**Chem 111 : Honors Chemistry-I**
Type of Paper	**Honors Course I**
Maximum Marks	**10 + 4-0 = 50**

Unit - I	**Statistical treatment of analytical data:** (a) Types of Errors-True, standard & observed value, absolute and relative errors, mean and relative mean deviation. Physical significance of standard deviation, confidence limits and probability, Accuracy and precision. Significant figures, Rejection of observation- Q test, confidence interval test of significance-t test, chi-square test and F test. (b) Sampling and sample handling- Concept of sampling, Representative sample, storage, Pre-treatment and its preparation.
Unit – II	**Methods of analysis:** **(a) Qualitative analysis**:- Basic concept of Inorganic analysis- Common ion effect, solubility product, ionic product, effect of pH and buffer in inorganic analysis. **(b) Quantitative analysis** (i) Volumetric analysis – Basic concept and its types, theories of indicator, Law of equivalence, standards and its type. (ii) Gravimetric analysis- Basic concept **(c) Instrumental method of analysis** (i) Conductivity- TDS meter- Principle, selection of standard solutions, calibration (ii) pH meter-Principle, selection of standards, calibration (iii) Potentiometer- Principle, selection of standards, calibration
Unit – III	**Atmospheric Chemistry:** (a) Evolution of Atmosphere, Major region of Atmosphere, composition of Atmosphere, Temperature inversion, Meteorology and Human activities, Surface temperature of Earth, Earth's Heat balances. (b) Photochemistry: Primary photochemical process, Radicals in Atmosphere ($OH^{\cdot}$) and ($HO_2^{\cdot}$). Ions in mesosphere and lower Thermosphere, Reactions of atmospheric Nitrogen, O_2, CO_2 and H_2O.
Unit – IV	**Pollution:** **Air Pollution:** Classification and control of air Pollutants **Water Pollution:** Classification of water pollutants: Hardness and Alkalinity, DO, BOD and COD **Soil Pollution:** Soil type, Trace metals, Organic matter in soil and micro nutrients in soil, pollution of soil, Agricultural pollution

Unit – V	**Biochemical Effect of Toxic Metals on Man:** Enzymes inhibited by Toxic metals, Effect of Mercury, Lead, Arsenic, Cadmium and Cobalt.

Suggested Books:

1. Singh Mahinder, Analytical Chemistry, Dominant Publication.
2. Chatwal G.R, Analytical Chromatography, Himalaya Publication.
3. Khandpur R.S, Handbook of Analytical Instruments, Tata McGraw Publication.
4. Verma R.M, Analytical Chemistry, CBS Publication.
5. Chatwal,G.R., Environmental Studies, Himalaya Publication
6. Sharma, B.K., Environment Chemistry, Krishna Prakashan
7. Dara, S.S, Environment Chemistry and Pollution Control, S. Chand Publication
8. Sawyer, Clair, Chemistry for Environmental Engineering, Tata McGraw Publication
9. Sindhu, P.S., Environmental Chemistry, New Age Publication



JIWAJI UNIVERSITY, GWALIOR

B.Sc. Honor's Chemistry : 2019-22

Class	**B.Sc. I Year**
Paper	**Chem 112 : Practical Based on Chem-108, 109 & Chem-110**
Type of Paper	**Practical-I : Pass Course**
Maximum Marks	**50**

Paper	Exercises
Inorganic Chemistry	**(A) Titrimetric Analysis** (i) Calibration and use of apparatus (ii) Preparation of solutions of different Molarity/Normality of titrants **(B) Acid-Base Titrations** (i) Estimation of carbonate and hydroxide present together in mixture. (ii) Estimation of carbonate and bicarbonate present together in a mixture. **(C) Oxidation-Reduction Titrimetry** (i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution. (iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic, acid) and external indicator.
Organic Chemistry	(A) Systematic identification of Organic Compounds, its M.P. & derivative preparation. (B) Standard operating procedure (SOP) for laboratory.
Physical Chemistry	**(A) Surface tension Measurements** (i) Determine the surface tension by (i) drop number (ii) drop weight method. (ii) Study the variation of surface tension of detergent solutions with concentration. **(B) pH metry** (i) Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures. (ii) Preparation of Buffer solutions of different pH (a) Sodium acetate-acetic acid (b) Ammonium chloride-ammonium hydroxide (iii) pH metric titration of (a) strong acid vs. strong base (b) weak acid vs. strong base (iv) Determination of dissociation constant of a weak acid.

Suggested Books:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009).
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012).
4. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
5. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
6. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003)..

JIWAJI UNIVERSITY, GWALIOR

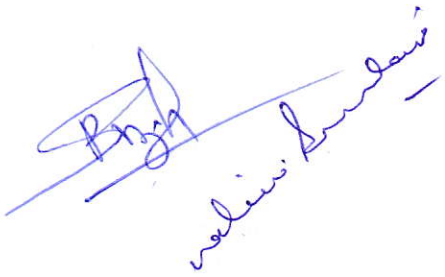
B.Sc. Honor's Chemistry : 2019-22

Class	**B.Sc. I Year**
Paper	**Chem 113 : Practical Based on Chem-111**
Type of Paper	**Practical-II : Honors Course**
Maximum Marks	**50**

Paper	Exercises
Honors Course	**(A) Weighing techniques** I. Preparation of standard solutions II. Calibration of Glassware's III. Calibration of thermometer's **(B) Volumetric techniques** I. Acid-base titration II. Redox titration III. Precipitation titration IV. Complex metric titration **(C) Separation techniques** I. TLC Chromatography **(D) Analysis of Water/Soil** I. Sampling techniques II. pH III. Conductivity IV. TDS, turbidity V. Acidity & Alkalinity **(E) Analysis of Water** I. Hardness II. BOD III. COD IV. DO V. Chlorine **(F) Analysis of Soil** I. Phosphate II. Ammonia Content III. Spot Test in Water/Soil sample IV. Green Chemistry, Eco-friendly techniques

Suggested Books:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.
2. Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.
7. Mikes, O. & Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London



JIWAJI UNIVERSITY, GWALIOR

B.Sc. Honor's Chemistry : 2019-22

Class	**B.Sc. II Year**
Paper	**Chem 204 : Inorganic Chemistry-II**
Type of Paper	**Pass Course I**
Maximum Marks	**7.5 + 25.5 = 33**

Unit - I	**General Principles of Metallurgy** Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining. **Lanthanoids and Actinoids:** Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).
Unit – II	Werner's theory and its experimental verification, Effective atomic number concept, IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes.
Unit – III	Valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt). Octahedral vs. tetrahedral coordination. Square planar complexes. Qualitative aspect of Ligand field and MO Theory.
Unit – IV	**Transition Elements:** General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Bsworth diagrams). Difference between the first, second and third transition series. Chemistry of Mn, Fe and Co in various oxidation states (excluding their metallurgy).
Unit – V	**Bioinorganic Chemistry:** Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine. Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.

Suggested Books:

1. Purcell, K.F & Kotz, J.C. Inorganic Chemistry W.B. Saunders Co, 1977.
2. Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
3. Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry Panima Publishing Company 1994.
4. Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry. Wiley-VCH, 1999
5. Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
6. Greenwood, N.N. & Earnshaw A., Chemistry of the Elements, Butterworth-Heinemann,1997.

JIWAJI UNIVERSITY, GWALIOR

B.Sc. Honor's Chemistry : 2019-22

Class	**B.Sc. II Year**
Paper	**Chem 205 : Organic Chemistry-II**
Type of Paper	**Pass Course II**
Maximum Marks	**7.5 + 25.5 = 33**

Unit - I	**Chemistry of Halogenated Hydrocarbons:** **Alkyl halides:** Methods of preparation, nucleophilic substitution reactions – SN1, SN2 and SNi mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination. **Aryl halides:** Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; SNAr, Benzyne mechanism. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.
Unit – II	**Alcohols, Phenols, Ethers and Epoxides:** **Alcohols:** preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Preparation and properties of glycols: Pinacol-Pinacolone rearrangement; **Phenols:** Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Claisen rearrangements with mechanism. **Ethers and Epoxides:** Preparation and important reactions with acids. **Sulphur containing compounds:** Preparation and important reactions of thiols, thioethers and sulphonic acids.
Unit – III	**Carbonyl Compounds:** Structure, reactivity and preparation; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Perkin, Cannizzaro and Wittig reaction, haloform reaction. Addition reactions of unsaturated carbonyl compounds: Michael addition. Active methylene compounds: Keto-enol tautomerism. Preparation and important synthetic applications of diethyl malonate. **Carboxylic Acids and their Derivatives:** Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids. Preparation and reactions of acid chlorides, anhydrides, esters and amides; Hofmannbromamide degradation and Curtius rearrangement.

Unit – IV	**Nitrogen Containing Functional Groups** Preparation and important reactions of nitro compounds, Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines. Diazonium Salts: Preparation and their synthetic applications. **Polynuclear Hydrocarbons** Reactions and important properties of naphthalene phenanthrene and anthracene.
Unit – V	**Alkaloids** Natural occurrence, General structural features, Isolation and their physiological action Hoffmann's exhaustive methylation, Structure elucidation and synthesis Nicotine. Medicinal importance of Nicotine, Quinine, Morphine, Cocaine, and Reserpine. **Terpenes** Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral, and α-terpineol.

Suggested Books:

1. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry of Natural Products*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds,* John Welly & Sons (1976).
5. Graham Solomons, T.W. *Organic Chemistry,* John Wiley & Sons, Inc.
6. Kalsi, P. S. *Textbook of Organic Chemistry 1st Ed.*, New Age International (P) Ltd. Pub.
7. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry,* Oxford University Press.
8. Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Parakashan (2010).
9. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
10. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
11. Graham Solomons, T.W. *Organic Chemistry,* John Wiley & Sons, Inc.

JIWAJI UNIVERSITY, GWALIOR

B.Sc. Honor's Chemistry : 2019-22

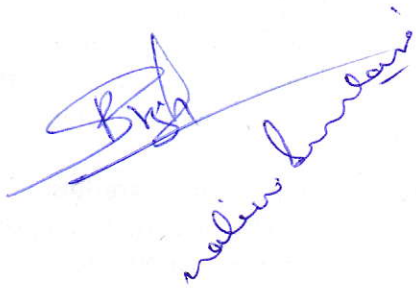
Class	**B.Sc. II Year**
Paper	**Chem 206 : Physical Chemistry-II**
Type of Paper	**Pass Course III**
Maximum Marks	**7.5 + 25.5 = 33**

Unit - I	**Phase Equilibria:** Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius- Clapeyron equation and its applications to solid liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. Three component systems, water-chloroform-acetic acid system, triangular plots. **Binary solutions:** Gibbs- Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.
Unit – II	**Catalysis:** Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.
Unit – III	**Surface chemistry:** Physical adsorption, Chemisorption, adsorption isotherms. nature of adsorbed state.
Unit – IV	**Conductance** Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye- Hückel-Onsager equation, Wien effect, Debye- Falkenhagen effect, Walden's rules. Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.
Unit – V	**Electrochemistry** Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry.

	Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb_2O_3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).

Suggested Books:

1. Peter Atkins & Julio De Paula, *Physical Chemistry 9th Ed.,* Oxford University Press (2010).
2. Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa (2004).
3. McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books Pvt. Ltd.: New Delhi (2004).
4. Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).
5. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).
6. Zundhal, S.S. *Chemistry concepts and applications* Cengage India (2011).
7. Ball, D. W. *Physical Chemistry* Cengage India (2012).
8. Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP (2009).
9. Levine, I. N. *Physical Chemistry 6th Ed.,* Tata McGraw-Hill (2011).
10. Metz, C. R. *Physical Chemistry 2nd Ed.,* Tata McGraw-Hill (2009).
11. Barrow, G. M., *Physical Chemistry 5th Ed.,* Tata McGraw Hill: New Delhi (2006).
12. Rogers, D. W. *Concise Physical Chemistry* Wiley (2010).
13. Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. *Physical Chemistry 4th Ed.,* John Wiley & Sons, Inc. (2005).



JIWAJI UNIVERSITY, GWALIOR

B.Sc. Honor's Chemistry : 2019-22

Class	**B.Sc. II Year**
Paper	**Chem 210 : Novel Inorganic Solids**
Type of Paper	**Honors Course II**
Maximum Marks	**10 + 40 = 50**

Unit - I	**Synthesis and modification of inorganic solids:** Conventional heat and beat methods, Co-precipitation method, Sol-gel methods, Hydrothermal method, Ion-exchange and Intercalation methods. **Inorganic solids of technological importance:** Solid electrolytes – Cationic, anionic, mixed Inorganic pigments – coloured solids, white and black pigments. Molecular material and fullerides, molecular materials & chemistry – one-dimensional metals, molecular magnets, inorganic liquid crystals.
Unit – II	**Nanomaterials:** Overview of nanostructures and nanomaterials: classification. Preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires. Bio-inorganic nanomaterials, DNA and nanomaterials, natural and antisical nanomaterials, bionano composites.
Unit – III	**Introduction to engineering materials for mechanical construction:** Composition, mechanical and fabricating characteristics and applications of various types of cast irons, plain carbon and alloy steels, copper, aluminum and their alloys like duralumin, brasses and bronzes cutting tool materials, super alloys thermoplastics, thermosets and composite materials.
Unit – IV	**Composite materials:** Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, environmental effects on composites, applications of composites.
Unit – V	**Speciality polymers:** Conducting polymers - Introduction, conduction mechanism, polyacetylene, polyparaphenylene and polypyrole, applications of conducting polymers, Ion-exchange resins and their applications. Ceramic & Refractory: Introduction, classification, properties, raw materials, manufacturing and applications

Suggested Books:

1. Shriver & Atkins. Inorganic Chemistry, Peter Alkins, Tina Overton, Jonathan Rourke, Mark Weller and Fraser Armstrong, 5th Edition, Oxford University Press (2011-2012)
2. Adam, D.M. Inorganic Solids: An introduction to concepts in solid-state structural chemistry.
3. Frank J. Ovens, Introduction to Nanotechnology

JIWAJI UNIVERSITY, GWALIOR

B.Sc. Honor's Chemistry : 2019-22

Class	**B.Sc. II Year**
Paper	**Chem 211 : Molecular Modeling and Drug Design**
Type of Paper	**Honors Course III**
Maximum Marks	**10 + 40 = 50**

Unit - I	**Introduction to Molecular Modelling:** Introduction. Useful Concepts in Molecular Modelling: Coordinate Systems. Potential Energy Surfaces. Molecular Graphics. Surfaces. Computer Hardware and Software. The Molecular Modelling Literature.
Unit – II	**Force Fields:** Fields. Bond Stretching. Angle Bending. Introduction to nonbonded interactions. Electrostatic interactions. van der Waals Interactions. Hydrogen bonding in Molecular Mechanics. Force Field Models for the Simulation of Liquid Water.
Unit – III	**Energy Minimization and Computer Simulation:** Minimization and related methods for exploring the energy surface. Non-derivative method, First and second order minimization methods. Computer simulation methods. Simple thermodynamic properties and Phase Space. Boundaries. Analyzing the results of a simulation and estimating Errors.
Unit – IV	**Molecular Dynamics & Monte Carlo Simulation:** Molecular Dynamics Simulation Methods. Molecular Dynamics using simple models. Molecular Dynamics with continuous potentials. Molecular Dynamics at constant temperature and pressure. Metropolis method. Monte Carlo simulation of molecules. Models used in Monte Carlo simulations of polymers.
Unit – V	**Structure Prediction and Drug Design:** Structure prediction - Introduction to comparative Modeling. Sequence alignment. Constructing and evaluating a comparative model. Predicting protein structures by 'Threading', Molecular docking. Structure based de novo ligand design, Drug Discovery – Chemoinformatics – QSAR.

Suggested Books:

1. A.R. Leach, Molecular Modelling Principles and Application, Longman, 2001.
2. J.M. Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
3. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

JIWAJI UNIVERSITY, GWALIOR

B.Sc. Honor's Chemistry : 2019-22

Class	**B.Sc. II Year**
Paper	**Chem 209 : Practical Based on Chem 204, Chem 205 & Chem 206**
Type of Paper	**Practical-I**
Maximum Marks	**7.5 + 25.5 = 33**

Paper	Exercises
Inorganic Chemistry	**(A) Iodo / Iodimetric Titrations** (i) Estimation of Cu (II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically). (ii) Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically (iii) Estimation of available chlorine in bleaching powder iodometrically. **(B) Inorganic Preparations** (i) Cuprous Chloride, Cu_2Cl_2 (ii) Preparation of Manganese (III) phosphate, $MnPO_4.H_2O$ (iii) Preparation of Aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum.
Organic Chemistry	1. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group. **2. Organic preparations:** (i) Acetylation of one of the following compounds: amines (aniline, *o*-, *m*-, *p*- toluidines and *o*-, *m*-, *p*-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method: a. Using conventional method. b. Using green approach (iii). Bromination of any one of the following: a. Acetanilide by conventional methods b. Acetanilide using green approach (Bromate-bromide method) (iv). Nitration of any one of the following: a. Acetanilide/nitrobenzene by conventional method b. Salicylic acid by green approach (using ceric ammonium nitrate).
Physical Chemistry	I. Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it. II. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method: a. simple eutectic and

	b. congruently melting systems. III. Distribution of acetic/ benzoic acid between water and cyclohexane. IV. Study the equilibrium of at least one of the following reactions by the distribution method: (i) $I_2(aq) + I^- \rightarrow I_3^-(aq)2+$ (ii) $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)n$ V. Study the kinetics of the following reactions. 1. Initial rate method: Iodide-persulphate reaction 2. Integrated rate method: a. Acid hydrolysis of methyl acetate with hydrochloric acid. b. Saponification of ethyl acetate. 3. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate. VI. Adsorption I. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Suggested Books:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS. 1978
2. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R.Chand & Co.:New Delhi (2011).
3. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.*;McGraw-Hill: New York (2003).
4. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

JIWAJI UNIVERSITY, GWALIOR

B.Sc. Honor's Chemistry : 2019-22

Class	**B.Sc. II Year**
Paper	**Chem 210 : Practical Based on Chem 210 Chem 211**
Type of Paper	**Practical-II**
Maximum Marks	**10 + 40 =50**

Paper	Exercises
Novel Inorganic Solids	1. Determination of cation exchange method 2. Determination of total difference of solids. 3. Synthesis of hydrogel by co-precipitation method. 4. Synthesis of silver and gold metal nanoparticles.
Molecular modeling and Drug Design	-Compare the optimized C-C bond lengths in ethane, ethene, ethyne and benzene. Visualize the molecular orbitals of the ethane σ bonds and ethene, ethyne, benzene and pyridine π bonds. -Perform a conformational analysis of butane. (b) Determine the enthalpy of isomerization of *cis* and *trans* 2-butene. -Visualize the electron density and electrostatic potential maps for LiH, HF, N2, NO and CO and comment. Relate to the dipole moments. Animate the vibrations of these molecules. - (a) Relate the charge on the hydrogen atom in hydrogen halides with their acid character. (b) Compare the basicities of the nitrogen atoms in ammonia, methylamine, dimethylamine and trimethylamine. - Compare the shapes of the molecules: 1-butanol, 2-butanol, 2-methyl-1-propanol, and 2-methyl-2-propanol. Note the dipole moment of each molecule. (b) Show how the shapes affect the trend in boiling points: (118 ºC, 100 ºC, 108 ºC, 82 ºC, respectively). -Build and minimize organic compounds of your choice containing the following functional groups. Note the dipole moment of each compound: (a) alkyl halide (b) aldehyde (c) ketone (d) amine (e) ether (f) nitrile (g) thiol (h) carboxylic acid (i) ester (j) amide. -Determine the heat of hydration of ethylene. (b) Compute the resonance energy of benzene by comparison of its enthalpy of hydrogenation with that of cyclohexene. viii. Arrange 1-hexene, 2-methyl-2-pentene, (*E*)-3-methyl-2-pentene, (*Z*)-3-methyl-2-pentene, and 2,3-dimethyl-2-butene in order of increasing stability.

	-(a) Compare the optimized bond angles H_2O, H_2S, H_2Se. (b) Compare the HAH bond angles for the second row dihydrides and compare with the results from qualitative MO theory. *Note:* Software: ChemSketch, ArgusLab (www.planaria-software.com), TINKER 6.2 (dasher.wustl.edu/ffe), WebLab Viewer, Hyperchem, or any similar software.

Suggested Books:

1. Fahan, *Materials Chemistry,* Springer (2004).
2. A.R. Leach, Molecular Modelling Principles and Application, Longman, 2001.
3. J.M. Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
4. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

JIWAJI UNIVERSITY, GWALIOR

B.Sc. Honor's Chemistry : 2019-22

Class	**B.Sc. III Year**
Paper	**Chem 304 : Inorganic Chemistry-III**
Type of Paper	**Pass Course I**
Maximum Marks	**7.5 + 25.5 = 33**

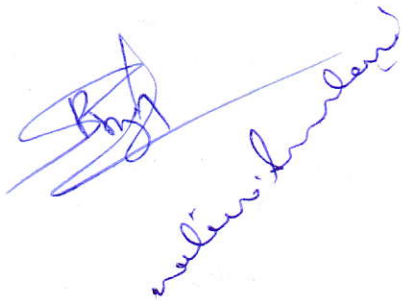
Unit - I	Basic principles involved in analysis of cations and anions and solubility products, common ion effect. Principles involved in separation of cations into groups and choice of group reagents. Interfering anions (fluoride, borate, oxalate and phosphate) and need to remove them after Group II.
Unit – II	Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls. Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium.
Unit – III	Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene. Bis benzene chromium: Preparation and reactions (Nucleophilic substitution/addition reactions, arene replacement reactions).
Unit – IV	Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes.
Unit – V	**Magnetic Properties of Transition metal Complexes:** Types of Magnetic Behaviour, Methods of Determining magnetic Susceptibility, Spin only formula, L-S Coupling, Correlation of μ_s and μ_{exp} values, Orbital contribution to magnetic Moments, Application of Magnetic Moment data for 3d Metal Complexes.

Suggested Books:

Vogel, A.I. *Qualitative Inorganic Analysis*, Longman, 1972.

2. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, 7th Edition, Prentice Hall, 1996-03-07.
3. Cotton, F.A. G.; Wilkinson & Gaus, P.L. *Basic Inorganic Chemistry 3rd Ed.;*Wiley India,
4. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed.*, Harper Collins 1993, Pearson,2006.
5. Sharpe, A.G. *Inorganic Chemistry*, 4th Indian Reprint (Pearson Education) 2005.

6. Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry3rd Ed.,* John Wiley and Sons, NY, 1994.
7. Greenwood, N.N. & Earnshaw, A. *Chemistry of the Elements*, *Elsevier 2nd Ed*, 1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
8. Lee, J.D. *Concise Inorganic Chemistry 5th Ed.,* John Wiley and sons 2008.
9. Powell, P. *Principles of Organometallic Chemistry*, Chapman and Hall, 1988.
10. Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.,* Oxford University Press, 1994.
11. Basolo, F. & Person, R. *Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution 2nd Ed.,* John Wiley & Sons Inc; NY.
12. Purcell, K.F. & Kotz, J.C., *Inorganic Chemistry*, W.B. Saunders Co. 1977
13. Miessler, G. L. & Donald, A. Tarr, *Inorganic Chemistry 4th Ed.,* Pearson, 2010.
14. Collman, James P. et al. *Principles and Applications of Organotransition Metal Chemistry*. Mill Valley, CA: University Science Books, 1987.
15. Crabtree, Robert H. *The Organometallic Chemistry of the Transition Metals*. New York, NY: John Wiley, 2000.
16. Spessard, Gary O., &Gary L. Miessler. *Organometallic Chemistry*. Upper Saddle River, NJ: Prentice-Hall, 1996.



JIWAJI UNIVERSITY, GWALIOR

B.Sc. Honor's Chemistry : 2019-22

Class	**B.Sc. III Year**
Paper	**Chem 305 : Organic Chemistry-III**
Type of Paper	**Pass Course II**
Maximum Marks	**7.5 + 25.5 = 33**

Unit - I	**Nucleic Acids:** Components of nucleic acids, Nucleosides and nucleotides; Structure, synthesis and important reactions of: Adenine, Guanine and Cytosine. **Amino Acids, Peptides and Proteins:** Amino acids, Peptides and their classification. α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, p*K*a values, isoelectric point and electrophoresis;
Unit – II	**Enzymes:** Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action, factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance. **Lipids:** Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenntion of fats and oils, Saponification value, acid value, iodine number.
Unit – III	**Pharmaceutical Compounds: Structure and Importance:** Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An elementary treatment of Antibiotics, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).
Unit – IV	**Organic Spectroscopy:** General principles Introduction to absorption and emission spectroscopy. **UV Spectroscopy:** Types of electronic transitions, λmax, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λmax in conjugated dienes. **IR Spectroscopy:** Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis. **NMR Spectroscopy:** Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin – Spin coupling and coupling constant. Applications of IR, UV and NMR for identification of simple organic molecules.

Unit – V	**Carbohydrates:** Occurrence, classification and their biological importance. **Monosaccharides:** Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Interconversions of aldoses and ketoses; Killiani- Fischer synthesis. Disaccharides – Structure elucidation of lactose and sucrose. Polysaccharides – Elementary treatment of starch and cellulose. **Dyes:** Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing; Synthesis and applications of: Azo dyes – Methyl Orange and Congo Red (mechanism of Diazo Coupling); Triphenyl Methane Dyes -Malachite Green, Crystal Violet; Phthalein Dyes – Phenolphthalein and Fluorescein; Natural dyes –structure elucidation and synthesis of Alizarin.

Suggested Books:

1. Kalsi, P. S. *Textbook of Organic Chemistry 1st Ed.*, New Age International (P) Ltd. Pub.
2. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Billmeyer, F. W. *Textbook of Polymer Science*, John Wiley & Sons, Inc.
4. Gowariker, V. R.; Viswanathan, N. V. & Sreedhar, J. *Polymer Science*, New Age International (P) Ltd. Pub.
5. Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry of Natural Products*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Graham Solomons, T.W. *Organic Chemistry,* John Wiley & Sons, Inc.
7. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry,* Oxford University Press.
8. Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Prakashan (2010).
9. Kemp, W. *Organic Spectroscopy*, Palgrave.
10. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VIth Edition. W.H. Freeman and Co.
11. Nelson, D.L., Cox, M.M. and Lehninger, A.L. (2009) Principles of Biochemistry. IV Edition. W.H. Freeman and Co.
12. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009) Harper's Illustrated Biochemistry. XXVIII edition. Lange Medical Books/ McGraw-Hill.

JIWAJI UNIVERSITY, GWALIOR

B.Sc. Honor's Chemistry : 2019-22

Class	**B.Sc. III Year**
Paper	**Chem 306 : Physical Chemistry-III**
Type of Paper	**Pass Course III**
Maximum Marks	**7.5 + 25.5 = 33**

Unit - I	**Quantum Chemistry** Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wave functions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy. Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wave functions. Vibrational energy of diatomic molecules and zero-point energy. Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component. Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution.
Unit – II	**Chemical bonding:** Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2. Comparison of LCAO-MO and VB treatments of H_2 (only wave functions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic (BeH_2, H_2O) molecules. Qualitative MO theory and its application to AH_2 type molecules.
Unit – III	**Photochemistry:** Introduction of radiation with matter, difference between thermal and photochemical process, Laws of photochemistry: Grothus- Drapper Law, Stark – Einstein Law, Jablonski diagram depicting various process occuring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative process (internal conversion, intersystem crossing) quantum yield, photosensitized reaction, energy transfer process (Simple examples).
Unit – IV	**Spectroscopy:** Introduction, electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born Oppenheimer approximation, degrees of freedom.

	Rotational spectrum: Diatomic molecules, Energy levels of a rigid rotor (semi classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell Bottzmann distribution) 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 η M.O., their energy levels and the respective transitions.
Unit – V	**Solution, Dilute Solution and Colligative Properties** Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity co-efficient, Dilute solutions, colligative properties, Raoult's Law, relative lowering of vapour pressure, molecular weight determination. Osmosis, Law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure. Elevation of boiling point and depression of freezing point Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point, Experimental methods for determining various colligative properties Abnormal molar mass, degree of dissociation and association of solutes.

Suggested Books:

1. Singh N.B., *Physical Chemistry*, Dominant Publication
2. Laidler Keith J., *Chemical Kinetics*, Pearson Education Publication
3. Berry R.Stephan, *Physical Chemistry*, Oxford Press Publication
4. Yadav J.B., *Physical Chemistry*, Goel Publication
5. Raj Gurdeep, *Advanced Physical Chemistry*, Krishna Prakashan
6. Laidler J. Keith, *Physical Chemistry*, CBS publication
7. Castellan Gilbert W., *Physical Chemistry*, Narosa publication
8. Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006).
9. Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
10. House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004).
11. Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).
12. Kakkar, R. Atomic & Molecular Spectroscopy, Cambridge University Press (2015).

JIWAJI UNIVERSITY, GWALIOR

B.Sc. Honor's Chemistry : 2019-22

Class	**B.Sc. III Year**
Paper	**Chem 310 : Honors Chemistry-I (Analytical Methods in Chemistry)**
Type of Paper	**Honors Course I**
Maximum Marks	**10 + 40 = 50**

Unit - I	**Qualitative and quantitative aspects of analysis:** Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.
Unit – II	**Optical methods of analysis:** Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method. Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Structural illustration through interpretation of data, Effect and importance of isotope substitution. Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.
Unit – III	**Thermal methods of analysis:** Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.
Unit – IV	**Electroanalytical methods:** Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

Unit – V	**Separation techniques:** Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC. Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC). Role of computers in instrumental methods of analysis.

Suggested Books:

1. Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed. The English Language Book Society of Longman .
2. Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.
7. Mikes, O. & Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London.
8. Ditts, R.V. Analytical Chemistry – Methods of separation.

JIWAJI UNIVERSITY, GWALIOR

B.Sc. Honor's Chemistry : 2019-22

Class	**B.Sc. III Year**
Paper	**Chem 311 : Green Chemistry**
Type of Paper	**Honors Course II**
Maximum Marks	**10 + 40 = 50**

Unit - I	**Introduction to Green Chemistry** What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.
Unit – II	**Principles of Green Chemistry and Designing a Chemical synthesis** Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/ minimization of hazardous/ toxic products; designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups; use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products; prevention of chemical accidents; strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.
Unit – III	**Examples of Green Synthesis/ Reactions** 1. Green Synthesis of the following compounds: adipic acid, catechol, BHT, ethyl methacrylate, urethane, aromatic amines (4-aminodiphenylamine), benzyl bromide, acetaldehyde, disodium iminodiacetate (alternative to Strecker synthesis), citral, buprofen, paracetamol, furfural. 2. Microwave assisted reactions in water: Hofmann Elimination, Hydrolysis (of benzyl chloride, benzamide, n-phenyl benzamide, methylbenzoate to benzole acid), Oxidation (of toluene, alcohols). Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Orthoester Claisen Rearrangement, Diels-Alder Reaction, Decarboxylation. Microwave assisted solid state reactions: acetylation, Deprotection. Saponification of esters, Alkylation of reactive methylene compounds, reductions, synthesis of nitriles from aldehydes; anhydrides from dicarboxylic acid; pyrimidine and pyridine derivatives; 1,2- dihydrotriazine derivatives; benzimidazoles.
Unit – IV	Ultrasound assisted reactions: Esterification, saponification, substitution reactions, Alkylations, oxidation, reduction, coupling reaction, Cannizaro reaction, Strecker synthesis, Reformatsky reaction.

	Selective methylation of active methylene group using dimethylcarbonate: Solid-state polymerization of amorphous polymers using diphenylcarbonate; Use of "Clayan", a nonmetallic oxidative reagent for various reactions; Free Radical Bromination; Role of Tellurium in organic syntheses; Biocatalysis in organic syntheses.
Unit – V	**Future Trends in Green Chemistry** Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; on covalent derivatization; Green chemistry in sustainable development.

Suggested Books:

1. V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry,Anamalaya Publishers (2005).
3. P.T. Anastas & J.K. Warner: Oxford Green Chemistry- Theory and Practical, University Press (1998).
4. A.S. Matlack: Introduction to Green Chemistry, Marcel Dekker (2001).
5. M.C. Cann & M.E. Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
6. M.A. Ryan & M. Tinnes and, Introduction to Green Chemistry, American Chemical Society, Washington (2002).

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B.Sc. Honor's Chemistry : 2019-22

Class	**B.Sc. III Year**
Paper	**Chem 309 : (Practical Based on Chem-304, 305 & Chem- 306)**
Type of Paper	**Practical-III : Pass Course**
Maximum Marks	**50**

Paper	Exercises
Inorganic Chemistry	1. Estimation of total hardness of water. 2. Estimation of phosphate and sulphate by complexation titration. 3. Estimation of chloride by Mohr's method. 4. Estimation of halide by volhard's method. 5. Estimation of Barium gravimetrically. 6. Estimation of Magnesium gravimetrically. 7. Estimation of Al (III) by precipitating with oxine and weighing as Al $(Oxine)_3$ (aluminium oxinate)
Organic Chemistry	1. Extraction of caffeine from tea leaves. 2. Saponification value of an oil or a fat. 3. Determination of Iodine number of an oil/ fat. 4. Analysis of Carbohydrate by simple method. 5. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided). 6. Preparation of methyl orange
Physical Chemistry	**UV/Visible spectroscopy** I. Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M H_2SO_4) and determine the λmax values. Calculate the energies of the two transitions in different units (J molecule-1, kJ mol-1, cm-1, eV). II. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $K_2Cr_2O_7$. III. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds. **Colorimetry** I. Verify Lambert-Beer's law and determine the concentration of CuSO4/KMnO4/K2Cr2O7 in a solution of unknown concentration II. Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture. III. Study the kinetics of iodination of propanone in acidic medium. IV. Determine the amount of iron present in a sample using 1,10-phenathroline. V. Determine the dissociation constant of an indicator (phenolphthalein). VI. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide. VII. Analysis of the given vibration-rotation spectrum of HCl(g)

Suggested Books:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS. 1978
2. Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry,* R.Chand & Co.: New Delhi (2011).
3. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).
4. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H.Freeman & Co.: New York (2003).

JIWAJI UNIVERSITY, GWALIOR

B.Sc. Honor's Chemistry : 2019-22

Class	**B.Sc. III Year**
Paper	**Chem 310 : Practical Based on Chem-310 & 311**
Type of Paper	**Practical-II : Honors Course**
Maximum Marks	**50**

Paper	Exercises
Analytical Methods in Chemistry	**I. Separation Techniques** **1. Chromatography:** (a) Separation of mixtures (i) Paper chromatographic separation of Fe^{3+} Al^{3+} and Cr^{3+} (ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values. (b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify Them on the basis of their R_f values. (c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC **II. Solvent Extractions:** (i) To separate a mixture of Ni^{2+}, & Fe^{2+} by complex cation with DMG and extracting the Ni^{2+} - DMG complex in chloroform, and determine its concentration by spectrophotometry. (ii) Solvent extraction of zisconium with amberliti LA-1, separation from a mixture of Irons and gallium. 3. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps. 4. Determination of Na, Ca, Li in cola drinks and fruit juices using fame photometric techniques. 5. Analysis of soil: (i) Determination of pH of soil. (ii) Total soluble salt (iii) Estimation of calcium, magnesium, phosphate, nitrate **6. Ion exchange:** (i) Determination of exchange capacity of cation exchange resins and anion exchange resins. (ii) Separation of metal ions from their binary mixture. (iii) Separation of amino acids from organic acids by ion exchange chromatography.
Green Chemistry	**1. Safer starting materials** The Vitamin C clock reaction using Vitamin C tablets, tincture of iodine, hydrogen peroxide and liquid laundry starch. ➢ Effect of concentration on clock reaction ➢ Effect of temperature on clock reaction. (if possible) ➢

	2. Using renewable resources Preparation of biodiesel from vegetable oil. **3. Avoiding waste** Principle of atom economy. Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry. Preparation of propene by two methods can be studied **(I)** Triethylamine ion + OH- → propene + trimethylpropene + water **(II)** 1-propanol $\xrightarrow{H_2SO_4/\Delta}$ propene + water The other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy. **4. Use of enzymes as catalysts** Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide Alternative Green solvents **5. Diels Alder reaction in water** Reaction between furan and maleic acid in water and at room temperature rather than in benzene and reflux. 6. Extraction of D-limonene from orange peel using liquid CO_2 prepared form dry ice. 7. Mechanochemical solvent free synthesis of azomethines. 8. Co-crystal controlled solid state synthesis (C2S3) of N-organophthalimide using Phthalic anhydride and 3-aminobenzoic acid. **Alternative sources of energy** 9. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of Copper (II). 10. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Suggested Books:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.
2. Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.
7. Mikes, O. & Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London
8. Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice,* Oxford University Press (1998).
9. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC (2002).
10. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
11. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi*. Bangalore CISBN 978-93-81141-55-7 (2013).
12. Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society (2008).
13. Pavia, D. L. Lamponan, G. H. & Kriz, G.S. *W B Introduction to organic laboratory*