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)

Course Code: RJSUCHE

CBCS: 2020 - 2021

DISTRIBUTION OF TOPICS AND CREDITS

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. Nuclear Chemistry 4. Surface Chemistry & 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
RJSUCHEPR501 RJSUCHEPR502 RJSUCHEPR503 RJSUCHEPR504	Paper I Paper II Paper III Paper IV	6	Physical Chemistry Inorganic Chemistry Organic Chemistry Analytical Chemistry

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. 2. Polarography 3. Amperometric Titrations 4. Methods of separation – II 5. Gas Chromatography. 6. Ion Exchange Chromatography 7. Food and cosmetics analysis 8. Thermal methods and analytical method validation.
RJSUCHEPR601 RJSUCHEPR602 RJSUCHEPR603 RJSUCHEPR604	Paper I Paper II Paper III Paper IV	6	Physical Chemistry Inorganic Chemistry Organic Chemistry Analytical Chemistry

SEMESTER V (THEORY)		**L**	**Cr**
Paper-I (Physical Chemistry)	**Paper Code: RJSUCHE501**	60	2.5

	UNIT I	15	
1	**MOLECULAR SPECTROSCOPY** **1.1 Rotational Spectrum**: Introduction to dipole moment, polarization of a bond, bond moment, molecular structure, Rotational spectrum of a diatomic molecule, rigid rotor, moment of 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	15	
1	**1. CHEMICAL THERMODYNAMICS** **Colligative properties:** Vapour pressure and relative lowering of vapour pressure, Measurement of lowering of vapour pressure - Static and Dynamic method. 2. **Solutions of Solid in Liquid:** i. Elevation in the boiling point of a solution, thermodynamic derivation relating elevation in the boiling point of the solution and molar mass of non-volatile solute. ii. 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. 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	**CHEMICAL KINETICS** 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. 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	15	
1	**NUCLEAR CHEMISTRY** a. **Introduction**: **B**asic terms-radioactive constants (decay constant, half-life and average life) and units of radioactivity b. **Detection and Measurement of Radioactivity:** Types and characteristics of nuclear radiations, the behavior of ion pairs in an electric field, detection and measurement of nuclear radiations using G. M. Counter and Scintillation Counter. c. **Application of use of radioisotopes as Tracers:** chemical reaction mechanism, age determination - dating by C14. d. **Nuclear reactions**: nuclear transmutation (one example for each projectile), artificial radioactivity, Q - value of nuclear reaction, threshold energy. e. **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. f. **Fusion Process:** Thermonuclear reactions occurring on stellar bodies and earth.		
	UNIT IV	15	
1	**SURFACE CHEMISTRY** **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.		
2	**COLLOIDAL STATE** i. **Introduction to colloids** - Emulsions, Gels and Sols ii. **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. iii. **Colloidal electrolytes:** Introduction, micelle formation. iv. **Surfactants:** Classification and applications of surfactants in detergents and the food industry.		
SEMESTER V (THEORY)		**L**	**Cr**
Paper-II (Inorganic Chemistry)	**Paper Code: RJSUCHE502**	60	2.5

	UNIT I	15	
1	**Chemical Bonding** **1.1 Molecular Symmetry** **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** **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 ⌠- bonding only. (Examples like: 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.		
	UNIT II	15	
2	**2.0 Solid State Chemistry** **2.1 Structures of Solids** **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** **2.2.1** Discovery of Superconductivity, **2.2.2** Explanation of terms like superconductivity, transition temperature, Meissner effect. **2.2.2** Different types of superconductors viz, conventional superconductors, organic superconductors, alkali metal fullerides and high temperature		

	Superconductors. **2.2.3** Applications of superconductors.		
	UNIT III	15	
3	**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** (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** 3.3.1 Comparison 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.		
	UNIT IV	15	
4	**4.0 Some selected topics** **4.1 Chemistry in Non-aqueous Solvents** Classification of solvents and importance of non-aqueous solvents. **4.1.1** Supercritical carbon dioxide and ionic liquids as solvents. Characteristics and study of liquid ammonia, dinitrogen tetroxide and acetic acid as non-aqueous solvents with respect to (i) acid-base reactions and (ii) redox reactions. **4.2 Chemistry of Interhalogen** **4.2.1** Introduction **4.2.2** Preparation and uses **4.2.3** Bonding **4.3 Chemistry of Pseudohalogens** **4.3.1** Introduction **4.3.2** Preparation **4.3.3** Reactions and structures **4.4 Chemistry of Xenon** **4.4.1** Introduction. **4.4.2** Compounds of xenon: oxides Fluorides and oxyfluorides with respect to preparation, properties and bonding.		
	SEMESTER V (THEORY)	**L**	**Cr**

Paper-III (Organic Chemistry)	**Paper Code: RJSUCHE503**	60	2.5
	UNIT I	15	
1	**1.1 Mechanism of organic reactions** 1.1.1 The basic terms & concepts, bond fission, reaction intermediates electrophiles & nucleophiles, Electrophilicity vs. 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 catalyzed esterification of carboxylic acids ($A_{AC}2$) and base promoted hydrolysis of esters ($B_{AC}2$). 1.1.4 Pericyclic reactions, classification and nomenclature 1.1.4.1 Electrocyclic 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		
	1.2 Photochemistry 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: photoisomerization, 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)		
	UNIT II	15	
2	**2.1 Stereochemistry I** 2.1.1 Molecular chirality and elements of symmetry: Mirror plane symmetry, inversion center, rotation-reflection (alternating) axis. 2.1.2 Chirality of compounds without a stereogenic centre: cumulenes and biphenyls. **2.2 Agrochemicals** 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, Biopesticides – Neem oil & Karanj oil. **2.3 Heterocyclic chemistry:** 2.3.1 Reactivity of pyridine-N-oxide, quinoline and iso-quinoline.		

	2.3.2 Preparation of pyridine-N-oxide, quinoline (Skraup synthesis) and iso-quinolone (Bischler- Napieralski synthesis). 2.3.3 Reactions of pyridine-N-oxide: halogenation, 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.		
	UNIT III	15	
3	**3.1 IUPAC** IUPAC nomenclature of the following classes of compounds (including compounds up to 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 up to 3 double bonds 3.1.4 Quinolines and isoquinolines. **3.2 Organic Synthesis** 3.2.1 Introduction: Linear and convergent synthesis, criteria for an ideal synthesis, concept of chemo selectivity and regioselectivity with examples, calculation of yields. 3.2.2 Multicomponent Synthesis: Mannich reaction and Biginelli reaction. 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)		
	UNIT IV	15	
4	**4.1 Spectroscopy I** 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. **4.2 Natural Products** 4.2.1. Terpenoids: Introduction, Isoprene rule, special isoprene rule and the gem-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 and N – 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)		
SEMESTER V (THEORY)		**L**	**Cr**
Paper-IV (Analytical Chemistry)	**Paper Code: RJSUCHE504**	60	2.5
UNIT I		15	

1	1.1 **Quality Concepts in Analytical Chemistry** 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)** 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** 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	15	
2	**2.1 Redox Titrations** 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** 2.2.1 Introduction, construction of titration curve 2.2.2 Use of EDTA as titrant and its standardization, 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	15	
3	**3.1 Atomic Spectroscopy: Flame Emission spectroscopy (FES) and Atomic Absorption Spectroscopy (AAS)** 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 atomizer) 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** 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** 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	15	
4	**METHODS OF SEPARATION – I** **4.1 Solvent Extraction** 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)** 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)** 4.3.1 Introduction and Principle Stationary phase, Sample application and mobile phase 4.3.2 Detectors a) Scanning densitometer- Components. Types of densitometers- Single beam and Double beam b) Fluorometric Detector 4.3.3 Advantages, disadvantages and applications 4.3.4 Comparison of TLC and HPTLC		

	SEMESTER VI (THEORY)	L	Cr
	Paper-I (Physical Chemistry) **Paper Code: RJSUCHE601**	60	2.5
	UNIT I	15	
1	**1.1 NMR -NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY** **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** **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	15	
2	**2.1 BASICS OF QUANTUM CHEMISTRY** 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 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	15	
3	**3.1 ELECTROCHEMISTRY** 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** (ΔG, ΔH &ΔS) 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	15	
4	**POLYMERS** 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)***		
SEMESTER VI (THEORY)		**L**	**Cr**
Paper-II (Inorganic Chemistry)	**Paper Code: RJSUCHE602**	60	2.5
UNIT I		15	
1	**1.0 Co-ordination Chemistry:** **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) Nephelauxetic effect iv) NMR spectra **1.2 Molecular Orbital Theory (MOT) of Coordination Compounds**		

	1.2.1 Identification of central metal orbitals 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.		
	UNIT II	15	
2	**2.0 Properties of Coordination compounds** **2.1 Electronic Spectra** **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** **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. **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.		
	UNIT III	15	
3	**3.0 Organometallic Chemistry & catalysis** **3.1 Organometallic Compounds of main group metals**		

	3.1.1 General characteristics of various types of organometallic compounds, viz, ionic, ⌠- bonded and electron deficient compounds. **3.1.2** General synthetic methods of organometallic 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 reactions: (i) Reactions with oxygen, (ii) Alkylation and arylation reactions (iii) Reactions with protic reagents and (iv) Complex formation reactions. **3.2 Metallocenes** Introduction, Ferrocene: synthesis, properties, structure and bonding on the basis of VBT. **3.3 Catalysis** **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.		
	UNIT IV	15	
4	**4.1 Nanomaterials:** **4.1.1** Introduction and importance of nanomaterials. **4.1.2** Chemical methods of synthesis of nano materials. **4.1.3** Characterization 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 (comparison between bulk and nanomaterials): i) optical, ii) Electrical and iii) Mechanical properties. **4.1.6** Applications. **4.2 Bio-inorganic and Medicinal Chemistry:** **4.2.1** Metal coordination in biological systems: Enzymes, apoenzymes 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.		
	SEMESTER VI (THEORY)	**L**	**Cr**

Paper-III (Organic Chemistry)	**Paper Code: RJSUCHE603**	60	2.5
	UNIT I	15	
1	**1.1 Stereochemistry II** 1.1.1 Stereoselectivity and stereospecificity: Idea of enantioselectivity (ee) and Diastereoselectivity (de), Trorpicity: enantiotropic and diastereotropic atoms, groups and faces. 1.1.2 Stereochemistry of – i) Substitution reactions: SNi (reaction of alcohol with thionyl chloride) ii) Elimination reactions: E_2–Base induced 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. **1.2 Amino acids & Proteins** **1.2.1** α-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.		
	UNIT II	15	
2	**2.1 Molecular Rearrangement** Mechanism of the following rearrangements with examples and stereochemistry wherever applicable. 2.1.1 Migration to the electron deficient carbon: Pinacol-pinacolone rearrangement. 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. **2.2 Carbohydrates** 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), Wohl method (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		
	UNIT III	15	
3	**3.1 Spectroscopy II** **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 (™unit), 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 characteristics of 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). Problems of 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). **3.2 Nucleic Acids** 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, Merrifield solid phase nucleotide synthesis.		

	UNIT IV	15	
4	**4.1 Polymer** 4.1.1 Introduction: terms monomer, polymer, homopolymer, copolymer, thermoplastics 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), Styrene butadiene copolymer. 4.1.6 Additives to polymers: Plasticizers, stabilizers and fillers. 4.1.7 Biodegradable polymers: Classification and uses. Polylactic acid structure , properties and use for packaging and medical purposes. **4.2 Catalysts and Reagents** 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 **d.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 benzylic bromination)		
SEMESTER VI (THEORY)		**L**	**Cr**
Paper-IV (Analytical Chemistry)	**Paper Code: RJSUCHE604**	60	2.5
UNIT I: ELECTRO ANALYTICAL TECHNIQUES			

1.1	**Polarography**			
	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**		**04 L**	
	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 demineralized 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 Disodiumtartarate**.**		
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		

Semester V (PRACTICALS)		L	Cr
Practical-I (Physical)	**Paper Code:** RJSUCHEPR501		1.5
1	**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.		
Practical-II (Inorganic)	**Paper Code:** RJSUCHEPR502		1.5
2	**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 from the supplied commercial sample of milk of magnesia.		

	Practical-III (Organic)	**Paper Code:** RJSUCHEPR503		1.5
3	**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 analyzed and detected. This component is not to be weighed. b) The other component is dried, weighed and the m.p. is to be determined.			
	Practical-IV (Analytical Chemistry)	**Paper Code:** RJSUCHEPR504		
4	1. Estimation of fluoride content in the given solution calorimetrically. 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.			

Semester VI (PRACTICALS)		L	Cr
Practical-I (Physical Chemistry)	**Paper Code:** RJSUCHEPR601		1.5
1	**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.			
Practical-II (Inorganic Chemistry)	**Paper Code:** RJSUCHEPR602		1.5
2	**Inorganic Preparations:** 1) Preparation of Tris-(ethylenediamine) Ni (II)Thiosulphate 2) Preparation of Tetraammine copper (II)sulphate 3) Preparation of Magnesiumoxinate **Complexometric Titrations:** 1) Estimation of Nickel. 2) Estimation of Copper. 3) Estimation of Magnesium **(EDTA to be standardized)**		
Practical-III (Organic Chemistry)	**Paper Code:** RJSUCHEPR603		1.5

3	**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 identified can be decided by the examiner. The other component's vol/ weight and m.p/b.p to be reported.		
	Practical-IV (Analytical Chemistry)	**Paper Code:** RJSUCHEPR604	
4	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.		

T.Y. BSc.	Semester V Theory
RJSUCHE501 Paper I **Physical Chemistry**	**Course Outcomes:** ➢ To expose the learner to the basic concepts of surface chemistry and colloidal systems. ➢ To understand detection of radioactivity by using different types of counters. To study the principles of nuclear fission and nuclear fusion. ➢ to study the origin of rotational, vibrational and Raman spectra. ➢ to identify selection rules and relationship between structure and composition of molecules. ➢ to study the colligative properties and their methods of determination. ➢ to study the reaction rate theories and methods to study fast reactions. **Learning outcomes:** After successful completion of the course, the learner will be able to ➢ learn the basics of rotational spectroscopy as well as its application in determination of internuclear distance in a molecule. ➢ 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. ➢ understand the basics of Raman spectroscopy and comparison between IR & Raman spectra. ➢ analyze Rotational, Vibrational and Raman spectra and correlate with structure of molecule. ➢ detect the presence of different functional groups, isotopes in the molecule from the spectral data. ➢ justify the strength of bonds from the spectral information. ➢ learn the colligative properties of dilute solution and the methods used to determine the same. ➢ know the collision theory of reaction rates applied to unimolecular and bimolecular reactions. ➢ study the kinetics of fast reactions. ➢ determine the molecular weight of dissolved solute. ➢ to understand advantages and disadvantages of osmotic pressure. ➢ to obtain the dependence of reaction rate on reactant concentration on the basis of collision theory.

	➢ Understand techniques for determination of rate of fast reactions which are difficult to determine by slow classical methods. ➢ learn the basic terminologies involved in nuclear chemistry. ➢ understand how the nuclear radiations are detected and measured. ➢ study the nuclear fission & fusion processes, nuclear reactors and the applications of radioisotopes as tracers. ➢ distinguish between physical adsorption and chemical adsorption. ➢ explain the Langmuir adsorption isotherm & BET equation; ➢ determine the surface area of an adsorbent. ➢ understand the concepts of sol, gel, emulsion, electrical double layer, electrokinetic phenomena, colloidal electrolytes and surfactants.
T.Y.BSc	Semester V Theory
RJSUCHE502 Paper II **Inorganic Chemistry**	**Course Outcomes:** ➢ Students learn about the symmetry operations, solid state molecules, super conductivity, Inner transition elements and acid-base reactions. ➢ The topic, Chemistry of Inner transition elements will enable students understand two series of inner transition elements,w.r.t.their position in periodic table, their properties and separation methods. ➢ **Learning outcomes:** ➢ Students become aware of the symmetry elements present in the molecules, to perform different operation on the molecules and to assign point group. ➢ Students understand the packing density in SC, BCC, FCC and HCP structures, concept of voids and calculation of tetrahedral void. Also understand the phenomenon of superconductivity and the properties of superconductors. ➢ Students learn to justify placing of lanthanides in f block based on electronic configuration and their physical properties. The phenomenon of lanthanide contraction and its impact on post lanthanide elements, difficulties in their separation and separation methods such as solvent extraction, ion exchange are understood. ➢ Students become aware of the acid – base and redox reactions in non-aqueous solvents, properties and structures of interhalogen and xenon compounds.

T.Y.BSc.	Semester V Theory
RJSUCHE503 Paper III **Organic Chemistry**	**Course Outcomes:** ➢ On completion of this course students will understand and explain the mechanism of pericyclic reactions and its stereochemistry. ➢ Understand and illustrate the applications of photochemistry in organic synthesis ➢ To study various symmetry elements associated with organic compounds. ➢ To know different types of agrochemicals and synthesis of a few of them. ➢ To study advanced heterocycles. ➢ Students will learn IUPAC Nomenclature of Bicyclo, Spiro Compound with multiple functional groups and substituents. ➢ Students will learn the incorporation of green chemistry and safety during synthesis, design of compounds in the laboratory. ➢ Students will learn the importance of natural products and alkaloids in drug discovery, synthetic modifications and retro-approach for structure elucidation. **Learning outcomes:** ➢ Understanding of the fundamentals of chirality with suitable illustrations. ➢ Acquire knowledge on agrochemicals as an applied organic chemistry topic with synthesis of certain compounds. ➢ Understanding of heterocyclic chemistry at an advanced level. ➢ Understand IUPAC nomenclature of bicyclic systems. ➢ Understand the concept of organic synthesis from the basic concepts to modern methods of synthesis with a reference to Green synthesis. ➢ Understand Basics of spectroscopy To explore UV –Visible and Mass spectroscopic techniques as a tool in structural elucidation of organic compounds. ➢ Understand natural products chemistry w.r.t. terpenoids and alkaloids. ➢ Understand and propose mechanisms of organic reactions to introduce the concept of pericyclic reactions with relevant examples. ➢ Understand organic photochemistry w.r.t. basic principles and selected photochemical reactions.

T.Y. B.Sc.	**Semester V Theory**
RJSUCHE504 Paper IV **Analytical Chemistry**	**Course Outcomes:** ➢ Understand the accurate procedure of sampling or calculating errors involved in measurement. ➢ To learn basic principles of redox and complexometric titration. & To learn Basic Principle, working and applications of various optical methods like AAS, Flame Photometry, Turbidimetry, Nephelometry, Phosphorimetry, Fluorimetry. ➢ To learn the principle and working of solvent extraction, HPLC and HPTLC. **Learning outcomes:** On completion of this course student will ➢ Acquire a basic knowledge and understanding of core principles of analytical chemistry. ➢ Create awareness amongst learners about the scope of analytical chemistry in various fields. ➢ Acquire a basic knowledge of redox titration and complexometric titration ➢ Understand basic analytical techniques and practical aspects of classical chemical analysis, ➢ modern instrumental methods of analysis and separation techniques. ➢ solve problems related to chemical analysis and interpret analytical results. ➢ inculcate research culture in learners. ➢ Acquire a basic knowledge and understanding of separation techniques like solvent extraction, HPLC and HPTLC.

T.Y. BSc.	**Semester VI Theory**
RJSUCHE601 Paper I	**Course Outcomes:** ➢ To study the origin, principle (quantitative relationship) and instrumentation of NMR and ESR spectroscopy.

Physical Chemistry	➢ To study the significance and future preparedness for availing renewable sources of energy with special emphasis on solar energy. ➢ To study electrolytic preparation, storage and safe application of hydrogen gas. ➢ To study the laws of quantum mechanics and their implementation in predicting the mechanical parameters. ➢ To impart basic concepts of polymer chemistry and light emitting polymers. ➢ To understand the application of Nernst equation on different types of concentration cells. To study in detail about applied electrochemistry. **Learning outcomes:** After successful completion of the course, the learner will be able to ➢ Study the principle, instrumentation, working and applications of NMR. ➢ Study the principle, instrumentation, working and applications of ESR. ➢ select and apply mathematical functions for tracking the behaviour of quantum systems. ➢ learn the basics of quantum mechanics and terminologies involved in it. ➢ Study the renewable energy sources: solar energy and hydrogen as fuel. ➢ Learn the basic terminologies involved in electrochemistry. ➢ Study the classification of cells. ➢ Understand the polarization process, decomposition potential and over voltage. ➢ Grasp the basic terminologies involved in polymer chemistry. ➢ Calculate/determine the molecular weight of a polymer ➢ Understand the importance of polymer additives ➢ Explain the principle, construction, working & applications of light emitting polymers. ➢ To understand and interpret observed NMR and ESR signals with the chemical and electronic environment nuclei, atoms, molecules and radicals.
T.Y. BSc.	**Semester VI Theory**
RJSUCHE602 Paper II	**Course Outcomes:**

Inorganic Chemistry	➢ Students learn in detail about coordination chemistry, concept of stability of the coordination complexes, organometallic complexes and nano materials. ➢ The topic Organometallic Chemistry will impart the knowledge of organometallic compounds (OMCs) of main group elements w.r.t to their methods of synthesis, chemical properties. Concept of sandwitch compounds (metallocenes) will be understood. Application of OMCs as catalysts will be understood with specific catalytic reactions. **Learning outcomes:** ➢ Students understand the concept of metal ions and ligands, effect of ligands in various geometries around metal ions responsible for crystal field splitting. ➢ Also understand the Effect of crystal field splitting on various physical and chemical properties of complex compounds. Further students should understand the need for the concept of MOT, construction of ligand group orbitals, molecular orbitals for octahedral complexes. ➢ Students understand the basics of the origin of electronic spectra, different terms and term symbols, and the concept of Rusell-Sauders coupling. It may help in determination of terms and term symbols for different atoms/ions. ➢ Students also learn about the ability of complexes and its reactivity in different chemical reactions. ➢ Students learn the basic concept of organometallic compounds, their synthesis, structure, bonding and applications. ➢ Metallocene, ferrocene, is understood in view of its structure and bonding. The concept of catalysis and importance of organometallic compounds as catalysts is understood wrt a few catalytic reactions (Wilkinson catalysis, Heck and Suzuki reaction). . ➢ Students understand the concept of nanomaterials, its synthesis, characterization and applications in different fields. ➢ Also study the role of metal ions in biological systems, different biochemical terms and the role of metal complexes in medicine.
T.Y. BSc.	Semester VI Theory
RJSUCHE603 Paper III **Organic Chemistry**	**Course Outcomes:** ➢ Students will be able to reason why the properties of stereoisomers of a compound are different and reactions to prepare stereo-isometrically pure compounds. ➢ Amino acids classification and synthesis, classification of proteins.

	➢ To study some selected rearrangement reactions with mechanisms. ➢ To study various structural formulae of different carbohydrates. ➢ To know different reactions of carbohydrates. ➢ understand and know the concept of IR and NMR spectroscopy apply the concept of IR and NMR spectroscopy for structural elucidation of organic compound ➢ Students will have a clear idea about types, synthesis and applications of polymers. ➢ Different types of oxidation and reduction catalysts used in organic synthesis. **Learning outcomes:** ➢ Understand stereochemistry of reactions with selected examples. ➢ Get a brief idea of amino acids and proteins with emphasis on nomenclature and properties. ➢ Study the mechanistic aspects of molecular rearrangement and selected name reactions. ➢ Understand carbohydrate chemistry w.r.t. mono-saccharides with 5 & 6 carbons including reactions and stereochemical aspects. ➢ Understand 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. ➢ Study the structure of nucleic acids - a basic approach. ➢ Understand organic synthetic polymers w.r.t. preparation, properties & uses of selected polymers. ➢ Acquire knowledge on catalysts and reagents in organic synthesis.
T.Y.BSc	**Semester VI Theory**
RJSUCHE604 Paper IV **Analytical Chemistry**	**Course Outcomes:** ➢ To learn polarographic techniques ➢ To impart basic concepts of chromatographic techniques like ion exchange chromatography and Gas Chromatography ➢ study ingredients and methods of analysis of products used our daily needs

	➢ To impart knowledge of various thermal methods like TGA, DTA, thermometric titration ➢ To understand method validation and validation parameters like selectivity, sensitivity etc. **Learning outcomes:** On successful completion of this course students will be able to ➢ study the principal & working of various instruments. ➢ learn various techniques involved in separation of mixtures of chemicals. ➢ Understand the basic concepts of ion exchange chromatography and Gas Chromatography ➢ study ingredients and methods of analysis of products used our daily needs ➢ develop modern methods of separation or analysis of various products. ➢ Understand principle and working of thermal methods like TGA, DTA, thermometric titration ➢ Understand how analytical methods are validated and which are the parameters used.

T.Y.B.Sc	**Semester V Practical**
RJSUCHEPR501	**Course Outcomes:** ➢ Study rate of reaction, quantitative adsorption, potentiometric and pH metric estimation. **Learning outcomes:** ➢ learn how to determine the order of a reaction by a fractional change method. ➢ How to test the validity of Freundlich adsorption isotherm. ➢ learn how to estimate the amount of halides in their mixture as well as to determine the solubility of AgCl potentiometrically. ➢ learn how to determine the isoelectric point of an amino acid.

T.Y.B.Sc	Semester V Practical

RJSUCHEPR502	**Course Outcomes:** ➢ Students learn the synthesis of various complexes and to estimate the metal content in the complexes by volumetric estimations. **Learning outcomes:** ➢ Students learn to prepare co-ordination complexes of nickel, copper and magnesium and also learn to estimate the amount of metal content in the complex by using EDTA..

T.Y.B.Sc	Semester V Practical
RJSUCHEPR503	**Course Outcomes:** ➢ To impart knowledge to carry out the separation of organic solids from their mixture. **Learning outcomes:** ➢ Able to carry out separation of solid mixtures of organic compounds using chemical method.

T.Y. B.Sc.	Semester V Practical
RJSUCHEPR504	**Course Outcomes:** ➢ To learn methods for the assay of commercial samples. ➢ To use various instrumental methods. **Learning outcomes:** ➢ carry out assay of commercial samples. ➢ calculate the error in various ways by using their experimental data. ➢ carry out analysis of water samples for various parameters.

T.Y. B.Sc.	Semester VI Practical

RJSUCHEPR601	**Course Outcomes:** ➢ Study the graphical method, viscometric method, colorimetric and conductometric methods for various reactions. **Learning outcomes:** Learner will be able to ➢ Determine the order of a reaction by plotting a graph. ➢ Find out the molecular weight of polymer samples by viscometry. ➢ Confidently use common lab instruments

T.Y. B.Sc.	Semester VI Practical
RJSUCHEPR602	**Course Outcomes:** ➢ Students learn quantitative techniques involving synthesis and estimations. **Learning outcomes:** ➢ Students learn to prepare transition metal complexes. ➢ Also learn to estimate copper by iodometry and to estimate the amount of magnesium from the supplied sample of milk of magnesia.

T.Y. B.Sc.	Semester VI Practical
RJSUCHEPR603	**Course Outcomes:** ➢ To train the students to separate the liquid-liquid and solid-liquid mixtures of organic compounds **Learning outcomes:** ➢ On successful completion of this course students will be able to get a clear understanding of separation technique for Liq.- Liq. and Liq.-Solid mixtures using distillation method.

T.Y.B.Sc.	Semester VI Practical
RJSUCHEPR604	**Course Outcomes:** ➢ To impart the knowledge of various ways of analyzing commercial samples

	Learning outcomes: ➢ Use the technique of ion exchange for separation & estimation of metal ions. ➢ Have experience of handling various instruments and preparation of samples for it. ➢ Carry out analysis of water.

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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

Semester end exam paper pattern

Total marks: 60

- Each question paper will have 5 questions of 12 marks each.
- All questions will be compulsory.
- The nature of Q.1 (from unit 1), Q.2 (from unit 2), Q.3 (from unit 3), Q.4 (from unit 4) will be as follows:
- Learners to answer any **3** questions out of 5 (each of 4 marks)
- Q.5 will be of type:
  A or A from unit 1 of 3 marks
  B or B from unit 2 of 3 marks
  C or C from unit 3 of 3 marks
  D or D from unit 4 of 3 marks

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: 10 marks
- Experiment : 35 marks