Hindi Vidya Prachar Samiti's

Ramniranjan Jhunjhunwala College

of Arts, Science & Commerce

(Autonomous College)

Affiliated to

UNIVERSITY OF MUMBAI

Syllabus for the T.Y.B.Sc.

Program: B.Sc (Chemistry)

Program Code: RJSUCHE

CBCS : 2018 -2019

T.Y.B.Sc CHEMISTRY SEMESTER V

Course	Nomenclature	Credits	Topics
RJSUCHE501	**Paper I** (Physical Chemistry)	2.5	1. Molecular spectroscopy 2. Chemical thermodynamics, Chemical kinetics 3. Nucler Chemistry 4. Surface Chemistry 5. Colloidal state
RJSUCHE502	**Paper II** (Inorganic Chemistry)	2.5	1. Chemical Bonding 2. Solid State Chemistry 3. Chemistry of elements (Inner transition elements) 4. Some selected topics Chemistry in Non-aqueous Solvents. Chemistry of Interhalogen. Chemistry of Pseudohalogens. Chemistry of Xenon
RJSUCHE503	**Paper III** (Organic Chemistry)	2.5	1. Mechanism of organic reactions. Photochemistry. 2. Stereochemistry I Agrochemicals. Heterocyclic chemistry. 3. IUPAC Organic Synthesis. 4. Spectroscopy I Natural Products
RJSUCHE504	**Paper IV** (Analytical Chemistry)	2.5	1. Introduction to quality concepts, chemical calculations and sampling. 2. Classical methods of analysis (titrimetry). 3. Optical methods 4. Methods of separation – I
RJSUCHEAC505	**Paper V** (Applied Component – Drugs & Dyes)	2.5	1. General Introduction to Drugs. Routes of Drug Administration and Dosage Forms. Pharmacodynamic agents 2. Analgesics, Antipyretics and Anti-inflammatory, Antihistaminic, Cardiovascular, Antidiabetic, Antiparkinsonism Drugs, Drugs for Respiratory System. 3. Introduction to the dye-stuff Industry. Substrates for Dyes : Types of fibres. Classification of dyes based on applications and dyeing methods. 4. Colour and Chemical Constitution of Dyes. Unit process and Dye Intermediates.
RJSUCHEPR501 RJSUCHEPR502 RJSUCHEPR503 RJSUCHEPR504 RJSUCHEACPR505	Paper I Paper II Paper III Paper IV Paper V	6	Physical Chemistry Inorganic Chemistry Organic Chemistry Analytical Chemistry Applied Component

T.Y.B.Sc CHEMISTRY SEMESTER VI

Course	Nomenclature	Credits	Topics
RJSUCHE601	**Paper I** (Physical Chemistry)	2.5	**1.** NMR-Nuclear Magnetic Resonance Spectroscopy. Electron Spin Resonance Spectroscopy. **2.** Basics of Quantum Chemistry. Renewable Energy Resources. **3.** Electrochemistry **4.** Polymers
RJSUCHE602	**Paper II** (Inorganic Chemistry)	2.5	1. Co-ordination Chemistry: 2. Properties of Coordination compounds. 3. Organometallic Chemistry & catalysis. 4. Nanomaterials.
RJSUCHE603	**Paper III** (Organic Chemistry)	2.5	1. Stereochemistry II. Amino acids & Proteins. 2. Molecular Rearrangement Carbohydrates 3. Spectroscopy II Nucleic Acids. 4. Polymer Catalysts and Reagents
RJSUCHE604	**Paper IV** (Analytical Chemistry)	2.5	1. Electro analytical techniques Polarography Amperometric Titrations 2. Methods of separation – II Gas Chromatography. Ion Exchange Chromatography 3. Food and cosmetics analysis 4. Thermal methods and analytical method validation
RJSUCHEAC605	**Paper V** (Applied Component – Drugs & Dyes)	2.5	1**.** Drug Discovery, Design and Development. Drug Metabolism,Chemotherapeutic Agents: Antibiotics and antivirals, Antimalarials, Anthelmintics and AntiFungal agents. 2. Chemotherapeutic Agents: Antiamoebic, Antitubercular, Antileprotic, Anti-Neoplastic, Anti- HIV Drugs, Drug Intermediates, Nano particles in Medicinal Chemistry, Drugs and Environmental Aspects. 3. Classification of Dyes based on Chemical Constitution and Synthesis of Selected Dyes.Health and Environmental Hazards of Synthetic Dyes and their Remediation Processes. 4. Non-textile uses of dyes,Pigments, Dyestuff Industry - Indian Perspective
RJSUCHEPR601 RJSUCHEPR602 RJSUCHEPR603 RJSUCHEPR604 RJSUCHEACPR605	Paper I Paper II Paper III Paper IV Paper V	6	Physical Chemistry Inorganic Chemistry Organic Chemistry Analytical Chemistry Applied Component

B.Sc. (Chemistry) Semester – V Paper – I
Paper code: RJSUCHE501

UNIT I

Learning Objectives:

1. To learn the basics of rotational spectroscopy as well as its application in determination of internuclear distance in a molecule.
2. To learn the basics of vibrational spectroscopy, its application in determination of force constant of a bond as well as the IR spectra of CO_2 and H_2O.
3. To understand the basics of Raman spectroscopy and comparison between IR & Raman spectra.

MOLECULAR SPECTROSCOPY 15L

1.1 Rotational Spectrum: Introduction to dipole moment,polarization of a bond, bond moment, molecular structure,Rotational spectrum of a diatomic molecule, rigid rotor, momentof inertia, energy levels, conditions for obtaining pure rotational spectrum, selection rule, nature of spectrum, determination of internuclear distance and isotopic shift.

1.2 Vibrational spectrum: Vibrational motion, degrees of freedom, modes of vibration, vibrational spectrum of a diatomic molecule, simple harmonic oscillator, energy levels, zero point energy, conditions for obtaining vibrational spectrum, selection rule, nature of spectrum.

1.3 Vibrational-Rotational spectrum of diatomic molecule: energy levels, selection rule, nature of spectrum, P and R branch lines. Anharmonic oscillator - energy levels, selection rule, fundamental band, overtones. Application of vibrational-rotational spectrum in determination of force constant and its significance. Infrared spectra of simple molecules like H_2O and CO_2.

1.4 Raman Spectroscopy : Scattering of electromagnetic radiation, Rayleigh scattering, Raman scattering, nature of Raman spectrum, Stoke's lines, anti-Stoke's lines, Raman shift, quantum theory of Raman spectrum, comparative study of IR and Raman spectra, rule of mutual exclusion- CO_2 molecule.

UNIT-II

Learning Objectives:

1. To learn the colligative properties of dilute solution and the methods used to determine the same.
2. To know the collision theory of reaction rates applied to unimolecular and bimolecular reactions.
3. To study the kinetics of fast reactions.

2.1 CHEMICAL THERMODYNAMICS 10 L

2.1.1 **Colligative properties:** Vapour pressure and relative lowering of vapour pressure, Measurement of lowering of vapour pressure - Static and Dynamic method.

2.1.2 **Solutions of Solid in Liquid:**

2.1.2.1 Elevation in boiling point of a solution, thermodynamic derivation relating elevation in boiling point of the solution and molar mass of non-volatile solute.

2.1.2.2 Depression in freezing point of a solution, thermodynamic derivation relating the depression in the freezing point of a solution and the molar mass of the non-volatile solute. Beckmann Method and Rast Method.

2.1.3. **Osmotic Pressure :** Introduction, thermodynamic derivation of Van't Hoff equation, Van't Hoff Factor. Measurement of Osmotic Pressure - Berkeley and Hartley's Method, Reverse Osmosis. Advantages & disadvantages.

2.2 CHEMICAL KINETICS 5 L

2.2.1 **Collision theory of reaction rates** : Application of collision theory to 1. Unimolecular reaction Lindemann theory and 2. Bimolecular reaction. (derivation expected for both)

2.2.2 Classification of reactions as slow, fast and ultra -fast. Study of kinetics of fast reactions by Stop flow method and Flash photolysis (No derivation expected).

UNIT III

Learning Objectives:

1. To learn the basic terminologies involved in nuclear chemistry.
2. To understand how the nuclear radiations are detected and measured.
3. To study the nuclear fission & fusion processes nuclear reactors and the applications of radio isotopes as tracers.

NUCLEAR CHEMISTRY 15 L

3.1. **Introduction**: **B**asic terms-radioactive constants (decay constant, half life and average life) and units of radioactivity

3.2 **Detection and Measurement of Radioactivity:** Types and characteristics of nuclear radiations, behaviour of ion pairs in electric field, detection and measurement of nuclear radiations using G. M. Counter and Scintillation Counter.

3.3 **Application of use of radioisotopes as Tracers :** chemical reaction mechanism, age determination - dating by C14.

3.4 **Nuclear reactions**: nuclear transmutation (one example for each projectile), artificial radioactivity, Q - value of nuclear reaction, threshold energy.

3.5 **Fission Process :** Fissile and fertile material, nuclear fission, chain reaction, factor controlling fission process. multiplication factor and critical size or mass of fissionable material, nuclear power reactor and breeder reactor.

3.6 **Fusion Process :** Thermonuclear reactions occurring on stellar bodies and earth.

UNIT IV

Learning Objectives:

1. To learn about physical adsorption and chemical adsorption.
2. To understand Langmuir adsorption isotherm, BET equation and determination of surface area of an adsorbent.
3. To learn about sol, gel, emulsion, electrical double layer, electrokinetic phenomena, colloidal electrolytes and surfactants.

4.1 SURFACE CHEMISTRY 6 L

4.1.1 **Adsorption:** Physical and Chemical Adsorption, types of adsorption isotherms . Langmuir's adsorption isotherm (Postulates and derivation expected). B.E.T. equation for multilayer adsorption, (derivation not expected). Determination of surface area of an adsorbent using B.E.T. equation.

4.2 COLLOIDAL STATE 9 L

4.2.1 **Introduction to colloids** - Emulsions, Gels and Sols

4.2.2 **Electrical Properties**: Origin of charges on colloidal particles, Concept of electrical double layer, zeta potential, Helmholtz and Stern model.

Electro-kinetic phenomena - Electrophoresis, Electro-osmosis, Streaming potential, Sedimentation potential; Donnan Membrane Equilibrium.

4.2.3 **Colloidal electrolytes :** Introduction, micelle formation.

4.2.4 **Surfactants:** Classification and applications of surfactants in detergents and food industry.

Reference Books :

1. Physical Chemistry, Ira Levine, 5th Edition, 2002 Tata McGrawHill Publishing Co.Ltd. 2. Physical Chemistry, P.C. Rakshit, 6th Edition, 2001, Sarat BookDistributors, Kolkota.

3. Physical Chemistry, R.J. Silbey, & R.A. Alberty, 3rd Edition, John Wiley & Sons, Inc [part 1]

4. Physical Chemistry, G. Castellan, 3rd edition, 5th Reprint, 1995 Narosa Publishing House.

5. Modern Electrochemistry, J.O.M Bockris & A.K.N. Reddy, Maria Gamboa – Aldeco 2nd Edition, 1st Indian reprint,2006 Springer

6. Fundamental of Molecular Spectroscopy, 4th Edn., Colin NBanwell and Elaine M McCash Tata McGraw Hill Publishing Co.Ltd. New Delhi, 2008.

7. Physical Chemistry, G.M. Barrow, 6th Edition, Tata McGrawHill Publishing Co. Ltd. New Delhi.

8. The Elements of Physical Chemistry, P.W. Atkins, 2nd Edition,Oxford Universtity Press Oxford.

9. Physical Chemistry, G.K. Vemullapallie, 1997, Prentice Hall ofIndia, Pvt.Ltd. New Delhi.

10. Principles of Physical Chemistry B.R. Puri, L.R. Sharma, M.S.Pathania, VISHAL PUBLISHING Company, 2008.

11. Textbook of Polymer Science, Fred W Bilmeyer, John Wiley& Sons (Asia) Ple. Ltd., Singapore, 2007.

12. Polymer Science, V.R. Gowariker, N.V. Viswanathan, JayadevSreedhar, New Age International (P) Ltd., Publishers, 2005.

13. Essentials of Nuclear Chemistry, Arnikar, Hari Jeevan , NewAge International (P) Ltd., Publishers, 2011..

14. Chemical Kinetics, K. Laidler, Pearson Education India, 1987.

B.Sc. (Chemistry) Semester – V Paper – I Practical
Paper code: RJSUCHEPR501

Learning Objectives:

1. To learn how to determine the order of a reaction by fractional change method.
2. How to test the validity of Freundlich adorption isotherm.
3. To learn how to estimate the amount of halides in their mixture as well as to determine the solubility of AgCl potentiometrically.
4. To learn how to determine the isoelectric point of an amino acid.

Non-Instrumental

- **Chemical Kinetics**

  To determine the order of the reaction between $K_2S_2O_8$ and KI by fractional change method.

- **Surface phenomena**

  To investigate the adsorption of acetic acid on activated charcoal and test the validity of Freundlich adsorption isotherm.

Instrumental

- **Potentiometry**

1. To determine the amount of iodide, bromide and chloride in the mixture by potentiometric titration with silver nitrate.
2. To determine the solubility product and solubility of AgCl potentiometrically using chemical cell.

- **pH-metry**

  To determine acidic and basic dissociation constants of amino acid and hence to calculate isoelectric point.

Reference books

1. Practical Physical Chemistry 3rd edition A.M.James and F.E. Prichard, Longman publication
2. Experiments in Physical Chemistry R.C. Das and B. Behra, Tata Mc Graw Hill
3. Advanced Practical Physical Chemistry J.B.Yadav, Goel Publishing House
4. Advanced Experimental Chemistry. Vol-I J.N.Gurtu and R Kapoor, S.Chand and Co.
5. Experimental Physical Chemistry By V.D.Athawale.
6. Senior Practical Physical Chemistry By: B. D. Khosla, V. C. Garg and A. Gulati, R Chand and Co. 2011

B.Sc. (Chemistry) Semester – V Paper – II

Paper code: RJSUCHE502

Unit I

Learning Objectives:

- To make students aware of the symmetry elements present in the molecules, to perform different operation on the molecules and to assign point group.

1.0 Chemical Bonding

1.1 Molecular Symmetry **(07L)**

1.1.1 Introduction and Importance of symmetry in chemistry

1.1.2 Symmetry elements and symmetry operations.

1.1.3 Concept of a Point Group with illustrations using the following point groups:
(i) $C_{\infty v}$ (ii) $D_{\infty h}$ (iii) C_{2v} (iv) C_{3v} (v) C_{2h} and (vi) D_{3h}.

1.2 Molecular Orbital Theory for Polyatomic Species **(05L)**

1.2.1 LCAO-MO applied to triatomic species: H_3^+ and H_3 (correlation between bond angle and molecular orbitals).

1.2.2 Molecular orbital approach for bonding in AB_2 molecules. Application of symmetry concepts for linear and angular species considering σ- bonding only. (Examples like: i) BeH_2, ii) H_2O (Terms such as Walsh correlation diagram: Symmetry Adapted Linear Combinations (SALCs), Ligand Group orbitals (LGOs), transformation of atomic orbitals into appropriate symmetry types, expected to be discussed in unit 1.2)

1.3 Metallic bonding: Band theory, explanation of electrical properties of conductors, insulators and semiconductors, intrinsic and extrinsic semiconductors. **(03L)**

Unit II

Learning Objectives:

- To make students understand the packing density in SC, BCC, FCC and HCP structures, concept of voids and calculation of tetrahedral void. To understand the phenomenon of superconductivity and the properties of superconductors.

2.0 Solid State Chemistry

2.1 Structures of Solids **(11L)**

2.1.1 Importance of solid state chemistry, types of solids**,** Explanations of terms, viz. crystal lattice, lattice points, unit cells and lattice constants.

2.1.2 Closest packing of rigid spheres (hcp, ccp), packing density in simple cubic, bcc, fcc and hcp lattices (numerical problems expected).Relationship between density of unit cell, lattice parameters. (numerical problems expected).

2.1.3 Tetrahedral and octahedral interstitial voids in ccp lattice, tetrahedral holes, limiting radius ratios of different coordination numbers and their significance, calculation of limiting radius ratio for coordination number 4.

2.1.4 Stoichiometric point defect in solids.(Discussion on Frenkel and Schottky defects expected)

2.2 Superconductivity **(04L)**

2.2.1 Discovery of Superconductivity,

2.2.2 Explanation of terms like superconductivity, transition temperature, Meissner effect.

2.2.2 Different types of superconductor viz, conventional superconductors, organic superconductors, alkali metal fullerides and high temperature Superconductors.

2.2.3 Applications of superconductors.

References:

1. Modern Inorganic chemistry Satya prakash, R.D.Madan, 1986, S.Chand & Company Ltd.
2. Advance Inorganic chemistry Satya Prakash, Tuli, Madan, 2005, S.Chand & Company Ltd.
3. Solid State Chemistry and its applications 2nd edition by A.R. West
4. Introduction to superconductivity 2nd edition by Michael Tinkham.
5. Fundamental concepts of Inorganic chemistry by Asim Das.

Unit III

Learning Objectives:

- To study the two series of inner transition elements, their properties and separation methods.

3.0 Chemistry of elements (Inner transition elements)

3.1 Introduction: Definition, position in periodic table and electronic configuration of lanthanides and actinides.

3.2 Chemistry of Lanthanides **(11 L)** (i) lanthanide contraction
(ii) Oxidation states
(iii) magnetic and spectral properties,
(iv) Occurrence, extraction and separation of lanthanides by Solvent extraction.
(v) Applications of lanthanides.

3.3 Chemistry of Actinides **(4 L)**

3.3.1 comparision between lanthanides and actinides.
3.3.2 Chemistry of uranium with reference to occurrence and isolation (solvent extraction method)
3.3.3 properties and applications of Uranium.

References:

1. Modern Inorganic chemistry Satya prakash, R.D.Madan, 1986, S.Chand & Company Ltd.
2. Advance Inorganic chemistry Satya Prakash, Tuli, Madan, 2005, S.Chand & Company Ltd.
3. Advanced Inorganic Chemistry, 3rd edition, F.A. Cotton and G. Wilkinson

Unit IV

Learning Objectives:

- To study the acid – base and redon reactions in non-aqueous solvents, properties and structures of interhalogen and xenon compounds.

4.0 Some selected topics **(05 L)**

4.1 Chemistry in Non-aqueous Solvents
Classification of solvents and importance of non-aqueous solvents.

4.1.1 Super critical carbon dioxide and ionic liquids as solvents.

4.1.2 Characteristics and study of liquid ammonia, dinitrogen tetraoxide and acetic acid as non-aqueous solvents with respect to (i) acid-base reactions and (ii) redox reactions.

4.2 Chemistry of Interhalogen **(03L)**

4.2.1 Introduction

4.2.2 Preparation and uses

4.2.3 Bonding

4.3 Chemistry of Pseudohalogens **(03L)**

4.3.1 Introduction

4.3.2 Preparation

4.3.3 Reactions and structures

4.4 Chemistry of Xenon **(04L)**

4.4.1 Introduction.

4.4.2 Compounds of xenon: oxides Fluorides and oxyfluorides with respect to preparation, properties and bonding.

References:

1. Concise Inorganic chemistry 5th edition, J.D. Lee, 2005, Blackwell Science Publication.
2. Chemistry, Raymond Chang, Tata Mc. Graw-Hill Education private Ltd., 2008.
3. Inorganic chemistry principles of structure and reactivity, 4th Edition. J.E.Hubeey, 1993, Addison-Wesley Publication Company.
4. Modern aspects of Inorganic chemistry H.J. Emeleus and A.G. Sharpe 4th Ed. UBS Pub.
5. Selected topics in Inorganic Chemistry Malik, Tuli and Madam; S Chand Pub.

B.Sc. (Chemistry) Semester – V Paper – II Practical
Paper code: RJSUCHEPR502

Learning Objectives:

Student s learn to preparae co-ordination complexes of nickel, copper and magnesium and also learn to estimate the amount of metal content in the complex by using EDTA.

Inorganic Preparations:

1) Preparation of tris(acetylacetonato)iron(III)
2) Preparation of bis(dimethylglyoximato)nickel(II)
3) Preparation of Mercury tetrathiocynato cobaltate(II)
4) Preparation of potassium trioxalatoferrate(III)

Inorganic Estimation / Analysis:

1) Estimation of copper Iodometrically.
2) Estimation of magnesium in commercial sample of milk of magnesia.

References:

1) Inorganic Laboratory Manual, S. Mumtazuddin, 2009,Atlantic publishers & Distributors.
2) Practical Inorganic chemistry,G.Marr, B.W.Rockett, 1972, Van Nostrand Reimhold Company.
3) College Practical Chemistry, V.K.Ahluwalia, 2005, Universal press (India) Pvt. Ltd.
4) Advanced Experiments In Chemistry, Gurtu, Kapoor, 1973, S.Chand & Co.

B.Sc. (Chemistry) Semester – V Paper – III
Paper code: RJSUCHE503

Unit I

Learning Objectives:

1. To enable students to understand and propose mechanism of organic reactions to introduce the concept of pericyclic reactions with relevant examples.
2. Introduction of organic photochemistry w.r.t. basic principles and selected photochemical reactions.

1.1Mechanism of organic reactions (10 L)

1.1.1 The basic terms &concepts ,bond fission, reaction intermediates electrophiles & nucleophiles, Electrophilicityvs.acidity & nucleophilicity vs basicity.

1.1.2 Neighbouring group participation in nucleophilic substitution reactions**:** participation of lone pair of electrons, kinetics and stereochemical outcome.

1.1.3 Acyl nucleophilic substitution (Tetrahedral mechanism): Acid catalysed esterification of carboxylic acids ($A_{AC}2$) and base promoted hydrolysis of esters ($B_{AC}2$).

1.1.4 Pericyclic reactions, classification and nomenclature

1.1.4.1Electrocyclic reactions (ring opening and ring closing), cycloaddition, sigma tropic rearrangement, group transfer reactions, cheletropic reaction (definition and one example of each type)

1.1.4.2 Pyrolytic elimination: Cope, Chugaev, pyrolysis of acetates

References:

1. A guidebook to mechanism in Organic Chemistry, 6th edition, Peter Sykes, Pearson education, New Delhi
2. Organic Reaction Mechanism, 4th edition, V. K. Ahluvalia, R. K. Parashar, Narosa Publication.
3. Organic reactions & their mechanisms,3rd revised edition, P.S. Kalsi, New Age International Publishers.
4. M.B.Smith and J. March, advanced organic chemistry- reactions mechanism and structure,5thedition.

1.2 Photochemistry (5 L)

1.2.1 Introduction: Difference between thermal and photochemical reactions. Jablonski diagram, singlet and triplet states, allowed and forbidden transitions, fate of excited molecules, photosensitization.

1.2.2 Photochemical reactions of olefins: photoisomerisation, photochemical rearrangement of 1,4-dienes (di- π methane)

1.2.3 Photochemistry of carbonyl compounds: Norrish I, Norrish II cleavages. Photoreduction (e.g. benzophenone to benzpinacol)

References:

1. Organic Chemistry, 7th Edition, R.T. Morrison, R. N. Boyd & S. K. Bhattacharjee, Pearson.
2. Organic chemistry,8th edition, John McMurry

Unit II
Learning Objectives:

1. To give a brief understanding on fundamentals of chirality with suitable illustrations.
2. To introduce agrochemicals as an applied organic chemistry topic with synthesis of certain compounds.
3. Continuation of heterocyclic chemistry in an advanced level

2.1 Stereochemistry I **(5 L)**

2.1.1 Molecular chirality and elements of symmetry: Mirror plane symmetry, inversion center, roation-refelction (alternating) axis.

2.1.2 Chirality of compounds without a stereogeniccentre: cummulenesand biphenyls.

References:

1. L. Eliel , stereochemistry of carbon compounds, Tata McGrawnHill
2. Stereochemistry P.S.Kalsi , New Age International Ltd.,4th Edition
3. Stereochemistry by Nassipuri.

2.2 Agrochemicals **(4 L)**

2.2.1 General introduction & scope, meaning & examples of insecticides, herbicides, fungicide, rodenticide,pesticides, plant growth regulators.

2.2.2 Advantages & disadvantages of agrochemical

2.2.3 Synthesis & application of IAA(indole Acetic acid)&Endosulphan,

2.2.4 Biopesticides – Neem oil &Karanj oil.

References:

1. Insecticides& pesticides :SaxenaA. B. Anmol publication.
2. Growth regulators in Agriculture & Horticulture: Amarjit Basra, CRC press 2000

2.3 Heterocyclic chemistry: **(6 L)**

2.3.1 Reactivityof pyridine-N-oxide, quinoline and iso-quionoline.

2.3.2 Preparation of pyridine-N-oxide, quinoline (Skraup synthesis) and iso-quinoline(Bischler-Napieralski synthesis).

2.3.3 Reactions of pyridine-N-oxide: halogentation, nitration and reaction with $NaNH_2$/liq.NH_3, n-BuLi.

2.3.4 Reactions of quinoline and isoquinoline; oxidation,reduction,nitration,halogenation and reaction with $NaNH_2$/liq.NH_3,n-BuLi.

References

1. Name Reactions in Heterocyclic Chemistry, Jie-Jack Li, Wiley-Interscience publications, 2005.
2. Handbook of Heterocyclic Chemistry, 2nd Edition, Alan R. Katritzky and Alexander F. Pozharskii, Elsevier Science Ltd, 2000.
3. Heterocyclic Chemistry, 5th Edition, John A. Joule and Keith Mills, Wiley publication, 2010.
4. Heterocyclic chemistry, 3rd Edition, Thomas L. Gilchrist, Pearson Education, 2007.

Unit III

Learning Objectives:

1. Understanding IUPAC nomenclature of bicyclic systems.
2. To introduce the concept of organic synthesis from the basic concepts to modern methods of synthesis with a reference to Green synthesis.

3.1 IUPAC **(5 L)**

IUPAC nomenclature of the following classes of compounds (including compounds upto 2 substituents / functional groups):

3.1.1 Bicyclic compounds – spiro, fused and bridged (upto 11 carbon atoms) – saturated and unsaturated compounds.

3.1.2 Biphenyls

3.1.3 Cummulenes with upto 3 double bonds

3.1.4 Quinolines and isoquinolines

References

1. Nomenclature of Organic Chemistry**:** IUPAC recommendations and preferred Names 2013, RSC publication.
2. IUPAC nomenclature by S.C.Pal.

3.2 Organic Synthesis **(10 L)**

3.2.1 Introduction: Linear and convergent synthesis, criteria for an ideal synthesis, concept of chemoselectivity and regioselectivity with examples, calculation of yields.

3.2.2 Multicomponent Synthesis: Mannich reaction and Biginellireaction. Synthesis with examples (no mechanism)

3.2.3 Green synthesis:

Introduction: Twelve principles, concept of atom economy and E-factor, calculations and their significance, numerical examples.

i) Green reagents: dimethyl carbonate.
ii) Green starting materials : D-glucose
iii) Green solvents : supercritical CO_2
iv) Green catalysts : Bio catalysts.

3.2.4 Planning of organic synthesis

i) o & p – nitroanilines
ii) halobenzoic acid
iii)alcohols (primary / secondary / tertiary) using Grignard reagents.
iv) alkanes (using organolithium compounds)

Reference:

1. Green chemistry an introductory text : Mike Lancaster.
2. Green chemistry : V. K. Ahluwalia (Narosa publishing housepvt. ltd.)
3. Green chemistry an introductory text : RSC publishing.
4. New trends in green chemistry V. K. Ahluwalia , M. Kidwai, Klumer Academic publisher
5. Green chemistry by V. Kumar.
6. Organic chemistry: Francis Carey
7. Organic chemistry: Carey and Sundberg.

Unit IV: Learning Objectives:

1. Basics of spectroscopy To explore UV –Visible and Mass spectroscopic techniques as a tool in structural elucidation of organic compounds.
2. Introduction to natural products chemistry w.r.t. terpenoids and alkaloids.

4.1 Spectroscopy I **(5 L)**

4.1.1 Introduction: Electromagnetic spectrum, units of wavelength and frequency

4.1.2 UV – Visible spectroscopy: Basic theory, solvents, nature of UV-Visible spectrum, concept of chromophore, auxochrome, bathochromic and hypsochromic shifts, hyperchromic and hypochromic effects, chromophore-chromophore and chromophore-auxochrorne interactions.

4.1.3 Mass spectrometry: Basic theory. Nature of mass spectrum. General rules of fragmentation. Importance of molecular ion peak, isotopic peaks, base peak, nitrogen rule, rule of 13 for determination of empirical formula and molecular formula. Fragmentation of alkanes and aliphatic carbonyl compounds.

References:

1. Organic spectroscopy (Second edition),Jag Mohan,Narosa publication
2. Spectroscopy,Pavia,Lampman,Kriz,Vyvyan.
3. Elementary organic spectroscopy (Third edition), Y.R.Sharma,S.Chand.
4. Introduction to spectroscopy (third edition), Pavia, Lampman, Kriz,johnvondeling, EmilyBarrosse.
5. Organic chemistry Paula Y. Bruice, Pearson education.
6. Spectral identification of organic molecules by Silverstein.
7. Absorption spectroscopy of organic molecules by V.M.Parikh.

4.2 Natural Products **(10L)**

4.2.1. Terpenoids: Introduction, Isoprene rule, special isoprene rule and thegem-dialkyl rule.

4.2.2 Citral:

a) Structural determination of citral.
b) Synthesis of citral from methyl heptenone
c) Isomerism in citral. (cis and trans form).

4.2.3. Alkaloids :Introduction and occurrence.

Hofmann's exhaustive methylation and degradation in**:** simple open chain andN – substituted monocyclic amines.

4.2.4 Nicotine:

a) Structural determination of nicotine.(Pinner's work included)
b) Synthesis of nicotine from nicotinic acid
c) Harmful effects of nicotine.

4.2.5 Hormones:

Introduction, structure of adrenaline(epinephrine), physiological action of adrenaline.

Synthesis of adrenaline from

a) Catechol
b) p-hydroxybenzaldehyde(Ott's synthesis)

References:

1. Chemistry of natural products by ChatwalAnand – Vol I and Vol II
2. Chemistry of natural products by O.P. Agarwal
3. Chemistry of natural products by Meenakshi Sivakumar and Sujata Bhat.
4. Organic Chemistry by Morrision and Boyd,7th edition.
5. Organic Chemistry, I.L.Finar,Vol-I and Vol-II, 5th edition.

B.Sc. (Chemistry) Semester – V Paper – III **Practical**
Paper code: RJSUCHEPR503

Learning Objectives:

To enable students to develop skills in organic separation of solid mixtures using chemical method.

Separation of solid-solid mixture (2.0 g mixture given).

1. Minimum Six mixtures to be completed by the students.

2. Components of the mixture should include water soluble and water insoluble acids (carboxylic acid), water insoluble phenols(2-naphthol, 1-naphthol), water insoluble bases (nitroanilines) , water soluble(urea ,thiourea) and water insoluble neutral compounds(anilides , amides, m-DNB, hydrocarbons)

3. A sample of the mixture to be given to the student for detection of the chemical type of the mixture.

4. After correct determination of chemical type, the fixing reagent should be decided by the student for separation.

5. After separation into component A and component B,
   a) One component (decided by the examiner) is to be analysed and detected. This component is not to be weighed.
   b) The other component is dried, weighed and the m.p. is to be determined.

B.Sc. (Chemistry) Semester – V Paper – IV
Paper code: RJSUCHE504

Learning Objectives:

1. To provide a basic knowledge and understanding of core principles of analytical chemistry.
2. To introduce basic analytical techniques and practical aspects of classical chemical analysis.
3. To introduce stake holders to various modern instrumental methods of analysis and separation techniques.
4. To solve problems related to chemical analysis and interpret analytical results.
5. To inculcate research culture in learners.
6. Creating awareness amongst learners about the scope of analytical chemistry in various fields.

UNIT I :INTRODUCTION TO QUALITY CONCEPTS,CHEMICAL CALCULATIONS AND SAMPLING			
1.1	**Quality in Analytical Chemistry**		**05 L**
	1.1.1	Concepts of Quality, Quality Control and Quality Assurance	
	1.1.2	Importance of Quality concepts in Industry	
	1.1.3	Chemical Standards and Certified Reference Materials; Importance in chemical analysis Quality of material: Various grades of laboratory reagents	
1.2	**Chemical Calculations (Numericals and word problems are expected)**		**04 L**
	1.2.1	Inter conversion of various concentration units. (Conversion of concentration from one unit to another unit with examples)	
	1.2.2	Percent composition of elements in chemical compounds	
1.3	**Sampling**		**06 L**
	1.3.1	Terms involved in sampling	
	1.3.2	Purpose, significance and difficulties encountered in sampling	
	1.3.3	Sampling of solids: Sample size – bulk ratio, size to weight ratio, multistage and sequential sampling, size reduction methods, sampling of compact solids, equipments and methods of sampling of compact solids, sampling of particulate solids, methods and equipments used for sampling of particulate solids.	
	1.3.4	Sampling of liquids: Homogeneous and heterogeneous, Static and flowing liquids.	
	1.3.5	Sampling of gases: Ambient and stack sampling: Apparatus and methods for sampling of gases.	
	1.3.6	Collection, preservation and dissolution of the sample.	
UNIT II : CLASSICAL METHODS OF ANALYSIS (TITRIMETRY)			
2.1	**Redox Titrations**		**08 L**
	2.1.1	Introduction	

	2.1.2	Construction of the titration curves and calculation of E_{system} in aqueous medium in case of: (1) One electron system (2) Multielectron system **(Numerical Problems expected)**	
	2.1.3	Theory of redox indicators, Criteria for selection of an indicator Use of diphenyl amine and ferroin as redox indicators	
2.2	**Complexometric Titrations**		**07 L**
	2.2.1	Introduction, construction of titration curve	
	2.2.2	Use of EDTA as titrant and its standardisation , Absolute and conditional formation constants of metal EDTA complexes.	
	2.2.3	Types of EDTA titrations. Methods of enhancing selectivity of EDTA as a titrant	
	2.2.4	Advantages and limitations of EDTA as a titrant.	
	2.2.5	Metallochromic indicators, theory, examples and applications	
UNIT III: OPTICAL METHODS			
3.1	**Atomic Spectroscopy: Flame Emission spectroscopy(FES) and Atomic Absorption Spectroscopy(AAS)**		**07 L**
	3.1.1	Flame Photometry – Principle, Instrumentation (Flame atomizers, types of Burners, Wavelength selectors, Detectors)	
	3.1.2	Atomic Absorption Spectroscopy – Principle, Instrumentation (Source, Chopper, Flame and Electrothermal atomiser)	
	3.1.3	Quantification methods of FES and AAS – Calibration curve method and Standard addition method.	
	3.1.4	Comparison between FES and AAS	
	3.1.5	Applications, Advantages and Limitations	
3.2	**Molecular Fluorescence and Phosphorescence Spectroscopy**		**04L**
	3.2.1	Introduction and Principle	
	3.2.2	Relationship of Fluorescence intensity with concentration	
	3.2.3	Factors affecting Fluorescence and Phosphorescence	
	3.2.4	Instrumentation and applications	
	3.2.5	Comparison of Fluorimetry and Phosphorimetry	
	3.2.6	Comparison with Absorption methods	
3.3	**Turbidimetry and Nephelometry**		**04 L**
	3.3.1	Introduction and Principle	

	3.3.2	Factors affecting scattering of Radiation: Concentration, particle size, wavelength, refractive index	
	3.3.3	Instrumentation and Applications	
UNIT IV: METHODS OF SEPARATION - I			
4.1	**Solvent Extraction**		**06 L**
	4.1.1	Factors affecting extraction: Chelation, Ion pair formation and Solvation	
	4.1.2	Graph of percent extraction versus pH. Concept of $[pH]_{1/2}$ and its significance (derivation not expected)	
	4.1.3	Craig's counter current extraction: Principle, apparatus and applications	
	4.1.4	Solid phase extraction: Principle, process and applications.	
	4.1.5	Comparison of solid phase extraction and solvent extraction.	
4.2	**High Performance Liquid chromatography (HPLC)**		**05L**
	4.2.1	Introduction and Principle Instrumentation- components with their significance: Solvent Reservoir, Degassing system, Pumps-(reciprocating pumps, screw driven- syringe type pumps, pneumatic pumps, advantages and disadvantages of each pump), Precolumn, Sample injection system, HPLC Columns, Detectors(UV – Visible detector, Refractive index detector)	
	4.2.2	Qualitative and Quantitative Applications of HPLC	
4.3	**High Performance Thin Layer Chromatography (HPTLC)**		**04 L**
	4.3.1	Introduction and Principle Stationary phase, Sample application and mobile phase	
	4.3.2	Detectors a) Scanning densitometer- Components. Types of densitometer- Single beam and Double beam b) Fluorometric Detector	
	4.3.3	Advantages, disadvantages and applications	
	4.3.4	Comparison of TLC and HPTLC	

B.Sc. (Chemistry) Semester – V Paper – IV **Practical**
Paper code: RJSUCHEPR504

Learning Objectives:

1. Students will be able to carry out assay of commercial samples.
2. Students can calculate the error in various ways by using their experimental data.
3. Students can carry out analysis of water sample for various parameters.
4. Students can develop method for the assay of commercial samples.

Experiments:

1. Estimation of fluoride content in the given solution colorimetrically.
2. Estimation of magnesium content in Talcum powder by complexometry, using standardized solution of EDTA).
3. Determination of COD of water sample.
4. Determination of the potassium content of a fertilizer by Flame photometry (calibration curve method)
5. Determination of the amount of persulphate in the given sample solution by back titration with standard Fe (II) ammonium sulphate solution.

References:

1.	3000 solved problems in Chemistry, David E. Goldberg,PhD.,Schaums Outline	Unit -I
2.	A guide to Quality in Analytical Chemistry: An aid to accreditation, CITAC and EURACHEM, (2002),	Unit-I
3.	A premier sampling solids, liquids and gases, Smith Patricia I, American statistical association and the society for industrial and applied mathematics, (2001)	Unit-I
4.	Analysis of food and Beverages, George Charalanbous, Academic press 1978	Unit-III
5.	Analytical chemistry David Harvey The ,McGraw Hill Companies, Inc.	All units
6.	Analytical chemistry, R. K. Dave.	Unit-II
7.	Analytical Chemistry Skoog, West ,Holler,7th Edition:	Unit-IV
8.	Analytical Chromatography, Gurdeep R Chatwal, Himalaya publication	Unit -III
9.	Basic Concepts of Analytical Chemistry, by S M Khopkar, new Age International (p) Limited	Unit - IV
10.	Fundamentals of Analytical Chemistry by Skoog and West , 8th Edition	Unit- I
11.	High Performance Thin Layer Chromatography by Dr P.D. Sethi, CBS Publisher and Distribution	Unit-III
12.	Instrumental methods Of Analysis, by Willard Merritt Dean, 7thEdition, CBS Publisher and distribution Pvt Ltd	Unit- III
13.	Instrumental Methods of Chemical Analysis by B.K. Sharma Goel Publishing House	Unit- III
14.	Principles of Instrumental Analysis , 5th Edition, By Skoog, Holler, Nieman	Unit- III
15.	Principles of Polarography by Jaroslav Heyrovský , Jaroslav Kůta, 1st Edition, Academic Press, eBook ISBN: 978148326478	Unit- I
16.	Quality control and Quality assurance in Amalytical Chemical Laboratory, Piotr Konieczka and Jacek Namiesnik, CRC press (2018)	Unit-I
17.	Solvent extraction and ion exchange, J Marcus and A. S. Kertes Wiley INC 1969	Unit- IV
18.	Vogel's Textbook of Quantitative Chemical analysis, Sixth edition, J.Mendham et.al	Unit-II

B.Sc. (Chemistry) Semester – V Paper – V

Paper code : RJSUCHEAC505

Learning Objective:

1. To study basic information about the drug and related medicinal terms.
2. Students will acquainted with the synthesis of some important class of the drug.
3. To understand basic chemistry involved in dyes.
4. To learn different types of fibres and forces involves between dye and fibres.

Unit I (Drugs)

Unit			Topics	
I	**1.1**		**General Introduction to Drugs**	**(8L)**
		1.1.1	Definition of a drug, sources of drugs, requirements of an ideal drug, classification of drugs (based on therapeutic action),	
		1.1.2	Nomenclature of drugs: Generic name, Brand name, Systematic name	
		1.1.3	Definition of the following medicinal terms: Pharmacon, Pharmacology, Pharmacophore, Prodrug, Half – life efficiency, LD_{50}, ED_{50},GI_{50} Therapeutic Index.	
		1.1.4	Brief idea of the following terms: Receptors, Agonists, Antagonists, Drug-receptor interaction, Drug Potency, Bioavailability, Drug toxicity, Drug addiction, Spurious Drugs, Misbranded Drugs, Adulterated Drugs, Pharmacopoeia.	
	1.2		**Routes of Drug Administration and Dosage Forms**	**(3L)**
		1.2.1	Oral and Parenteral routes with advantages and disadvantages.	
		1.2.2	Formulations & combination formulation, Different dosage forms (including Patches & Adhesives, emphasis on sustained release formulations and enteric coated tablets).	
	1.3		**Pharmacodynamic agents:** A brief introduction of the following pharmacodynamic agents and the study with respect to their chemical structure, chemical class, therapeutic uses, and side effects.	
		1.3.1	**CNS Drugs:** Classification based on pharmacological actions: CNS Depressants & CNS Stimulants. Concept of sedation and hypnosis, anaesthesia. • Phenytoin (Hydantoin) • Trimethadione (Oxazolidinediones) (**Synthesis from acetone**) • Alprazolam (Benzodiazepines) • Levetiracetam (Pyrrolidines) • Amphetamine (Phenethylamine) (**Asymmetric synthesis from phenyl acetic acid**) • Chlorpromazine (Phenothiazines)	**(4L)**

UNIT-II (Drugs)

2	**2.1**		**Analgesics, Antipyretics and Anti-inflammatory Drugs.**	**(4L)**
		2.1.1	**Analgesics and Antipyretics** • Morphine (Phenanthrene alkaloids) • Tramadol (Cyclohexanols) (**Synthesis from salicylic acid**) • Aspirin (Salicylates) • Paracetamol (p-Amino phenols)	

		2.1.2	**Anti-inflammatory Drugs** Mechanism of inflammation and various inflammatory conditions. • Steroids: Prednisolone, Betamethasone • Sodium Diclofenac, Aceclofenac (N- Aryl anthranilic acids) **(Synthesis from 2,6-dichlorodiphenyl amine)**	
	2.2		**Antihistaminic Drugs**	**(2L)**
			• Diphenhydramine (Ethanol amines) • Cetrizene (Piperazine) (**Synthesis from 4-Chlorobenzhydryl chloride)** • Chlorpheniramine maleate (Ethyl amines) • Pantoprazole (Benzimidazoles)	
	2.3		**Cardiovascular drugs**	**(3L)**
			Classification based on pharmacological action • Isosorbide dinitrate (Nitrates) • Valsartan (Amino acids) (structure not expected) • Atenolol (Aryloxy propanol amines) (**Synthesis from 3-Hydroxy phenyl acetamide)** • Amlodipine (Pyridines) • Frusemide /Furosemide (Sulfamoyl benzoic acid) • Rosuvastatin (Pyrimidine)	
	2.4		**Antidiabetic Agents**	**(2L)**
			General idea and types of diabetes; Insulin therapy • Glibenclamide (Sulphonyl ureas) • Metformin (Biguanides) • Dapagliflozin (Pyranose) • Pioglitazone (Thiazolidinediones) (**Synthesis from 2-(5-ethylpyridin-2-yl) ethanol)**	
	2.5		**Antiparkinsonism Drugs**	**(2L)**
			Idea of Parkinson's disease. • Procyclidine hydrochloride (Pyrrolidines) • Ethopropazine hydrochloride (Phenothiiazines) • Levodopa (Amino acids) (**Synthesis from Vanillin)**	
	2.6		**Drugs for Respiratory System** General idea of: Expectorants; Mucolytes; Bronchodilators; Decongestants; Antitussives • Ambroxol (Cyclohexanol) (**Synthesis from paracetamol)** • Salbutamol (Phenyl ethyl amines) • Oxymetazoline (Imidazolines) • Codeine Phosphate (Opiates)	**(2L)**

Reference Books: (For units I & II)

1. Foye's principles of medicinal chemistry. 6th Edition, Edited by Davis William & Thomas Lemke, Indian edition by B I Publication Pvt Ltd, Lippmcolt Williams & Wilkins.
2. Text book of organic medicinal & pharmaceutical chemistry. Wilson &Gisovolds, 11th Edition by John H Block, John M Beale Jr.
3. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
4. Burger's Medicinal Chemistry, Drug Discovery and Development. Abraham and Rotella. Wiley
5. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
6. Medicinal chemistry. V.K. Ahluwalia and Madhu Chopra, CRC Press.
7. Principle of medicinal chemistry. Vol 1 &2 S. S. Kadam, K. R. Mahadik, K. G. Bothara
8. The Art of Drug synthesis. Johnson and Li. Wiley, 2007.
9. The organic chemistry of drug design & drug action. 2nd ed. By Richard B Silvermann, Academic Press.
10. The Organic Chemistry of Drug Synthesis. Lednicer and Mitsher, Wliey.

Unit III (Dyes)

3	**3.1**		Introduction to the dye-stuff Industry	**(5L)**
		3.1.1	Dyes	
			Definition of dyes, requirements of a good dye i.e. Colour, Chromophore and Auxochrome, Solubility, Linearity, Coplanarity, Fastness, Substantivity, Economic viability. Definition of fastness and its properties and Mordants with examples Explanation of nomenclature or abbreviations of commercial dyes with at least one example suffixes – G, O, R, B, K, L, C, S H, 6B, GK, 6GK, Naming of dyes by colour index (two examples) used in dye industries.	
		3.1.2	Natural and Synthetic Dyes	
			Natural Dyes: Definition and limitations of natural dyes. Examples and uses of natural dyes w.r.t Heena, Turmeric, Saffron, Indigo, Madder, Chlorophyll –**names** of the chief dyeing material/s in each natural dye **[structures not expected]**, Synthetic dyes: Definition of synthetic dyes, primaries and intermediates. Important milestones in the development of synthetic dyes – Emphasis on Name of the Scientist, dyes and the year of the discovery is required. (structure is not expected)	
	3.2		**Substrates for Dyes : Types of fibres**	**(3L)**
		3.2.1	Natural: cellulosic and proteinaceous fibres, examples – wool, silk and cotton structures and names of dyes applied on each of them.	
		3.2.2	Semi – synthetic: definition and examples [structures not expected]	
		3.2.3	Synthetic: Nylon, Polyesters and Polyamides structures and names of dyes applied on each of them	
		3.2.4	Blended fabrics: definition and examples [structures not expected]	

		3.2.5	Binding forces of dyes on substrate: ionic forces, covalent linkages, hydrogen bonding, vander-walls forces	
	3.3		Classification of dyes based on applications and dyeing methods	**(7L)**
		3.3.1	Dyeing methods	
			Basic Operations involved in dyeing process: i. Preparation of fibres ii. Preparation of dyebath iii. Application of dyes iv. Finishing	
			Dyeing Method of Cotton Fibres: (i) Direct dyeing (ii) Vat dyeing (iii) Mordant dyeing (iv) Disperse dyeing	
		3.3.2	Classification of dyes based on applicability on substrates (examples with structures) (a) Acid Dyes- Orange II, (b) Basic Dyes-methyl violet, (c) Direct cotton Dyes- Benzofast Yellow 5GL (d) Azoic Dyes – Diazo components; Fast yellow G, Fast orange R. Coupling components. Naphthol AS, Naphthol ASG (e) Mordant Dyes-Eriochrome Black A, Alizarin. (f) Vat Dyes- Indanthrene brown RRD, (g) Sulphur Dyes- Sulphur Black T (no structure) (h) Disperse Dyes-Celliton Fast brown 3R, (i) Reactive Dyes- Cibacron Brilliant Red B,	
		3.3.3	Optical Brighteners: General idea, important characteristics of optical brighteners and their classes [Stilbene, Coumarin, Heterocyclic vinylene derivatives, Diarylpyrazolines, Naphthylamide derivatives] general structure of each class.	

Unit – IV (Dyes)

4	**4.1**		**Colour and Chemical Constitution of Dyes**	**(4L)**
		4.1.1	Absorption of visible light, Colour of wavelength absorbed, Complementary colour.	
		4.1.2	Relation between colour and chemical constitution.	
			(i) Armstrong theory (quinonoid theory) and its limitations. (ii) Witt's Theory: Chromophore, Auxochrome, Bathochromic & Hypsochromic Shift, Hypochromic & Hyperchromic effect (iii) Valence Bond theory, comparative study and relation of colour in the following classes of compounds/dyes: Benzene, Nitrobenzene, Nitroanilines, Nitrophenols, Benzoquinones, Azo, Triphenyl methane, Anthraquinones. (iv) Molecular Orbital Theory.	
	4.2		**Unit process and Dye Intermediates**	
		4.2.1	**A brief idea of Unit Processes**	**(3L)**
			Introduction to primaries and intermediates	
			Unit processes: definition and brief ideas of below unit processes: (a) Nitration (b) Sulphonation (c) Halogenation (d) Diazotization: (3 different methods& its importance) (e) Ammonolysis (f) Oxidation NB: Definition, Reagents, Examples of each unit processes mentioned above with reaction conditions (mechanism is not expected)	

		4.2.2	**Preparation of the Following Intermediates**	**(8L)**
			Benzene derivatives: Benzenesulphonic acid; 1,3-Benzenedisulphonic acid; sulphanilic acid; o-, m-, p-chloronitrobenzenes; o-, m-, p-nitroanilines; o-, m-, p-phenylene diamines; Naphthol ASG	
			Naphthalene Derivative: Schaeffer acid; Tobias acid; Naphthionic acid; N.W. acid; cleve-6-acid; H-acid; Naphthol AS	
			Anthracene Derivative: 1-Nitroanthraquinone; 1-Aminoanthraquinone Anthraquinone-2-sulphonic acid; Benzanthrone.	

References (For Units III & IV):

1. Chemistry of Synthetic Dyes, Vol I – VIII, Venkatraman K., Academic Press 1972
2. The Chemistry of Synthetic Dyes and Pigments, Lubs H.A., Robert E Krieger Publishing Company, NY ,1995
3. Chemistry of Dyes and Principles of Dyeing, Shenai V.A., Sevak Publications, 1973

B.Sc. (Chemistry) Semester – V Paper – V Practical

Paper code : RJSUCHEACPR505

Learning objective :

- To know methods of estimation of drugs.
- To understand dying of cotton fabric by direct dyeing.

Practicals

1. Estimation of Ibuprofen (back titration method)
2. Estimation of Acid neutralizing capacity of a drug
3. Preparation of Aspirin from salicylic acid.
4. Preparation p-nitroacetanilide from acetanilide
5. Separation of components of natural pigments by paper chromatography (eg: chlorophyll)

Projects:

- **Preparation of monograph of any one drug from syllabus by I.P. method.**
- **Dying of cotton fabric using congo red dye.**

B.Sc. (Chemistry) Semester – VI Paper – I
Paper code: RJSUCHE601

UNIT I

Learning Objectives:

1. To study the principle, instrumentation, working and applications of NMR.
2. To study the principle, instrumentation, working and applications of ESR.

1.1 NMR -NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY 7L

1.1.1. Principle : Nuclear spin, magnetic moment, nuclear 'g' factor, energy levels, Larmor precession, Relaxation processes in NMR (spin -spin relaxation and spin - lattice relaxation).
1.1.2. Instrumentation: NMR Spectrometer

1.2 ELECTRON SPIN RESONANCE SPECTROSCOPY 8L

1.2.1. Principle: fundamental equation, g-value – dimensionless constant or electron g-factor, hyperfine splitting.
1.2.2. Instrumentation: ESR spectrometer, ESR spectrum of hydrogen and deuterium.

UNIT II

Learning Objectives:

1. To study the limitations of classical mechanics.
2. To learn the basics of quantum mechanics and terminologies involved in it.
3. To study the renewable energy sources: solar energy and hydrogen as fuel.

2.1 BASICS OF QUANTUM CHEMISTRY 10 L

2.1.1 **Classical mechanics**: Introduction, limitations of classical mechanics, Black body radiation, photoelectric effect, Compton effect.

2.1.2 **Quantum mechanics :** Introduction, Planck's theory of quantization, wave particle duality, de –Broglie's equation, Heisenberg's uncertainty principle.

2.1.3 **Progressive and standing waves-** Introduction, boundary conditions, Schrodinger's time independent wave equation (No derivation expected), interpretation and properties of wave function.

2.1.4 **Quantum mechanics** : State function and its significance, Concept of operators - definition, addition, subtraction and multiplication of operators, commutative and non – commutative operators, linear operator, Hamiltonian operator, Eigen function and Eigen value.

2.2 RENEWABLE ENERGY RESOURCES 5 L

2.2.1. **Renewable energy resources** : Introduction.

2.2.2 **Solar energy**: Solar cells, Photovoltaic effect, Differences between conductors, semiconductors, insulators and its band gap, Semiconductors as solar energy converters, Silicon solar cell

2.2.3. **Hydrogen :** Fuel of the future, production of hydrogen by direct electrolysis of water, advantages of hydrogen as a universal energy medium.

UNIT III

Learning Objectives:

1. To learn the basic terminologies involved in electro chemistry.
2. To study the classification of cells.
3. To understand the polarization process, decomposition potential and over voltage.

3.1 ELECTROCHEMISTRY 7 L

3.1.1 **Activity and Activity Coefficient:** Lewis concept, ionic strength, Mean ionic activity and mean ionic activity coefficient of an electrolyte, expression for activities of electrolytes. Debye- Huckel limiting law (No derivation).

3.1.2 **Classification of cells:** Chemical cells and Concentration cells. Chemical cells with and without transference, Electrode Concentration cells, Electrolyte concentration cells with and without transference (derivations are expected),

3.2 **Applied electrochemistry & determination thermodynamic parameter for cell reaction** ($\Delta G, \Delta H$ & ΔS) **8 L**

3.2.1 **Polarization**: concentration polarization and it's elimination

3.2.2 **Decomposition Potential and Overvoltage** : Introduction, experimental determination of decomposition potential, factors affecting decomposition potential. Tafel's equation for hydrogen overvoltage, experimental determination of over –voltage

UNIT IV

Learning Objectives:

1. To learn the basic terminologies involved in polymer chemistry.
2. To study the classification of polymers, molar masses and their determination.
3. To know what are light emitting polymers, antioxidants and stabilizers.

POLYMERS 15 L

4.1 **Basic terms :** macromolecule, monomer, repeat unit, degree of polymerization.
4.2. **Classification of polymers:** Classification based on source, structure, thermal response and physical properties.
4.3. **Molar masses of polymers:** Number average, Weight average, Viscosity average molar mass, Monodispersity and Polydispersity
4.4. **Method of determining molar masses of polymers:** Viscosity method using Ostwald Viscometer. (derivation expected)

4.5. **Light Emitting Polymers :** Introduction, Characteristics, Method of preparation and applications.
4.6. **Antioxidants and Stabilizers :** Antioxidants , Ultraviolet stabilizers, Colourants, Antistatic agents and Curing agents.

(Note : Numericals are expected from all units)

Reference Books :

1. Physical Chemistry, Ira Levine, 5th Edition, 2002 Tata McGraw Hill Publishing Co.Ltd.
2. Physical Chemistry, P.C. Rakshit, 6th Edition, 2001, Sarat Book Distributors, Kolkota.
3. Physical Chemistry, R.J. Silbey, & R.A. Alberty, 3rd edition , John Wiley & Sons, Inc [part 1]
4. Physical Chemistry, G. Castellan, 3rd edition, 5th Reprint, 1995 Narosa Publishing House.
5. Modern Electrochemistry, J.O.M Bockris & A.K.N. Reddy, Maria Gamboa – Aldeco 2nd Edition, 1st Indian reprint,2006 Springer
6. Fundamental of Molecular Spectroscopy, 4th Edn., Colin N Banwell and Elaine M McCash Tata McGraw Hill Publishing Co. Ltd. New Delhi, 2008.
7. Physical Chemistry, G.M. Barrow, 6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
8. The Elements of Physical Chemistry, P.W. Atkins, 2nd Edition, Oxford Universtity Press Oxford.
9. Physical Chemistry, G.K. Vemullapallie, 1997, Prentice Hall of India, Pvt.Ltd. New Delhi.
10. Principles of Physical Chemistry B.R. Puri, L.R. Sharma, M.S. Pathania, VISHAL PUBLISHING Company, 2008.
11. Textbook of Polymer Science, Fred W Bilmeyer, John Wiley & Sons (Asia) Ple. Ltd., Singapore, 2007.
12. Polymer Science, V.R. Gowariker, N.V. Viswanathan, Jayadev Sreedhar, New Age International (P) Ltd., Publishers, 2005.
13. Essentials of Nuclear Chemistry, Arnikar, Hari Jeevan , New Age International (P) Ltd., Publishers, 2011.
14. Chemical Kinetics,K. Laidler, Pearson Education India, 1987.

B.Sc. (Chemistry) Semester – VI Paper – I **Practical**
Paper code: RJSUCHEPR601

Learning Objectives:

1. In non-instrumental part, to learn kinetics through graphical method. Also, to estimate molecular weight of polymer by viscometry.
2. In instrumental part, to enable the students to use techniques such as potentiometry, conductometry and colorimetry for studying redox, acid-base titration and complex formation reactions, respectively.

Non-Instrumental

- To interpret the order of reaction graphically from the given experimental data and calculate the specific rate constant. (No fractional order)

Viscosity

- To determine the molecular weight of high polymer polyvinyl alcohol (PVA) by viscosity measurement.

Instrumental

Potentiometry

- To determine the number of electrons in the redox reaction between ferrous ammonium sulphate and cerric sulphate potentiometrically.

Conductometry

- To titrate a mixture of weak acid and strong acid against strong base and estimate the amount of each acid in the mixture conductometrically.

Colorimetry

- To estimate the amount of Fe(III) in the complex formation with salicylic acid by Static Method.

Reference books

1. Practical Physical Chemistry 3rd edition A.M.James and F.E. Prichard, Longman publication
2. Experiments in Physical Chemistry R.C. Das and B. Behra, Tata Mc Graw Hill
3. Advanced Practical Physical Chemistry J.B.Yadav, Goel Publishing House
4. Advanced Experimental Chemistry. Vol-I J.N.Gurtu and R Kapoor, S.Chand and Co.
5. Experimental Physical Chemistry By V.D.Athawale.
6. Senior Practical Physical Chemistry By: B. D. Khosla, V. C. Garg and A. Gulati, R Chand and Co. 2011

B.Sc. (Chemistry) Semester – VI Paper – II
Paper code: RJSUCHE602

Unit I

Learning Objectives:

1. Students should know the concept of metal ions and ligands, effect of ligands in various geometries around metal ions responsible for crystal field splitting.
2. Effect of crystal field splitting on various physical and chemical properties of complex compounds. Further students should understand the need of concept of MOT, construction of ligand group orbitals, molecular orbitals for octahedral complexes.

1.0 Co-ordination Chemistry: (10 L)

1.1 Theories of the Metal-Ligand Bond

1.1.1 Limitations of VBT.

1.1.2 Crystal field theory and effect of crystal field on central metal valence orbitals in various geometries.

1.1.3 Splitting of *d* orbitals in octahedral, tetrahedral and square planar crystal fields.

1.1.4 Distortions from the octahedral geometry ;(i) effect of ligand field and (ii) Jahn-Teller distortions.

1.1.5 Crystal field splitting parametersΔ, its calculation and factors affecting it in octahedral complexes, spectrochemical series.

1.1.6 Crystal field stabilization energy (CFSE), calculation of CFSE, for octahedral complexes with d^1 to d^{10} metal ion configuration.

1.1.7 Consequence of crystal field splitting on various properties such as ionic radii, hydration energy, lattice energy,enthalpies of formation, colour and magnetic properties.

1.1.8 limitations of CFT: Evidence for covalence in metal complexes:
i) intensities of d-d transitions, ii) ESR spectrum of $[IrCl_6]_2$, iii) Nephelauxctic effect,
iv) NMR spectra

1.2 Molecular Orbital Theory (MOT) of Coordination Compounds (05 L)

1.2.1 Identification of central metal orbital's and their symmetry suitable for formation of σ-bonds with ligands orbitals.

1.2.2 Construction of ligand group orbitals.

1.2.3 Construction of σ- molecular orbitals for an ML_6 complex.

References:

1. Group Theory & Chemistry, David. M.Bishop,2016, Dover Publication.
2. Group Theory & Symmetry in chemistry, Kamlesh Bansal, 2003, Camps Books, International Publications.
3. D. Banerjea, Coordination chemistry, Tata McGraw Hill, New Delhi, (1993)
4. D. F. Shriver and P.W. Atkins, Inorganic chemistry, 3rd Edition Oxford University Press, (1999)
5. K.F.Purcell and J.C. Kotz, Inorganic chemistry, Saunders, Hongkong, (1977).

Unit II

Learning Objectives:

1. Students should understand the basics of origin of electronic spectra, different terms and term symbols, the concept of Ruseell-Sauders coupling. It may help in determination of terms and terms symbol for different atoms/ions.
2. Student should learn about the ability of complexes and its reactivity in different chemical reactions.

2.0 Properties of Coordination compounds

2.1 Electronic Spectra (7 L)

2.1.1 Origin of Electronic spectra

2.1.2 Types of electronic transitions in coordination compounds : intra –ligand,charge transfer and intra-metal transitions

2.1.3 Electronic configuration and electronic micro states, Terms and terms symbols, coupling of spin momenta (M_s), orbital momenta (M_l) and spin orbit coupling or Russell-Saunders coupling.

2.1.4 Determination of terms for p^2 and d^2 electronic configurations.

2.1.5 Terms and micro states for transition metal atoms/ions.

2.1.6 Orgel Diagrams for D and F Terms (i.e, d^1, *to.*d^9 electronic configurations in octahedral co-ordination compounds).

2.1.7 Selection rules for electronic transitions:Spin and Laporte selection rules.

2.2 Stability of Complexes (04 L)

2.2.1 Thermodynamic stability and kinetic stability of complexes with examples.

2.2.2 Stability constants: Stepwise and overall stability constants and their interrelationship.

2.2.3 Factors affecting thermodynamic stability.(factors related to nature of central metal atom, nature of ligand, chelate effect to be discussed)

2.3 Reactivity of Metal Complexes:

2.3.1 Comparison between inorganic and organic reactions. **(04L)**

2.3.2 Types of reactions in metal complexes.

2.3.3 Inert and labile complexes: (Correlation between electronic configurations and lability of complexes.)

2.3.4 Ligand substitution reactions: Associative and Dissociative mechanisms.

2.3.5 Acid hydrolysis, base hydrolysis and anation reactions.

References:

1. Modern Inorganic chemistry Satya prakash, R.D.Madan, 1986, S.Chand & Company Ltd.
2. Advance Inorganic chemistry Satya Prakash, Tuli, Madan, 2005, S.Chand & Company Ltd.
3. D.F. Shriver, P. W. Atkins and C.H. Langford, Inorganic Chemistry 5th edition, Oxford University press.
4. Garyl Miessler, Iorganic Chemistry, 3rd edition, Pearson Prentice hall, Pearson Educational international
5. Wai-Kee Li, Advanced Inorganic Chemistry, Oxford university press, ISBN 978-0-19-921694-9

Unit III

Learning Objectives:

1. Student may learn the basic concept of organometallic compounds, their synthesis, structure, bonding and applications.
2. Use of organometallic compounds such as ferocene may be understand in view of its structure and reactivity.role of organometallic compounds as a catalyst may clear the concept of catalysis and importance of organometallic compounds.

3.0 Organometallic Chemistry & catalysis

3.1 Organometallic Compounds of main group metals (08L)

3.1.1 General characteristics of various types of organometallic compounds, viz, ionic, σ- bonded and electron deficient compounds.

3.1.2 General synthetic methods of organomettalic compounds: (i) Oxidative addition, (ii) Metal-Metal exchange (Transmetallation), Carbanion-Halide exchange, (iii) Metal Hydrogen exchange and (v) Methylene insertion reactions.

3.1.3 Chemical rections: (i) Reactions with oxygen, (ii) Alkylation and arylation reactions (iii) Reactions with protic reagents and (iv) Complex formation reactions.

3.2 Metallocenes (02L)

Introduction, Ferrocene: synthesis, properties, structure and bonding on the basis of VBT.

3.3 Catalysis (05 L)

3.3.1 Overview of Homogeneous catalysis.

3.3.2 Selection of catalytic cycles (should be read as reactions in catalytic cycles)

3.3.3 Coupling Reactions: Heck and Suzuki reactions.

References:

1. Modern Inorganic chemistry Satya prakash, R.D.Madan, 1986, S.Chand & Company Ltd.
2. Advance Inorganic chemistry Satya Prakash, Tuli, Madan, 2005, S.Chand & Company Ltd.
3. R.C. Mehrotra and A. singh, Organometallic chemistry: A unified approach, Wiley Eastern, New Delhi, (1991)
4. Catalysis – Heterogeneous and homogenous – Delmol and Janner.

Unit IV

Learning Objectives:

1. Student should understand the concept of nanomaterials , its synthesis characterization and applications in different field.
2. Role of metal ions in biological systems, different biochemical terms. Further student may learn about the role of metal complexes in medicine.

4.1 Nanomaterials (08L)

4.1.1 Introduction and importance of nanomaterials.

4.1.2 Chemical methods of synthesis of nano marerials.:

4.1.3 Characterisation of nano materials (UV AND XRD TECHNIQUES)

4.1.4 Dimensions and Forms of nanomaterials: nanofilms, nanolayers, nanotubes, nanowires, and nanoparticles.

4.1.5 Properties (comparision between bulk and nanomaterials): i) optical, ii) Electrical and iii) Mechanical properties.

4.1.6 Applications

4.2 Bio-Inorganic and Medicinal Chemistry: (07L)

4.2.1 Metal coordination in biological systems: Enzymes, apeoenzymes and coenzymes.

4.2.2 Biological role of carboxypeptidases,catalases and peroxidases.

4.2.3 Metal complexes in medicine:cis-platins and gold complexes

4.2.4 Inorganic radiopharmaceuticals.

References:

1. Concise Inorganic chemistry 5th edition, J.D. Lee, 2005, Blackwell Science Publication.
2. Chemistry, Raymond Chang, Tata Mc. Graw-Hill Education private Ltd., 2008.
3. Inorganic chemistry principles of structure and reactivity, 4th Edition. J.E.Hubeey, 1993,Addison-Wesley Publication Company.
4. G.N.Mukherjee and A. Das, Elements of bioinorganic chemistry, Dhuri and sons, Calcutta,(1988)
5. R. W. Hay, Bioorganic chemistry, Ellis Harwood, England, (1984)

B.Sc. (Chemistry) Semester – VI Paper – II Practical
Paper code: RJSUCHEPR602

Learning Objectives:

1. Students learn to prepare transition metal complexes.
2. Also learn to estimate copper by iodometry. Estimate the amount of magnesium from the supplied sample of milk of magnesia.

Inorganic Preparations:

1) Preparation of tris(ethylenediamine)nickel(II)thiosulphate
2) Preparation of tetraamminecopper(II)sulphate
3) Preparation of Magnesium Oxinate

Complexometric Titrations:

1) Estimation of Nickel.
2) Estimation of Copper.
3) Estimation of Magnesium
   (EDTA to be standardized)

References:

1. Inorganic Laboratory Manual, S. Mumtazuddin, 2009,Atlantic publishers & Distributors.
2. Practical Inorganic chemistry,G.Marr, B.W.Rockett, 1972, Van Nostrand Reimhold Company.
3. College Practical Chemistry, V.K.Ahluwalia, 2005, Universal press (India) Pvt. Ltd.
4. Advanced Experiments In Chemistry, Gurtu, Kapoor, 1973, S.Chand & Co.

B.Sc. (Chemistry) Semester – VI Paper – III
Paper code: RJSUCHE603

Unit I

Learning Objectives:

1. Understanding stereochemistry of reactions with selected examples.
2. A brief idea of amino acids and proteins with emphasis on nomenclature and properties.

1.1 Stereochemistry II **(10 L)**

1.1.1 Stereoselectivity and stereospecificity : Idea of enantioselectivity (ee) and diastereoselectivity (de) , Topicity : enantiotopic and diasterotopic atoms, groups and faces.

1.1.2 Stereochemistry of –

i) Substitution reactions :S_{Ni} (reaction of alcohol with thionyl chloride)

ii) Eliminationreactions:E_2–Baseinduced dehydrohalogenation of 1-bromo-1,2-diphenylpropane.

iii) Addition reactions to olefins:

a) bromination (electrophilic anti addition)

b) syn hydroxylation with O_sO_4 and $KMnO_4$

c) epoxidation followed by hydrolysis.

References:

Refer Stereochemistry –I (Sem-V, Unit-II)

1.2 Amino acids & Proteins **(5 L)**

1.2.1α-Amino acids:General Structure, configuration, and classification based on structure and nutrition. Properties: pH dependency of ionic structure, isoelectric point and zwitter ion. Methods of preparations: Strecker synthesis, amidomalonate synthesis, Erlenmeyer azalactone synthesis.

1.2.2 Polypeptides and Proteins:Polypeptides: Peptide bond. Nomenclature and representation of polypeptides (di- and tri-peptides) with examples.

References:

1. Biochemistry, 8th Ed., Jeremy Berg, LubertStryer, John L. Tymoczko, Gregory J. Gatto Pub. W. H. Freeman Publishers
2. Lehninger Principles of Biochemistry 7th Ed., David Nelson and Michael Cox, Publisher W. H. Freeman
3. Name Reactions – Jie Jack Li, 4th Edition, Springer Pub.

Unit II

Learning Objectives:

1. A study of mechanistic aspects of molecular rearrangement and selected name reactions.
2. Introduction to carbohydrate chemistry w.r.t. mono-saccharides with 5 & 6 carbons including reactions and stereochemical aspects.

2.1 Molecular Rearrangement **(5 L)**

Mechanism of the following rearrangements with examples and stereochemistry wherever applicable.

2.1.1 Migration to the electron deficient carbon: Pinacol-pinacolonerearrangement.

2.1.2 Migration to the electron deficient nitrogen: Beckmann rearrangement.

2.1.3 Migration involving a carbanion :Favorski rearrangement.

2.1.4 Name reactions: Michael addition, Wittig reaction.

References:

Refer Mechanism of organic reaction (Sem-V,Unit-I)

2.2 Carbohydrates **(10 L)**

2.2.1 Introduction: classification, reducing and non-reducing sugars, DL Notification

2.2.2 Structures of monosaccharides: Fischer projection (4-6 carbon monosaccharides) and Haworth formula (furanose and pyranose forms of pentoses and hexoses)
Interconversion: open chain and Haworth forms of monosaccharides with 5 and 6 carbons.Chair conformation with stereochemistry of D-glucose, Stability of chair form of D-glucose

2.2.3 Stereoisomers of D-glucose: enantiomer, diastereomers, anomers, epimers.

2.2.4 Mutarotation in D-glucose with mechanism

2.2.5 Chain lengthening & shortening reactions: Modified Kiliani-Fischer synthesis (D-arabinose to D-glucose and D-mannose), Wohlmethod (D-glucose to D-arabinose)

2.2.6 Reactions of D-glucose and D-fructose:
(a) Osazone formation (b) reduction: Hi/Ni, $NaBH_4$ (c) oxidation: bromine water, HNO_3, HIO_4 (d) acetylation (e) methylation:(d) and (e) with cyclic pyranose forms

2.2.7 Glycosides: general structure

References:

1. Organic chemistry (fourth edition),G,MarcLoudon,Oxford University press.
2. Introduction to Organic Chemistry (Third edition), Andrew Streitwieser, Jr. Clayton H. Heathcock, Macmilan publishing.
3. Organic chemistry fourth edition, Morrision and Boyd.
4. Introduction to Organic chemistry,JohnMcMurry.
5. Organic chemistry volume-1&2 (fifth and sixth edition) IL Finar.

Unit III

Learning Objectives:

1. A detailed discussion on IR & NMR spectroscopy and their application in structural determination problems involving a combination of UV-Vis. I.R. Mass and NMR spectra for structural elucidation of organic compounds.
2. To study the structure of nucleic acids - a basic approach.

3.1 Spectroscopy II **(10 L)**

3.1.1 IR Spectroscopy:Basic theory, nature of IR spectrum, selection rule, fingerprint region.

3.1.2 PMR Spectroscopy:Basic theory of NMR, nature of PMR spectrum, chemical shift (δunit), standard for PMR, solvents used. Factors affecting chemical shift: (1) inductive effect (2) anisotropic effect (with reference to C=C, C≡C, C=O and benzene ring). Spin- spin coupling and coupling constant. application of deuterium exchange. Application of PMR in structure determination.

3.1.3 Spectral characteristicsof following classes of organic compounds, including benzene and monosubstituted benzenes, with respect to IR and PMR: (1) alkanes (2) alkenes (3) alkynes (4) haloalkanes (5) alcohols (6) carbonyl compounds (7) ethers (8) amines (broad regions characteristic of different groups are expected).
Problemsof structure elucidation of simple organic compounds using individual or combined use of UV-Vis, IR, Mass and NMR spectroscopic technique are expected. (Index of hydrogen deficiency should be the first step in solving the problems).

References:

Refer spectroscopy –I, (Sem-V, Unit-IV)

3.2 Nucleic Acids **(5 L)**

Controlled hydrolysis of nucleic acids. sugars and bases in nucleic acids. Structures of nucleosides and nucleotides in DNA and RNA. Structures of nucleic acids (DNA and RNA) including base pairing merrified solid phase nucleotide synthesis.

References:

1. Organic chemistry R.T.Morrison and R.N.Boyd, 6th edition, pearson education
2. S.H.Pine, organic chemistry 4th edition. McGrawHill

Unit IV

Learning Objectives:

1. Understanding organic synthetic polymers w.r.t. preparation, properties & uses of selected polymers.
2. A brief study of selected catalysts and reagents in organic synthesis.

4.1 Polymer **(8 L)**

4.1.1 Introduction: terms monomer, polymer, homopolymer, copolymer, thermo plastics and thermosets.

4.1.2 Addition polymers: polyethylene, polypropylene, teflon, polystyrene, PVC, uses.

4.1.3 Condensation polymers: polyesters, polyamides, polyurethanes, polycarbonates,phenol formaldehyde resins.Uses

4.1.4 Stereochemistry of polymers: Tacticity, Mechanism of stereochemical control of polymerization using Ziegler Natta catalysts.

4.1.5 Natural and synthetic rubbers: Polymerisation of isoprene: 1,2 and 1,4 addition (cis and trans), Styrenebutadiene copolymer.

4.1.6 Additives to polymers: Plasticisers, stabilizers and fillers.

4.1.7 Biodegradable polymers: Classification and uses. Polylactic acid structure, properties and use for packaging and medical purposes.

References:

1. Polymer chemistry by M.G.Arora,K.Singh.
2. Polymer science – a text book by Ahluwalia and Mishra
3. Introduction to polymer chemistry - R.Seymour, Wiley Interscience.

4.2 Catalysts and Reagents **(7 L)**

Study of the following catalysts and reagents with respect to functional group transformations and selectivity (no mechanism).

4.2.1 Catalysts: Catalysts for hydrogenation:

a. Raney Nickel
b. Pt and PtO_2 (C=C, CN, NO_2, aromatic ring)
c. Pd/C: C=C, COCl→CHO (Rosenmund)
d. Lindlar catalyst: alkynes

4.2.2 Reagents**:**

a. $LiAlH_4$ (reduction of CO, COOR, CN,NO_2)
b. $NaBH_4$ (reduction of CO)
c. SeO_2(oxidation of CH_2 alpha to CO)
d. mCPBA (epoxidation of C=C)
e. NBS (allylic and benzylicbromination)

References:

1. Organic Chemistry by Francis Carey – McGraw Hill.
2. Oranic Chemistry by Carey and Sandberg, Part A & B

B.Sc. (Chemistry) Semester – VI Paper – III **Practical**
Paper code: RJSUCHEPR603

Learning Objectives:
To get a clear understanding of separation technique for Liq.- Liq. and Liq.-Solid mixtures using distillation method.

Separation of liquid-liquid and liquid- solid mixture.

1. Minimum Six mixtures to be completed by the students.
2. Components of the liq-liq mixture should include volatile liquids like acetone,methylacetate,ethylacetate,isopropylalcohol,ethyl alcohol,EMK and non volatile liquids like chlorobenzene , bromobenzene, aniline, N,Ndimethylaniline, acetophenone, nitrobenzene, ethyl benzoate.
3. Components of the liq- solid mixture should include volatile liquids like acetone, methylacetate, ethylacetate, ethyl alcohol, IPA, EMK and solids such as water insoluble acids, phenols, bases, neutral.
4. A sample of the mixture one ml to be given to the student for detection of the physical type of the mixture.
5. After correct determination of physical type, separation of the mixture to be carried out by using distillation method.
6. After separation into component A and component B,

a) In case of a liq-liq mixture, the volatile component is to be analysed and detected. The non-volatile component volume to be measured and the b.p. to be reported.(non-volatile component not to be analysed)

b) In case of a liq-solid mixture, the compound to be identifie can be decided by examiner. The other component's vol/ weight and m.p/b.p to be reported.

References:

1. Practical Organic Chemistry – A. I. Vogel
2. Practical Organic Chemistry – Middleton.
3. Practical Organic Chemistry – O.P.Aggarwal.

B.Sc. (Chemistry) Semester – VI Paper – IV

Paper code: RJSUCHE604

Learning Objectives:

1. To enable students to study the principal & working of various instruments.
2. To help students to understand the accurate procedure of sampling or calculating error involved in measurement.
3. To learn various techniques involved in separation of mixtures of chemicals.
4. To enable students to study ingredients and methods of analysis of products used our daily needs
5. To encourage students to develop modern methods separation or analysis of various products pertaining.

UNIT I: ELECTRO ANALYTICAL TECHNIQUES			
1.1	**Polarography**		**11L**
	1.1.1	Difference between potentiometry and voltammetry	
	1.1.2	Basic principle of polarography Polarizable and non-polarizable electrodes, H shaped polarographic cell, DME (construction, working, advantages and limitations)	
	1.1.3	DC polarogram: Terms involved - Residual current, Diffusion current, Limiting current, Half-Wave Potential Role and selection of supporting electrolyte, Interference of oxygen and its removal, polarographic Maxima and Maxima Suppressors Qualitative aspects of Polarography: Half wave potential $E_{1/2}$, Factors affecting $E_{1/2}$ Quantitative aspects of polarography: Ilkovic equations*: various terms involved in it (No derivation)	
	1.1.4	Quantification 1) Wave height – Concentration plots (working plots/calibration) 2) Internal standard (pilot ion) method 3) Standard addition method	
	1.1.5	Applications, advantages and limitations	
		(**Numerical problems wherever possible expected**)	
1.2	**Amperometric Titrations**		**04L**
	1.2.1	Principle, Rotating Platinum Electrode(Construction, advantages and limitations)	
	1.2.2	Titration curves with example	
	1.2.3	Advantages and limitations	
UNIT II: METHODS OF SEPARATION - II			
2.1	**Gas Chromatography** (**Numerical and word problems are expected**)		**09 L**
	2.1.1	Introduction, Principle and terms involved	
	2.1.2	Instrumentation: Block diagram and components,types of columns, stationary phases in GSC and GLC, Detectors: TCD, FID, ECD	
	2.1.3	Qualitative, Quantitative analysis and applications	
	2.1.4	Comparison between GSC and GLC	
2.2	**Ion Exchange Chromatography**		**06 L**
	2.2.1	Introduction, Principle.	
	2.2.2	Types of Ion Exchangers , Ideal properties of resin	
	2.2.3	Ion Exchange equilibria and mechanism, selectivity coefficient and separation factor Factors affecting separation of ions	
	2.2.4	Ion exchange capacity and its determination for cation and anion	

		exchangers.	
	2.2.5	Applications of Ion Exchange Chromatography with reference to Preparation of demineralised water, Separation of amino acids and separation of lanthanides.	
UNIT III:FOOD AND COSMETICS ANALYSIS			
3.1	**Introduction to food chemistry**		**10 L**
	3.1.1	Food processing and preservation: Introduction, need, chemical methods, action of chemicals(sulphur dioxide, boric acid, sodium benzoate, acetic acid, sodium chloride and sugar) and pH control Physical methods (Pasteurization and Irradiation)	
	3.1.2	Determination of boric acid by titrimetry and sodium benzoate by HPLC.	
	3.1.3	Study and analysis of food products and detection of adulterants **1)** Milk: Composition & nutrients, types of milk (fat free, organic and lactose milk) Analysis of milk for lactose by Lane Eynon's Method **2)** Honey: Composition Analysis of reducing sugars in honey by Coles Ferricyanide method **3)** Tea: Composition, types (green tea and mixed tea) Analysis of Tannin by Lowenthal's method **4)** Coffee: Constituents and composition, Role of Chicory Analysis of caffeine by Bailey Andrew method	
3.2	**Cosmetics**		**05 L**
	3.2.1	Introduction and sensory properties	
	3.2.2	Study of cosmetic products – **1)** Face powder: Composition Estimation of calcium and magnesium by complexometric titration **2)** Lipstick: Constituents Ash analysis for water soluble salts: borates, carbonates and zinc oxide **3)** Deodorants and Antiperspirants: Constituents, properties Estimation of zinc by gravimetry	
UNIT IV:THERMAL METHODS AND ANALYTICAL METHOD VALIDATION			
4.1	**Thermal Methods**		**12 L**
	4.1.1	Introduction to various thermal methods (TGA, DTA and Thermometric titration)	

	4.1.2	**Thermogravimetric Analysis(TGA)** Instrumentation-block diagram,thermobalance (Basic components: balance, furnace, temperature measurement and control, recorder) Thermogram (TG curve)for$CaC_2O_4.H_2O$ and $CuSO_4.5H_2O$ Factors affecting thermogram-Instrumental factors and Sample characteristics Applications: Determination of drying and ignition temperature range Determination of percent composition of binary mixtures (Estimation of Calcium and Magnesium oxalate)	
	4.1.3	**Differential Thermal Analysis (DTA):** Principle**,** Instrumentation, and Reference material used	
		Differential thermogram (DTA curve) $CaC_2O_4.H_2O$ and $CuSO_4.5H_2O$	
		Applications Comparison between TGA and DTA.	
	4.1.4	**Thermometric Titrations –** Principle and Instrumentation Thermometric titrations of : 1) HCl v/s NaOH 2) Boric acid v/s NaOH 3) Mixture of Ca^{+2} and Mg^{+2} v/s EDTA 4) Zn^{+2} with Disodium Tartarate**.**	
4.2	**Analytical Method Validation**		**03L**
	4.2.1	Introduction and need for validation of a method	
	4.2.2	Validation Parameters: Specificity, Selectivity, Precision, Linearity, Accuracy and Robustness	

Note: Concept of sensitivity is to be discussed for all techniques and instruments mentioned in the syllabus.

B.Sc. (Chemistry) Semester – VI Paper – IV **Practical**
Paper code: RJSUCHEPR604

Learning Objectives:

1. Students will be able to use the technique of ion exchange for separation & estimation of metal ions.
2. Students will have experience of handling various instruments and preparation of sample for it.
3. Students will be able to handle various types of commercial samples & develop the method of analysis of it.
4. Students will be able to carry out analysis of water.

Practicals:

1. Estimation of Chromium in water sample spectrophotometrically by using Diphenyl carbazide.
2. Estimation of reducing sugar in honey by Willstatter method.
3. Separation and estimation of Mg(II) and Zn(II) from given sample solution using an anion exchange resin.
4. Estimation of acetic acid in Vinegar sample by using Quinhydrone electrode potentiometrically.
5 Determination of phosphoric acid in cola sample pH metrically.

References :

1	Analytical chemistry David Harvey The ,McGraw Hill Companies, Inc.	All units
2	Analytical chemistry, R. K. Dave.	Unit -II
3	Analytical Chemistry Skoog, West ,Holler,7th Edition:	Unit -IV
4	Food Analysis, Edited by S. Suzanne Nielsen, Springer	Unit- III
5	Food Analysis: Theory and practice, YeshajahuPomeranz, Clifton E. Meloan, Springer	Unit- III
6	Formulation and Function of cosmetics, Sa Jellineck	Unit- III
7	Fundamentals of Analytical Chemistry, D .A. Skoog and D. M. West and F. J. Holler Holt., Saunders 6th Edition (1992)	Unit- II
8	Fundamentals of Analytical Chemistry by Skoog and West , 8th Edition	Unit- I Unit- III
9	Fundamentals of Analytical Chemistry by Skoog and West , 8th Edition	Unit- I
10	Harry's Cosmetology, Longman scientific co.	Unit- III
11	Instrumental methods of Analysis, by Dr Supriya S Mahajan, Popular Prakashan Ltd	Unit- IV
12	Instrumental methods Of Analysis, by Willard Merritt Dean, 7thEdition, CBS Publisher and distribution Pvt Ltd	Unit- IV
13	Instrumental Methods of Chemical Analysis by B.K. Sharma Goel Publishing House	Unit- I
14	Introduction to Polarography and Allied Techniques, By Kamala Zutshi, New Age International, 2006.	Unit- I
15	Modern cosmetics, E. Thomessen Wiley Inter science	Unit- III
16	The chemical analysis of food and food products III edition Morris Jacob	Unit-III

B.Sc. (Chemistry) Semester – VI Paper – V

Paper code: RJSUCHEAC605

Learning Objective:

1. To know steps involved in drug discovery, design and development.
2. To study different chemotherapeutic agents with their uses
3. To understand classification of dyes, their hazards and remedies.
4. Students will acquaint with different applications of dyes.

UNIT – I (Drugs)

1	**1.1**		**Drug Discovery, Design and Development**	**(6L)**
		1.1.1	Discovery of a Lead compound: Screening, drug metabolism studies and clinical observation, Lipinski's rule of 5	
		1.1.2	Medicinal properties of compounds from Natural Sources: Anti-infective and anticancer properties of Turmeric (Curcumin)	
		1.1.3	Development of drug: The Pharmacophore identification, modification of structure or functional group, Structure activity relationship (Sulphonamides).	
		1.1.4	Structure modification to increase potency: Homologation, Chain branching and Extension of the structure.	
		1.1.5	Computer assisted drug design.	
	1.2		**Drug Metabolism:** Introduction, Absorption, Distribution, Bio-transformation, Excretion Different types of chemical transformation of drugs with specific examples.	**(3L)**
	1.3		**Chemotherapeutic Agents:** Study of the following chemotherapeutic agents with respect to their chemical structure, chemical class, therapeutic uses, side effects and introduction to MDR wherever applicable.	
		1.3.1	**Antibiotics and antivirals:** Definition, • Amoxicillin (β- lactum antibiotics) • Cefpodoxime (Cephalosporins) • Doxycycline (Tetracyclines) • Levofloxacin (Quinolones) (**Synthesis from 2,3,4 – Trifluro -1-nitrobenzene)** • Aciclovir/Acyclovir (Purines)	**(2L)**
		1.3.2	**Antimalarials:** Types of malaria; Symptoms; Pathological detection during window period (Life cycle of the parasites not to be discussed) • Chloroquine (3-Amino quinolones) • Artemether(Benzodioxepins) **Following combination to be discussed:**Atremether-Lumefantrine (no structure)	**(2L)**
		1.3.3	**Anthelmintics and AntiFungal agents** Drugs effective in the treatment of Nematodes and Cestodes infestations. • Diethyl carbamazine (Piperazines) • Albendazole (Benzimidazoles) (**Synthesis from 2- Nitroaniline)** • Clotrimazole (Imidazole)	**(2L)**

			• Fluconazole (Triazole) (**Synthesis from 1- Bromo – 2,4-difluorobenzene)**	

UNIT – II(Drugs)
Chemotherapeutic Agents continued.

2	**2.1**		**Antiamoebic Drugs** Types of Amoebiasis • Metronidazole, Ornidazole, Tinidazole (Imidazole) Synthesis of Metronidazole from glyoxal by Debus-Radziszewski imidazole synthesis route **Following combination therapy to be discussed:** Ciprofloxacin-Tinidazole	**(1L)**
	2.2		**Antitubercular and Antileprotic Drugs** Types of Tuberculosis; Symptoms and diagnosis of Tuberculosis. Types of Leprosy. General idea of Antibiotics used in their treatment. • PAS (Amino salicylates) • Isoniazide (Hydrazides) • Pyrazinamide (Pyrazines) • (+) Ethambutol (Aliphatic diamines) (**Synthesis from 1- Nitropropane)** • Dapsone(Sulphonamides) (**Synthesis from 4- Chloronitrobenzene**) • Clofazimine (Phenazines) • Bedaquiline (Quinoline) **Following combination therapy to be discussed:** (i) Rifampin + Ethambutol + Pyrazinamide (ii) Rifampin + Isoniazide + Pyrazinamide	**(3L)**
	2.3		**Anti-Neoplastic Drugs** Idea of malignancy; Causes of cancer Brief idea of Immuno Stimulants &Immuno depressants • Lomoustine (Nitrosoureas) • Anastrozole(Triazoles) (**Synthesis from 3,5-bis (bromo methyl) toluene)** • Cisplatin (Chloro Platinum) • Vincristine, Vinblastine, Vindesine) (Vinca alkaloids) (structure not expected)	**(2L)**
	2.4		**Anti-HIV Drugs** Idea of HIV pathogenicity, Symptoms of AIDS • AZT/Zidovudine, Lamivudine,DDI (Purines)	**(1L)**
	2.5		**Drug Intermediates:** Synthesis and uses 1. 2,3,6-Triamino-6- hydroxypyrimidine from Guanidine 2. p-[2'-(5-Chloro-2-methoxy benzamido) ethyl]-benzenesulphonamide from Methyl-5-chloro-2- methoxybenzene 3. 3-(p-Chlorophenyl)-3- hydroxypiperidine from 3-Chloroacetophenone 4. p-Acetyl amino benzenesulphonyl chloride from Aniline 5. Epichlorohydrine from propene	**(2L)**
	2.6		**Nano particles in Medicinal Chemistry** Introduction; Carbon nano particles (structures) and Carbon nano tubes: • Functionalization for Pharmaceutical applications • Targeted drug delivery	**(4L)**

			• In vaccine (Foot and mouth disease) • Use in Bio-physical treatment. Gold nano particles in treatment of: Cancer; Parkinsonism; Alzheimer. Silver nano particles: Antimicrobial activity.	
	2.7		**Drugs and Environmental Aspects** • Impact of Pharma-industry on environment, • International regulation for human experimentation with reference to: "The Nuremberg Code" and "The Helsinki Declaration".	**(2L)**

Reference Books (For Units V & VI):

1. Foye's principles of medicinal chemistry. 6th Edition, Edited by Davis William & Thomas Lemke, Indian edition by B I Publication Pvt Ltd, Lippmcolt Williams & Wilkins.
2. Text book of organic medicinal & pharmaceutical chemistry. Wilson &Gisovolds, 11th Edition by John H Block, John M Beale Jr.
3. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
4. Burger's Medicinal Chemistry, Drug Discovery & Development. Abraham & Rotella. Wiley
5. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
6. Medicinal chemistry. V.K. Ahluwalia and Madhu Chopra, CRC Press.
7. Principle of medicinal chemistry. Vol 1 & 2 S. S. Kadam, K. R. Mahadik, K. G. Bothara
8. The Art of Drug synthesis. Johnson and Li. Wiley, 2007.
9. The organic chemistry of drug design & drug action. 2nd ed. By Richard B Silvermann, Academic Press.
10. The Organic Chemistry of Drug Synthesis. Lednicer and Mitsher, Wliey.
11. Text book of drug design and discovery. Povl-Krog-Sgaard-Larsen, Tommy Liljefors and ULF Madsen, 3rd Edition Taylor & Francis.
12. Bio-applications of nanoparticles. Edited by Warren C.W. Chan, Springer Publication.
13. Nanoparticle and technology for drug delivery (Drugs and pharmaceutical sciences). Ram B.Gupta&UdayB.Kompella Pub. Informa Healthcare.
14. Nano forms of carbon and its applications. Edited by Maheshwar Sharon and MadhuriSharon.MonadNanotechPvt. Ltd.
15. Environmental Chemistry. A. K. De
16. Text Book on Law and Medicine. Chokhani and Ghormade. 2nd Edition. Hind Law House,Pune.
17. Essentials of Medical Pharmacology. K D Tripathi, Jaypee Brothers Medical publishers Pvt. ltd.
    Practical organic chemistry, Vogel.

Unit – III (Dyes)

3	**3.1**		**Classification of Dyes based on Chemical Constitution and Synthesis of Selected Dyes** (Synthesis of the dyes marked with * is expected)	**(12L)**
			i)Nitro Dye: Naphthol Yellow S	
			ii) Nitroso Dye: Gambine Y	
			iii)Azo dyes: a) Monoazo dyes: Orange IV *(from sulphanilic acid) & Eriochrome Black T* (from β- naphthol) b) Bisazo dyes: Congo Red* (from nitrobenzene) c) Trisazo Dye: Direct Deep Black EW* (from benzidine)	
			iv)Diphenylmethane dye: Auramine O* (from N,N-dimethyl aniline)	
			v)Triphenylmethane dye: a) Diamine series: Malachite Green* (from benzaldehyde) b) Triamine series: Acid Magenta c) Phenol series: Rosolic acid	
			vi) Heterocyclic Dyes: a) Thiazine dyes: Methylene Blue	

			b) Azine dyes: Safranin T* (from o-toluidine) c) Xanthene Dyes: Eosin* (from phthalic anhydride) d) Oxazine Dyes: Capri Blue e) Acridine Dyes: Acriflavine	
			vii) Quinone Dyes: a) Naphthaquinone: Naphthazarin b) Anthraquinone Dyes: Indanthrene Blue* (from anthraquinone)	
			viii) Indigoid Dyes: Indigo* (from aniline + monochloroacetic acid)	
			ix) Phthalocyanine Dyes: Monastral Fast Blue B	
	3.2		**Health and Environmental Hazards of Synthetic Dyes and their Remediation Processes**	**(3L)**
		3.2.1	**Impact of the textile and leather dye Industry on the environment** with special emphasis on water pollution	
		3.2.2	**Health Hazards:** Toxicity of dyes w.r.t food colours.	
		3.2.3	**Effluent Treatment Strategies**: Brief introduction to effluent treatment plants (ETP) Primary Remediation processes:(Physical Processes) Sedimentation, Aeration, Sorption (activated charcoal, fly ashetc.) Secondary Remediation processes: Biological Remediation – Biosorption, bioremediation and biodegradation Chemical Remediation: Oxidation Processes (chlorination), Coagulation-flocculation-Precipitation	

Unit – IV (Dyes)

4	**4.1**		**Non-textile uses of dyes:**	**(8L)**
		4.1.1	**Biomedical uses of dyes** i) Dyes used in formulations (Tablets, capsules, syrups etc) Indigo carmine, Sunset yellow, Tartrazine ii) Biological staining agents Methylene blue, Crystal violet and Safranine T iii) DNA markers Bromophenol blue, Orange G, Cresol red iv) Dyes as therapeutics Mercurochrome, Acriflavine, Crystal Violet, Prontosil	
		4.1.2	**Dyes used in food and cosmetics:** i) Properties of dyes used in food and cosmetics ii) Introduction to FDA and FSSAI iii) Commonly used food colours and their limits	
		4.1.3	**Paper and leather dyes** i) Structural features of paper and leather ii) Dyes applicable to paper and leather	
		4.1.4	**Miscellaneous dyes** i) Hair dyes ii) Laser dyes iii) Indicators iv) Security inks iv) Coloured smokes and camouflage colours	
	4.2		**Pigments**	**(3L)**
			Definition of pigments, examples, properties of pigments, difference between dyes and pigments.	

			Definition of Lakes and Toners	
	4.3		**Dyestuff Industry - Indian Perspective**	**(4L)**
		4.3.1	Growth and development of the Indian Dyestuff Industry	
		4.3.2	Strengths, Weaknesses, Opportunities and Challenges of the Dyestuff industry in India	
		4.3.3	Make in India - Future Prospects of the Dye Industry	

References (For Units VII & VIII)

1. Chemistry of Synthetic Dyes, Vol I – IV, Venkatraman K., Academic Press 1972
2. The Chemistry of Synthetic Dyes and Pigments, Lubs H.A., Robert E Krieger Publishing Company, NY ,1995
3. Chemistry of Dyes and Principles of Dyeing, Shenai V.A., Sevak Publications, 1973
4. Environmental Studies, Joseph Benny, Tata McGraw Hill Education, 2005
5. Fundamental Concepts of Environmental Chemistry,Sodhi. G. S**.,** Alpha Science International, 2009
6. Planning Commission, NitiAayog, FSSAI and FDA websites
7. Green Chemistry for Dyes Removal from Waste Water- Research Trends and Applications, Ed. Sharma S.K., Wiley, 2015
8. Environmental Pollution- Monitoring and Control, Khopkar S.M., New Age International (P) Ltd, New Delhi, 1982.

B.Sc. (Chemistry) Semester – VI Paper – V Practicals

Paper code : RJSUCHEACPR605

Learning objective:

- To know preparation methods of dye intermediates.
- To learn the methods used for estimation of drugs and dyes.

1. O-Methylation of β-naphthol.
2. Preparation of anthraquinone
3. Estimation of aromatic primary amine.
4. Estimation of iodine in tincuture iodine solution.
5. Estimation of acid value of vegetable oil.

- **Industrial visit and report submission.**

B.Sc. (Chemistry) Semester – V & VI

Exam Pattern

Internal exam

Paper pattern of internal exam
Internal I – 20 Marks MCQ
Internal II – 20 Marks short questions (All questions will be compulsory)
Unit 1 – 5 marks
Unit 2 – 5 marks
Unit 3 – 5 marks
Unit 4 – 5 marks

Paper Pattern for Semester End Examination

Maximum Mark: 60 Duration : 2Hrs

There will be 5 questions each of 12 marks.

Q.1 from Unit I, Q.2 from Unit II, Q.3 from Unit III and Q.4 from Unit IV.

The pattern for above questions is as follows:

- Each question will have five sub questions of 4 marks each.
- Learners have to attempt any 3 questions out of 5.

Q. 5 will have 8 sub questions of 3 marks each (2 questions will be from each unit).

Learners have to attempt any 4 questions out of 8.

Semester end practical exam pattern

50 marks per course

- Journal : 5 marks per course
- Written test /Viva based on theory behind all the experiments conducted per course: 5 marks
- Experiment : 40 marks