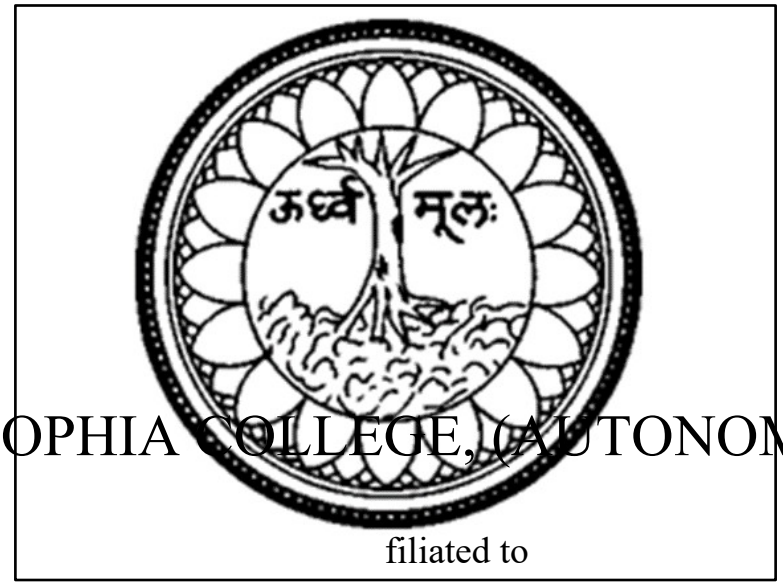

SOPHIA COLLEGE, (AUTONOMOUS)

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NIVERSITY OF MUMBAI

Pr

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Y.B.Sc.

(Choice Based Credit System with effect from the year 2020-21)

		Phosphorescence Spectroscopy 3.3 Turbidimetry and Nephelometry	
	4	4.1 Chromatography 4.2 Ion exchange chromatography 4.3 High Performance Liquid Chromatography	

SBSCHEP5		PRACTICALS	6

Applied Component

Course Code	Title of the Paper	Unit	Topic	Credits
SBSAPC501	**Pharmaceutical and Colour Chemistry**	1	1.1 General Introduction to Drugs 1.2 Routes of drug administration and dosage forms 1.3. Pharmacodynamic Agents	2
		2	2.1 Analgesics, Antipyretics and Anti-Inflammatory Drugs 2.2 Antihistaminic Drugs 2.3 Cardiovascular Drugs 2.4 Antidiabetic Agents 2.5 Antiparkinsonism Drugs 2.6 Drugs for Respiratory System	
		3	3.1 Introduction to the dye-stuff industry 3.2 Natural and Synthetic Dyes 3.3 Relation Between Colour and Chemical Constitution 3.4 Fluorescent Brightners 3.5 Pigments	
		4	4.1 Classification of Dyes Based on Application 4.2 Types of Fibres and Dye Fibre attachment 4.3 Basic Operations Involved in Dyeing Process 4.4 Dyeing Method of Cotton Fibers 4.5 Some Important Reactions in Dye Synthesis 4.6 Preparation of Some Intermediates	
SBSAPCP501	Applied component Practical	-	-	2

Programme Outline: TYBSc (SEMESTER VI)

Course Code	Unit No	Name of the Unit	Credits
SBSCHE601		PHYSICAL CHEMISTRY	2.5
	1	1.1Electrochemistry – III 1.2 Renewable energy resources	
	2	2.1 Polymers 2.2Phase Equilibria - II and thermodynamic relationships	
	3	Basics of quantum mechanics	
	4	Molecular Spectroscopy - IV	

SBSCHE602		INORGANIC CHEMISTRY	2.5
	1	Theories of metal ligand bond-I	
	2 2. 2	Theories of metal ligand bond-I 2.1 Stability of metal complexes 2.2 Reactivity of metal complexes 2.3 Electronic spectra	
	3	3.1 Organometallic chemistry 3.2 Metallocenes 3.3 Catalysis	
	4	4.1 Chemistry of Group 17 4.2 Chemistry of Group 18	
SBSCHE603		ORGANIC CHEMISTRY	2.5
	1	Spectroscopy- I (UV-VIS, IR AND 1H NMR)	
	2	2.1 Stereochemistry -IV 2.2 Name Reactions	
	3	3.1 Carbohydrates 3.2 Amino acids and proteins 3.3 Nucleic acids	
	4	4.1 Polymers 4.2 Heterocyclic chemistry	
SBSCHE604		ANALYTICAL CHEMISTRY	2.5
	1	1.1Redox titrations 1.2 Complexometric titrations 1.3 Precipitation titration	
	2	2.1 Thin Layer Chromatography 2.2 Paper Chromatography 2.3 Gas Chromatography	
	3	3.1 Polarography 3.2 Amperometric titrations	
	4	4.1 Thermal methods 4.2 Radioanalytical methods 4.3 Mass Spectrometry	
SBSCHEP6		PRACTICALS	6

Applied Component

Course Code	**Title of The Paper**	**Unit**	**Topic**	**Credits**
SBSAPC601	**Pharmaceutical and Colour Chemistry**	1	1.1 Drug Discovery, Design And Development	
		2	2.1Antibiotics And Antivirals 2.2Antimalarials	

			2.3Antihelmintics and Antifungal Agents 2.4Antiamoebic Drugs 2.5Antitubercular and Antileprotic Drugs 2.6Anti-Neoplastic Drugs 2.7Anti-HIV Drugs 2.8Drug Intermediates: Synthesis and Uses 2.9Nano Particles in Medicinal Chemistry	
		3	3.1 Classification of Dyes Based on Chemical Constitution And Synthesis of Selected Dyes 3.2 Dyes Used in Food And Cosmetics	
		4	4.1 Non-Textile Uses of Dyes 4.2 Chromic Materials 4.3 Health and Environmental Hazards of Synthetic Dyes and their remediation processes	
SBSAPCP601	Applied component Practical	-		

Preamble:

Programme: BSc Chemistry

Chemistry - a vibrant and ever growing science that encompasses every aspect of our lives. The fascinating study of matter and its applications is vital in areas like drug designing, material science, nanotechnology and most importantly, 'green chemistry', areas that are beneficial to both humanity and the environment. Bachelor's degree in Chemistry is the culmination of in-depth knowledge of Inorganic, Organic and Physical chemistry, Analytical chemistry and specialized courses such as Pharmaceutical Chemistry, spectroscopy, Nanoscience, Forensic Science, Cosmeticology, Food chemistry, Dairy Chemistry, Environmental chemistry and so on.

The learning objectives are designed to provide a focused outcome based syllabus with an agenda to structure the teaching learning experiences in a more student centric manner. This programme helps learners in building a solid foundation for higher studies in Chemistry. The hands-on experience the students gain in Practical enable them to apply theoretical knowledge acquired to solve problems in everyday life, think critically and innovatively. The syllabus is designed so that the student starts from the basic concepts of chemistry and will gradually move towards the advanced level. They are given opportunities to improve their creativity, scientific writing and communication skills through assignments and other co-curricular activities in all the semesters. The credit courses on "Positive Health in Women" and "Innovation in Natural dyeing and Entrepreneurship Skills" offered by the department further enhances their life skills and helps them evolve as entrepreneurs.

Students completing this programme will be equipped with knowledge of the concepts of Chemistry, interpret data and present their findings to both the scientific community and laymen. Completion of this programme will also enable the learners to join teaching professions, conducting research in Industry and Government run research labs.

PROGRAMME OBJECTIVES	
PO1	The students are expected to understand the basic concepts in chemistry and be aware of the recent development in the subject area.
PO2	To inculcate critical thinking and scientific attitude in the students.
PO3	The students should be able to apply the theoretical knowledge and practical skills acquired to solve the real world problems and environmental issues.

PROGRAMME SPECIFIC OBJECTIVES	
PSO1	**Core competency:** The chemistry graduates are expected to gain the theoretical and practical knowledge of the basic concepts in chemistry.
PSO2	**Skill development:** They would acquire necessary skills and training to pursue higher studies in the field of chemistry and to be an entrepreneur.
PSO3	**Responsible citizens:** The students will get trained to adopt and practice sustainable techniques for their personal growth and to address societal and environmental problems.

SEMESTER 5

NAME OF THE COURSE	PHYSICAL CHEMISTRY	
CLASS	TYBSc	
COURSE CODE	SBSCHE501	
NUMBER OF CREDITS	2.5	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	To understand different types of spectroscopy - rotational, vibrational and raman spectroscopy and numericals based on them
CO 2.	To study different types of adsorption isotherms, properties of colloidal solutions and applications of surfactants
CO 3.	To study different transmutation reactions, applications of radioisotopes, fission and fusion processes and to calculate the Q-values
CO 4.	To study the influence of ionic strength, hydrostatic pressure, dielectric constant and effect of substituents on the rate of reactions

COURSE LEARNING OUTCOMES: Learner will be able to

CLO 1.	solve numerical based on energy levels, wavenumbers and Raman spectra
CLO 2.	determine the surface area of an adsorbent using B.E.T. equation
CLO 3.	understand and apply the Hammet equation, also comment on how ionic strength affects the rate of reactions using numerical
CLO 4.	explain the electrical properties of colloids, micellization and classify surfactants
CLO 5.	calculate the Q-values, explain the nuclear reactor, fissile material and applications of radioisotopes as tracers

UNIT	TOPIC	Lectures
I	**MOLECULAR SPECTROSCOPY**	**15**

		L
1.1 **1.2** **1.3** **1.4**	**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 (Numericals expected) **Vibrational Spectrum -** Vibrational motion, degrees of freedom, modes of vibration, vibrational spectrum of a diatomic molecule, simple harmonic oscillator, energy levels, zero point energy (Numericals expected), conditions for obtaining vibrational spectrum, selection rule and nature of spectrum. **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 (Numericals expected). Application of vibrational-rotational spectrum in determination of force constant; its significance. Infrared spectra of simple molecules like H_2O and CO_2. **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 (Numericals expected), comparative study of IR and Raman spectra, rule of mutual exclusion - CO_2 molecule.	
II	**2.1 SURFACE CHEMISTRY**	**8L**
	Adsorption - Physical and Chemical Adsorption, types of adsorption isotherms, Langmuir's adsorption isotherm, B.E.T equation for multilayer adsorption, (derivation not expected). Determination of surface area of an adsorbent using B.E.T. equation (Numericals expected)	
	2.2 COLLOIDAL STATE	**7L**
2.2.1 **2.2.2** **2.2.3** **2.2.4**	**Introduction to Colloids -** Emulsions, Gels, Sols. **Electrical properties of colloids -** Origin of charge 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. **Colloidal Electrolytes -** Introduction, classification; Properties of colloidal electrolytes, types of ionic micelles, micellization, Critical Micelle Concentration. **Surfactants:** Introduction, Classification, reverse micelles, solubilization of surfactant solutions; applications of surfactants in detergents, insecticides and food industry.	
III	**NUCLEAR CHEMISTRY**	**15L**

3.1 **3.2** **3.3** **3.4** **3.5** **3.6**	**Law of disintegration**(Numericals expected) **Detection of radiation -** Characteristics of nuclear radiations, behavior of ion pairs in electric field, GM counter, Scintillation counter **Application of radioisotopes -** Use of radioisotopes as tracers **Nuclear reactions -** Nuclear transmutation, artificial radioactivity, Q – value of nuclear reaction, threshold energy (Numericals expected) **Fission process -** Fissile and fertile material, nuclear fission, chain reaction, factor controlling fission process- Multiplication factor and Critical size or mass of fissionable materials, nuclear power reactor and breeder reactor. **Fusion process -** Thermonuclear reactions occurring on stellar bodies and earth.	
IV	**4.1 DILUTE SOLUTIONS**	**8L**
	Colligative properties - Vapour pressure and relative lowering of vapour pressure – Raoult's Law. Measurement of lowering of vapour pressure- Static and Dynamic method. **Elevation of Boiling point -** Thermodynamic derivation relating elevation in boiling point of the solution and molar mass of non- volatile solute (Numericals expected). **Depression of Freezing point -** Thermodynamic derivation relating depression in the freezing point of the solution and molar mass of non- volatile solute (Numericals expected) **Osmotic pressure -** Introduction, thermodynamic derivation of Van't Hoff equation, Van't Hoff factor (Numericals expected), Measurement of Osmotic Pressure- Berkeley and Hartley's method, Reverse Osmosis- principle and method.	
4.2.1 **4.2.2** **4.2.3** **4.2.4**	**Influence of solvent dielectric constant** **Influence of ionic strength (Numericals expected)** **Influence of hydrostatic pressure** **Linear Gibbs energy relationships- (Hammett's equation)** -Substituent constant, reaction constant, equation, reaction mechanism, σ constant	**7L**
	PRACTICALS **Course Objectives:** 1. To train the students to handle different instruments and maintain laboratory discipline 2. To carry out the experiments mentioned in the course and thereby be able to correlate the importance of the theory with the practical experiments **Course Outcomes: Learner will be able to** 1. Understand the handling of instruments and correlate practical experiments with theoretical knowledge 2. Set up different electrochemical cells 3. Practice laboratory safety measures and precautions to be taken while handling the instrument, electrodes and different chemicals 1. To investigate the adsorption of acetic acid on activated charcoal and test the validity of Freundlich adsorption isotherm. 2. To determine the Critical Micelle Concentration of sodium lauryl sulfate from the measurement of conductance at different concentrations. 3. To determine the solubility product and solubility of AgCl potentiometrically using a chemical cell.	**24L**

	4. To determine the amount of iodide, bromide and chloride in the mixture by potentiometric titration. 5. To determine the half-life, decay constant and the average life of a radioactive element graphically. 6. To study the influence of ionic strength on reaction between potassium persulphate and potassium iodide. 7. To determine the Hamette's constant of ortho-, meta- and para- amino/nitro benzoic acid by pH measurements.	

References

Theory

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. Fundamental of Molecular Spectroscopy, 4th Edn. Colin N Banwell and Elaine McCash Tata McGraw Hill Publishing Co. Ltd. New Delhi, 2008.
4. Physical Chemistry, G.M. Barrow, 6th Edition (2007), Tata McGraw Hill Publishing Co. Ltd. New Delhi.
5. The Elements of Physical Chemistry, P.W. Atkins, 2nd Edition, Oxford Universtity Press Oxford.
6. Polymer Science, V.R. Gowariker, N.V. Viswanathan, Jayadev Sreedhar, New Age International (P) Ltd., Publishers, 2005.
7. Essentials of Nuclear Chemistry, Arnikar, Hari Jeevan, New Age International (P) Ltd., Publishers, 2011.
8. Physical Chemistry, Keith J Laidler, John H. Meiser, 2nd Edition, CBS publication and distributors Pvt. Ltd.

Practical

1.Experiments in Physical Chemistry C.W. Garland, J.W. Nibler and D.P. Shoemaker, McGraw Hill New York 8th Edition (2003)

2.Practical Physical chemistry, Vishwanathan B. and Raghavan P.S. Viva Books (2017)

3.Experimental Physical Chemistry, V.D. Athawale and P. Mathur, New Age International Publishers, 2001

NAME OF THE COURSE	INORGANIC CHEMISTRY	
CLASS	TYBSc	
COURSE CODE	SBSCHE502	
NUMBER OF CREDITS	2.5	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	To expose students to the concept of symmetry and symmetry elements
CO 2.	To understand structure of crystalline solids and defects
CO 3.	To learn the preparation and properties of superconductors and nanomaterials
CO 4.	To familiarize with chemistry of inner transition elements

COURSE LEARNING OUTCOMES: Learner will be able to

CLO 1.	interpret the symmetry of simple inorganic molecules and assign appropriate point groups
CLO 2.	classify crystalline solids based on structures
CLO 3.	write synthesis, properties and application of superconductors and nanomaterials
CLO 4.	compare properties of inner transition elements and transition elements

UNIT	TOPIC	
I	**MOLECULAR SYMMETRY AND CHEMICAL BONDING** **L11Lecture**	
1.1	**Molecular symmetry:** Introduction, importance, symmetry elements and operations. Concept of point groups with illustrations.	**8L**
1.2	**Chemical bonding:** MOT of heteronuclear diatomic and polyatomic species (**BeH_2, H_2O, H_3^+**). Molecular shapes of linear and angular molecules. Walsh co-relation diagrams of H_2O and H_3^+.	**7L**
II	**SOLID STATE CHEMISTRY**	
2.1	**Structure of solids:** Explanation of terms, closest packing of rigid spheres (SC, BCC, FCC, HCP) packing density, concept of voids, limiting radius ratio. Point defects in solids: ionic (Frenkel and Schottky) and non-ionic (vacancy and interstitial)	**8L**
2.2	**Solid state synthesis:** Film deposition using dip coating, spin coating, chemical vapor deposition.	**4L**
2.3	**Superconductivity:** Discovery, types, explanation of terms and applications	**3L**
III	**CHEMISTRY OF INNER TRANSITION ELEMENTS**	
3.1	**Chemistry of lanthanides:** Position in the periodic table and electronic configuration. Properties, occurrence, extraction and separation	**12L**

3.2	of Lanthanides; Applications of lanthanides **Chemistry of actinides (only Uranium):** Occurrence, extraction and application	**3L**
IV	**MISCELLANEOUS TOPICS**	
4.1 **4.2** **4.3**	**Comparative Chemistry of group 16**: Electronic configuration, trends in physical properties, allotropy. Manufacture of sulfuric acid by Contact process **Nano materials:** Introduction, properties (optical and electrical), methods of synthesis and applications **Non aqueous solvents:** Classification and importance of non-aqueous solvents. Characteristics and study of liquid ammonia and liquid dinitrogen tetroxide as non-aqueous solvents with respect to acid-base and redox reactions. Supercritical carbon dioxide and ionic liquids as solvents	**5L** **5L** **5L**
	PRACTICALS **Learning objectives** 1. To train students to prepare simple inorganic complexes, silver nanoparticles and to analyze given inorganic complexes 2. to analysis metal ions from variety of samples by complexometry 3. to train students to perform titrimetric analysis under non-aqueous conditions **Learning outcomes: The learner will be able to** 1. prepare and analyze simple inorganic complexes 2. prepare and characterize silver nanoparticles using UV spectrophotometer 3. estimate metal ions from an unknown sample with high degree of accuracy complexometrically 4. carry assay of given drug samples by non-aqueous titrations 1. Preparation of trisethylenediammine nickel thiosulphate complex. 2. Preparation of tetra amine copper complex. 3. Estimation of copper (complexometrically/iodometrically) in tetra amine copper complex. 4. Estimation of lead complexometrically (Standardization of EDTA expected) 5. Estimation of calcium from milk sample by EDTA back titration. 6. Preparation of silver nanoparticles and their spectroscopic characterization. 7. Estimation of two commercial drug samples using non aqueous titration.	**24L**

References

Theory

1. Concise Inorganic Chemistry, J.D. Lee, 4th Edn , ELBS
2. Inorganic Chemistry: Principles of Structure and Reactivity, James E. Huheey
3. Mechanisms of Inorganic Chemistry, Basolo F and Pearson R.C., John Wiley & Sons, NY,
4. Organometallic Chemistry: A Unified Approach, Ram Charan Mehrotra, New Age International.
5. Inorganic Chemistry, D. F. Shriver and P. W. Atkins, 3rd edition, Oxford University Press (1999)
6. Advanced Inorganic Chemistry, Cotton and Wilkinson, 3rd Edition.

Practical

1. Practical Inorganic Chemistry, Shikha Gulati, JL Sharma, Shagun Manocha, CBS Publishers and distributors.
2. Vogel Textbook of Quantitative Chemical Analysis G.H. Jeffery, J. Basset.

3. Advanced Experiments in Inorganic Chemistry, G. N. Mukherjee, 1st Edn, 2010, U.N. Dhur & Sons Pvt Ltd.

NAME OF THE COURSE	ORGANIC CHEMISTRY	
CLASS	TYBSc	
COURSE CODE	SBSCHE503	
NUMBER OF CREDITS	2.5	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

To understand

CO 1.	Method of naming organic compounds
CO 2.	Mechanisms of reactions and name reactions, catalysts and reagents involved in reactions (including selectivity), preparation and reactions of organometallic compound
CO 3.	Stereochemistry of compounds without stereogenic center and cycloalkanes
CO 4.	Natural products and their structure determination and synthesis and basic principles of photochemistry and some of the reactions.

COURSE LEARNING OUTCOMES:

Learner will be able to

CLO 1.	To identify and write the mechanism of reactions studied with different substrates, apply various catalysts and reagents for interconversion of functional groups
CLO 2.	Identify the optical activity of molecules without stereogenic center and stereospecific and stereoselective reactions
CLO 3.	Name a organic compound
CLO 4.	Identify and classify the natural products, determine the structure of some natural products.

UNIT	TOPIC	Lectures
I	**MECHANISM OF ORGANIC REACTIONS**	**15L**
1.1	Basics terms and concepts - bond fission, reaction intermediates, electrophiles and nucleophiles, ligand, base, electrophilicity vs. acidity and nucleophilicity vs basicity.	
1.2	Thermodynamic and kinetic control of organic reactions - concept with mechanism of	

1.3	the following addition of HX to butadiene; sulfonation of napthalene Neighbouring group participation in nucleophilic substitution reactions - participation of lone pair of electrons, kinetics and stereochemical outcome.	
1.4	Pyrolytic elimination - Cope, Chugaev, pyrolysis of acetates.	
1.5	Pericyclic reactions – introduction, definition, characteristics and types - Electro cyclic reactions (ring opening and ring closing), cycloaddition, sigma tropic rearrangement, cheletropic reaction	
1.6	Frontier Molecular orbitals FMO approach towards cycloaddition reactions (Diels Alder reaction and ethene dimerization), Woodward Hofmann rules	
1.7	Molecular rearrangements - mechanism of following rearrangements with examples and stereochemistry wherever applicable a) Migration to electron deficient carbon: Pinacol, Benzylic acid b) Migration to electron deficient nitrogen- Beckmann, Hofmann c) Migration involving a carbanion - Favorskii.	
II	**2.1 IUPAC NOMENCLATURE OF THE FOLLOWING CLASSES OF COMPOUNDS**	**7L**
2.1.1		
2.1.2	Bicyclic Compounds- spiro fused and bridged (up to 1 carbon atom) - saturated and unsaturated.	
2.1.3	Cumulenes, up to 3 double bonds.	
2.1.4	Biphenyls Monocyclic (5 and 6 membered) aromatic and non-aromatic heterocyclic compounds containing a maximum of two hetero atom among N,O,S	
	2.2 STEREOCHEMISTRY III	**8L**
2.2.1		
2.2.2	Recapitulation of important concepts including R/S configuration Molecular chirality and element of symmetry**:** Mirror plane symmetry, inversion centre, rotation-reflection (alternating) axis.	
2.2.3	Chirality of compounds without stereogenic centre: cummulenes, spirans and biphenyls.	
2.2.4	Conformations of cyclohexane, mono, disubstituted cyclohexanes and their relative stabilities	
III	**3.1 CATALYSTS AND REAGENTS**	**8L**
3.1.1		
3.1.2	Study of the following catalysts and reagents with respect to functional group transformations and selectivity (no mechanism)	
3.1.3	Catalysts - Catalysts for hydrogenation - Raney Ni, Pt and PtO_2 - C=C, CN, NO_2, aromatic ring; Pd/C – C=C, COCl → CHO (Rosenmund); Lindlar catalyst Reagents - (a) $LiAlH_4$ and Red-Al - reduction of CO, -COOR, -CN, and NO_2 (b) $NaBH_4$ - reduction of CO (c) SeO_2 - hydroxylation of allylic and benzylic positions, oxidation of CH_2 to CO (d) m-CPBA epoxidation of C=C (e) NBS - allylic and benzylic bromination (f) $KMnO_4$ OsO_4 - oxidation of C=C (g) Jones	
3.1.4	reagent , PCC and PDC oxidation of alcohols Designing synthesis via functional group interconversion.	

	3.2 ORGANOMETALLIC CHEMISTRY	**7L**
3.2.1	Organolithium/ magnesium compounds - Preparation using alkyl/aryl halides. Reactions with compounds containing acidic hydrogen, alkyl halides, carbonyl compounds, cyanides and CO_2.	
3.2.2	Lithium dialkylcuprates - Preparation and reactions with aliphatic/ aromatic/ vinylic halides. Micheal addition	
3.2.3	Organozinc compounds - Preparation and application in Simmons-Smith reaction with mechanism.	
3.2.4	Organopalladium compounds - Heck reaction and Suzuki coupling and basic catalytic cycle for coupling reaction.	
IV	**4.1 NATURAL PRODUCTS**	**10L**
4.1.1	**Natural products** - Introduction, sources, classification and functions (Structures of the compounds specified are expected) a) Terpenoids (isoprene rule) – i) citral ii) α-terpeniol iii) camphor iv) α-pinene b) Alkaloids – i) nicotine ii) atropine c) Vitamins – i) vitamin A ii) vitamin C d) Hormones – i) adrenaline ii) thyroxine e) Steroids – i) cholesterol ii) progesterone	
4.1.2	Structure determination of natural products - Ozonolysis in terpenoids, examples of open chain and monocyclic monoterpenoids ; Hofmann exhaustive methylation and degradation in alkaloids - simple open chain and monocyclic amines; Structure determination of citral and nicotine through degradation studies; Total synthesis – a) citral from 3-methylbutan-1-ol b) nicotine from nicotinic acid.	
4.1.3	Commercial synthesis - i) camphor from α-pinene ii) α- and β- ionones from citral	
4.1.4	Introduction to primary and secondary metabolites and broad classification of natural products based on biosynthesis	
	4.2 PHOTOCHEMISTRY	**5L**
4.2.1	Introduction - Difference between thermal and photochemical reactions; Jablonski diagram, singlet and triplet states, allowed and forbidden transitions, fate of excited molecules, photosensitization.	
4.2.2	Photochemical reactions of olefins – i) photoisomerisation ii) photochemical rearrangement of 1,4-dienes (di-π methane)	
4.2.3	Photochemistry of carbonyl compounds – i) Norrish I ii) Norrish II cleavages iii) photoreduction (e.g. benzophenone to benzpinacol).	
	PRACTICALS **Learning objective:** 1. To understand the method and concept of separation of a binary mixture quantitatively 2. To train the learners to perform qualitative analysis and identify a component 3. To understand the method of purification of the components. 4. To develop the skill of determining physical constant of compounds	**24L**

	Learning outcomes: Learners will be able 1. To identify the nature of a binary mixture and separate the mixture quantitatively. 2. To enable the students to develop skills in organic qualitative analysis 3. To enable students to purify compounds by recrystallization technique	
	Organic Separation Separation of a binary mixture - Type of mixture, Separation and identification (microscale) of one of the components through systematic scheme of identification. Type: Solid + Solid (no carbohydrates to be given) Mass of solid: 3 g	

Reference

Theory

1. Organic chemistry, T.W Graham, Solomons Craig, B Fryhle
2. Organic Chemistry, Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Wothers, Oxford University Press.
3. A Guidebook to mechanism in Organic Chemistry, Peter Sykes, 6th Edition, Pearson Education, New Delhi.
4. Organic Chemistry, 8th Edition John McMurry.
5. Stereochemistry By Nasipuri
6. Stereochemistry, P.S. Kalsi, 4th Edition, New age International Limited.
7. Name Reactions in Heterocyclic Chemistry-Jie Jack Li, Wiley Interscience publications, 2005.
8. Name Reactions- Jie Jack Li, 4th Edition, Springer Pub.
9. Lehninger Principles of Biochemistry, 7th Edition, David Nelson and Michael Cox, Publisher W.H Freeman
10. IUPAC Nomenclature by S.C.Pal
11. Chemistry of Natural Products, O.P.Agarwal
12. Chemistry of Natural Products, Chatwal Anand Vol I and II

Practical

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

NAME OF THE COURSE	ANALYTICAL CHEMISTRY	
CLASS	TYBSc	
COURSE CODE	SBSCHE504	
NUMBER OF CREDITS	2.5	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	To introduce the importance of sampling and statistical treatment of data in chemical analysis.
CO 2.	To get a knowledge of various concentration units and their interconversion for applying it to solve a hypothetical problem.
CO 3.	To introduce the learner to the various pre-concentration, separation and different chemical methods of analysis used in the field of analytical chemistry.
CO 4.	To learn principle, working and applications of atomic spectroscopy

COURSE LEARNING OUTCOMES: Learner will be able to

CLO 1.	decide appropriate sampling techniques for a given sample and apply statistical tests to the given data or the data generated in the laboratory to comment on the accuracy and precision of a given method.
CLO 2.	work comfortably with different concentration units, inter-convert them as per requirement and understand controlling of reactant concentration to increase yield in the lab and also at industrial level.
CLO 3.	to decide the most appropriate pre-concentration and the method of analysis for a given analyte.
CLO 4.	compare different spectroscopic methods with regards to working, limitations and advantages

UNIT	TOPIC	Lecture
I	**1.1 STATISTICAL TREATMENT OF DATA – I**	**8L**
1.1.1 **1.1.2** **1.1.3** **1.1.4**	Treatment of Analytical Data - Criteria for rejection of doubtful data - (i) 2.5 d rule (ii) 4 d rule (iii) Q test Concept of Confidence limit, confidence interval and its computation using - (i) Population standard deviation (ii) Student's t-test (ii) Range Test of significance- (i) Null hypothesis (ii) F-test (variance ratio test) Graphical representation of data and obtaining best fitting straight line i) line passing through origin ii) not passing through the origin (Derivation is not expected); i)Method of averages ii) Method of least squares	
	1.2 SAMPLING	**7L**
1.2.1 **1.2.2** **1.2.3** **1.2.4** **1.2.5**	Sampling - Terms involved, importance, types Sampling of gases - ambient and stack sampling, equipments used Sampling of liquids - homogeneous and heterogeneous, static and flowing Sampling of solids- free flowing and compact; importance of particle and sample size Reduction of sample size – need and methods (i) Coning and quartering (ii) Riffling	

II	**2.1 CHEMICAL CALCULATIONS**	**5L**
2.1.1 **2.1.2** **2.1.3**	Interconversion of various concentration units Percent composition of elements in chemical compounds Stoichiometry-limiting reagent **(Numericals expected)**	
	2.2 METHODS OF SEPARATION - SOLVENT AND SOLID EXTRACTION	**10L**
2.2.1 **2.2.2** **2.2.3** **2.2.4** **2.2.5** **2.2.6**	Partition coefficient, distribution ratio and separation factor Single step, multistep extraction, percentage extraction and extraction efficiency (Numericals expected) Role of complexing agents in solvent extraction, chelation, ion pair formation Types of solvent extraction: Batch and continuous, Craig's counter current extraction Solid phase extraction - Principle, process and applications Comparison of solid phase extraction with solvent extraction	
III	**3.1 Optical Methods – II**	
3.1.1 **3.1.2** **3.1.3** **3.1.4** **3.1.5** **3.1.6** **3.1.7**	Atomic Spectroscopy: Flame Emission Spectroscopy (FES) and Atomic Absorption Spectroscopy (AAS) – Introduction Energy level diagram, Atomic, Absorption and Emission spectra Flame Photometry – Principle; Instrumentation – Flame Atomizers, Types of burners, wavelength selectors, detectors Atomic Absorption Spectroscopy- Principle; Instrumentation- source, chopper, flame and electro-thermal atomizer Quantification, methods of FES and AAS- Calibration curve, Standard addition and Internal standard methods Comparison between FES and AAS Applications, advantages and limitations of FES and AAS	**7L**
	3.2 Molecular Fluorescence and Phosphorescence Spectroscopy	**4L**
3.2.1 **3.2.2** **3.2.3**	Introduction and Principle (Jablonski Diagram) Relationship between Fluorescence intensity with concentration Factors affecting Fluorescence and Phosphorescence Instrumentation and Applications of Molecular Fluorescence and Phosphorescence Spectroscopy Comparison of Fluorimetry and Phosphorimetry	

3.2.4 **3.2.5.** **3.2.6**	Comparison of Fluorimetry and Phosphorimetry with Absorptions methods	
	3.3 TURBIDIMETRY AND NEPHELOMETRY	**4L**
3.3.1 **3.3.2** **3.3.3**	Introduction and Principle Factors affecting scattering of radiation – Concentration, particle size, wavelength and refractive index Instrumentation and Applications of Turbidimetry and Nephelometry	
IV	**CHROMATOGRAPHY-I**	
4.1	Chromatography - Introduction to chromatographic techniques, Classification of chromatographic techniques. Separation based on partition, adsorption, ion-exchange and size exclusion.	**2L**
	4.2 ION EXCHANGE CHROMATOGRAPHY	**8L**
4.2.1 **4.2.2** **4.2.3** **4.2.4** **4.2.5**	Introduction, Principle Types of ion-exchanger, Ideal properties of resin Ion exchange equilibria and mechanism, selectivity coefficient and separation factor; Factors affecting separation of ions Ion exchange capacity and its determination for cation and anion exchangers Applications - Preparation in demineralized water, Separation of halides, concentration of trace elements, separation of amino acids and preparation of primary standard solutions	
	4.3 HIGH PERFORMANCE LIQUID CHROMATOGRAPHY	**5L**
4.3.1 **4.3.2** **4.3.3**	Principle and Instrumentation, Normal and Reverse phase HPLC Detectors – Universal detectors – RI and specific detector - UV Applications of HPLC	
	PRACTICALS **Learning Objectives:** 1. **To train learners to prepare standard solutions of known concentration.** 2. **To train learners to handle and standardize analytical instruments for its optimum use.** 3. **To introduce the learner to various classical and instrumental**	**24L**

	methods of analysis to real life and commercial samples. **Learning Outcomes: The learner will be able to** **1. decide suitability of an instrument for its use in analysis.** **2. learn to prepare and standardise solutions with the highest degree of accuracy.** **3. analyse different samples using various methods of chemical analysis** 1. Determination of sodium carbonate in washing soda by pH metry titration. 2. Estimation of the amount of Cr (VI) in the given solution as dichromate by the method of least squares spectrophotometrically 3. Estimation of the amount of vitamin C in the given solution by redox titration with Ce (IV) 4. Determination of saponification value of given oil 5. Determination of the amount of acetic acid in a sample of vinegar by the potentiometric titration with a standard base using quinhydrone electrode 6. Determination of the amount of Fe(III) using bioreagent in the given solution spectrophotometrically 7. Determination of the amount of potassium in commercial sample by flame photometry using calibration curve method	

Reference

Theory

1. Fundamentals of analytical Chemistry, 8th Edition :Skoog , West, Holler and Crouch, India Edition
2. Analytical Chemistry –G.D. Christian, 6th Edition, John Wiley and Sons.
3. Instrumental Analysis - Skoog, Holler and Crouch (2007), Cenage Learning India Private Limited (2007)
4. Modern analytical Chemistry- David Harvey, 2000
5. Thermal Methods, James Todd-Analytical Chemistry by Open Learning
6. Analytical Chemistry-Krupadanam David, University Press; 2012
7. Instrumental Methods of Analysis-Willard, Merritt, Dean and Settle, 7th Edition.
8. Instrumental Methods of Chemical Analysis –Chatwal Anand, 5th Edition, 2005. Himalaya Publishing House.

Practical

1. Vogel's Quantitative Chemical Analysis, 3rd edition

NAME OF THE COURSE	APPLIED COMPONENT
CLASS	TYBSc
COURSE CODE	SBSAPC501
NUMBER OF CREDITS	
NUMBER OF LECTURES PER WEEK	4

TOTAL NUMBER OF LECTURES PER SEMESTER	75	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	Understand the classification of drugs and dyes, basic terms used in medicinal and dyestuff chemistry, and routes of drug administration.
CO 2.	To understand the various pharmacodynamic agents with respect to chemical structure, therapeutic action and uses.
CO 3.	Understand the processes involved in the synthesis of dyes/drugs and their intermediate
CO 4.	To understand the correlation between the colour of a compound and the structure, the origin, mode of application, classification of dyes, pigments and fluorescent brighteners and the science behind dye fibre attachment.

COURSE LEARNING OUTCOMES: Learner will be able to

CLO 1.	Define various terms used in medicinal chemistry and color chemistry
CLO 2.	Reproduce the synthesis of drugs and dyes
CLO 3.	Predict the use of the drug
CLO 4.	To be able to identify, predict, classify commercially available dyes based on terminology/nomenclature, the nature of dye-fibre attachment and the fastness of dyes

UNIT	TOPIC	Lect
I	**1.1 GENERAL INTRODUCTION TO DRUGS**	**7**
1.1.1 **1.1.2** **1.1.3** **1.1.4**	Definition, requirement and classification of drugs (based on Therapeutic action) Nomenclature of drugs- generic, brand and systematic name. Medicinal terms- Pharmacon, Pharmacophore, Prodrug, Half-life efficiency, LD_{50}, ED_{50}, Therapeutic index. Drug related terms- receptors, drug-receptor interaction, potency, bioavailability, toxicity, addiction, spurious and misbranded drugs, Adulterated drugs, Pharmacopoeia	
	1.2 ROUTES OF DRUG ADMINISTRATION AND DOSAGE FORMS	**5**

1.2.1 **1.2.2** **1.2.3**	Oral and parenteral routes with advantages and disadvantages. Formulations, different dosage forms (emphasis on sustained release formulations.) Total Quality Management (TQM) – concept, Quality Control, Quality Assurance and their inter-relation; Food and Drug Administration (FDA) - concept, role and importance, classification; Pharmacopoeia - history, Drug act and schedules, components; Good Laboratory Practices (GLP), International Organization of Standardization (ISO), Good Manufacturing Practice (GMP), Drug Technical Advisory Board (DTAB).	
1.3	**PHARMACODYNAMIC AGENTS** - CNS Drugs- Classification based on pharmacological actions- CNS Depressants & CNS Stimulants; i) Concept of sedation and hypnosis, anaesthesia ii) Phenytoin (Hydantoin) iii) Trimethadione (Oxazolidinediones) Alprazolam (Benzodiazepines) iv) Levetiracetam (Pyrrolidines) v) Amphetamine (Phenethylamine) (Asymmetric synthesis from phenyl acetic acid) vi) Chlorpromazine (Phenothiazines) [*A brief introduction of the following pharmacodynamic agents and the study with respect to their chemical structure (memorizing the structure not expected) chemical class, therapeutic uses, and side effects]	**3**
II	**2.1 ANALGESICS, ANTIPYRETICS AND ANTI-INFLAMMATORY DRUGS**	**3**
2.1.1 **2.1.2**	Analgesics and Antipyretics – i) Morphine (Phenanthrene alkaloids) ii) Tramadol (Cyclohexanols) - Synthesis from salicylic acid iii) Aspirin (Salicylates) iv) Paracetamol (p-Amino phenol) Anti-inflammatory Drugs - Mechanism and inflammatory conditions; i) Steroids: Prednisolone, Betamethasone ii) Sodium Diclofenac iii) Aceclofenac (N- Aryl anthranilicacid) - Synthesis from 2,6-dichlorodiphenyl amine	
2.2	**ANTIHISTAMINIC DRUGS** - Histamine and histamine receptors - Synthesis and mechanism; i) Diphenhydramine (Ethanol amines) ii) Cetrizene (Piperazine) (Synthesis from 4- Chlorobenzhydryl chloride) iii) Chlorpheniramine maleate (Ethyl amines) iv) Pantoprazole (Benzimidazoles)	**2**
2.3	**CARDIOVASCULAR DRUGS** - Cardiovascular drugs - Classification based on pharmacological action; i) Isosorbidedinitrate (Nitrates) ii) Valsartan (Amino acids) (structure not expected) iii) Atenolol (Aryloxy propanol amines) - Synthesis from 3-Hydroxy phenyl acetamide iv) Amlodipine (Pyridines) v) Frusemide /Furosemide (Sulfamoyl benzoic acid) vi) Rosuvastatin (Pyrimidine)	**3**
2.4	**ANTIDIABETIC AGENTS** - Diabetes - General idea, types and Insulin therapy; i) Glibenclamide (Sulphonylureas) ii) Metformin (Biguanides) iii) Dapagliflozin (Pyranose) iv) Pioglitazone (Thiazolidinediones) – Synthesis from 2-(5-ethylpyridin-2-yl) ethanol	**2**
2.5	**ANTIPARKINSONISM DRUGS** - Parkinson's disease – general idea; i) Procyclidine hydrochloride (Pyrrolidines) ii) Ethopropazine hydrochloride (Phenothiiazines) iii) Levodopa (Amino acids) - Synthesis from Vanillin	**2**

2.6	**DRUGS FOR RESPIRATORY SYSTEM** - Drugs for respiratory system - general idea, types - Expectorants, Mucolytes, Bronchodilators, Decongestants, Antitussives; i) Ambroxol (Cyclohexanol) - Synthesis from paracetamol ii) Salbutamol (Phenyl ethyl amines) iii) Codeine Phosphate (Opiates) iv) Formoterol (N-formamide) v)Theophylline (methylxanthines)	**3**
III	**INTRODUCTION TO THE DYE-STUFF INDUSTRY**	
3.1	Dyes – Definition, requirements of an ideal dye - Colour, Solubility, Linearity, Coplanarity, Fastness, Substantivity, Economic viability; 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	**2**
	3.2 NATURAL AND SYNTHETIC DYES	**3**
3.2.1 **3.2.2**	Natural Dyes- Definition, Examples, limitations and uses - Heena, Turmeric, Saffron, Indigo, Chlorophyll, Tyrian purple and cochineal; names of the chief dyeing material/s in each natural dye [structures not expected] Synthetic dyes- Definition, 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 not expected)	
	3.3 RELATION BETWEEN COLOUR AND CHEMICAL CONSTITUTION	**5**
3.3.1 **3.3.2** **3.3.3** **3.3.4** **3.3.5**	Absorption of visible light, Colour of wavelength absorbed, Complementary colours. Armstrong theory (quinonoid theory) and its limitations Witt's Theory; Recapitulation - Chromophore, Auxochrome, Bathochromic and Hypsochromic Shift, Hypochromic and Hyperchromic effect Valence Bond theory, comparative study and relation of colour in the following classes of compounds/dyes – i) Benzene ii) Nitrobenzene iii) Nitroanilines iv) Nitrophenols v) Benzoquinones vi) Azo vii) Triphenyl methane viii) Anthraquinones. Molecular Orbital approach to colour – structure relationship	
3.4	**FLUORESCENT BRIGHTENERS** Fluorescent brightens – General idea, important charcteristics and applications one example with structure of each of the following classes - i) Stilbene ii) Coumarin iii) Hetrocyclic vinylene derivative iv) Naphthalimide	**3**
3.5	**PIGMENTS -** Characteristics, Classification, Difference between a dye and a pigment, applications - toners and lakes	**2**
IV	**CLASSIFICATION OF DYES BASED ON APPLICATION**	
4.1	**Dyes** - Definition, fastness properties and applicability of substrates, examples with structures - i) Acid Dyes- Orange II ii) Basic Dyes-methyl violet iii) Direct cotton Dyes- Benzofast Yellow 5GL iv) Azoic Dyes – a) Diazo components- Fast	**6**

	yellow G, Fast orange R b) Coupling components- Naphthol AS, Naphthol ASG v) Mordant Dyes-Eriochrome Black A, Alizarin vi) Vat Dyes- Indanthrene brown RRD vii) Sulphur Dyes- Sulphur Black T (no structure) viii) Disperse Dyes- Celliton Fast brown 3R ix) Reactive Dyes- Cibacron Brilliant Red B.	
	4.2 TYPES OF FIBRES AND DYE FIBRE ATTACHMENT	**2**
4.2.1 **4.2.2**	Introduction to the structure of fibres and corresponding classes of dyes applicable to these fibres – a) Natural: Cotton, wool, silk b) Synthetic: polyester, polyamides Binding forces of dyes on substrate- ionic forces, covalent linkages, hydrogen bonding, Van der Waals forces	
4.3	**BASIC OPERATIONS INVOLVED IN DYEING PROCESS –** Preparation of Fibers and Dye bath, Application of dyes and Finishing	**1**
4.4	**DYEING METHODS OF COTTON FIBERS -** Dyeing methods - Direct, Mordant, Vat and Disperse	**1**
4.5	**IMPORTANT REACTIONS IN SYNTHESIS OF DYES - i)** Nitration ii) sulfonation iii) halogenations iv) diazotization, v) ammonolysis vi) reduction - definition, reagents and examples of each type of reaction (mechanism not expected)	**2**
	4.6 PREPARATION OF DYE INTERMEDIATES	**3**
4.6.1	Benzene derivatives – i) Sulphanilic acid ii) o-m,p-nitroanilines iii) o-m-p-chloronitrobenzene iv) m-dinitrobenzene ; Naphthalene Derivatives – i) Naphthionic acid ii) H-Acid ; Anthraquinone derivatives- i) Benzanthrone	
	PRACTICALS **Course objectives** 1. To prepare dyes on a bench scale 2. To estimate the drug samples quantitatively 3. To learn the application of colorimeter/spectrophotometer in the assay of drugs. 4. To develop the skill of dyeing of fabric **Course Outcomes:**The learner will be able to 1. analyse commercial samples of drugs using a suitable method. 2. synthesis of dyes on a bench scale and dyeing of fabric **SYNTHESIS OF DYES: (Any Three)** 1. Preparation of Fluorescein from resorcinol and phthalic anhydride. 2. Preparation of eosin from fluorescein. 3. Preparation Orange II from sulphanilic acid. 4. Preparation of Indigo from o-nitrobenzaldehyde. **ESTIMATION OF DRUGS: (Any three)** 1. Estimation of Ibuprofen (Back titration) 2. Estimation of acid neutralizing capacity of a drug 3. Estimation of Iodine in Tincture Iodine 4. Assay of Riboflavin in a given drug **PROJECT WORK:** Dyeing of Fabric (silk, cotton, polyester) using Orange II/Indigo	

SEMESTER 6

NAME OF THE COURSE	PHYSICAL CHEMISTRY	
CLASS	TYBSc	
COURSE CODE	SBSCHE601	
NUMBER OF CREDITS	2.5	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	Understand the fundamental principles of electrochemical reactions, including electron transfer processes, electrode kinetics, and thermodynamics involved in redox reactions.
CO 2.	Learn the classification and characterization techniques of polymers based on their chemical structure, morphology, thermal properties, and mechanical behavior.
CO 3.	Explore the mathematical formalism of quantum mechanics, including wavefunctions, operators, eigenvalues, and eigenvectors, and their application in solving quantum mechanical problems.
CO 4.	Explore the instrumentation used in NMR and ESR spectroscopy, including magnet design, radiofrequency pulse generation, signal detection, and data processing techniques.

COURSE LEARNING OUTCOMES: Learner will be able to

CLO 1.	Display thorough understanding of the fundamental principles of electrochemical reactions, including electron transfer processes, electrode kinetics, and thermodynamics governing redox reactions.
CLO 2.	Proficiency in analyzing the relationship between polymer structure, processing methods, and the resulting properties, including mechanical, thermal, electrical, and optical properties.
CLO 3.	Comprehensive understanding of quantum mechanics, including the Schrödinger equation, operators, eigenvalues, and eigenvectors, to solve quantum mechanical problems.

CLO 4.	Gain proficiency in understanding the NMR and ESR instrumentation, including magnet setup, radiofrequency pulse generation, signal detection, and data processing techniques.

UNIT	TOPIC	
I	**1.1 ELECTROCHEMISTRY- III**	**9 L**
1.1.1 **1.1.2** **1.1.3** **1.1.4**	**Activity and Activity coefficient -** Lewis concept, ionic strength (Numericals expected), Mean ionic activity and mean ionic activity coefficient of an electrolyte, expression for activities of electrolytes. Debye-Huckel limiting law (No derivation). **Chemical and concentration cells -** Chemical cells with and without transference, Electrode concentration cells and Electrolyte concentration cells with and without transference (Numericals expected) **Polarization -** Concentration polarization and its elimination **Decomposition potential and Overvoltage -** Introduction, decomposition potential and its experimental determination, overvoltage, relationship between decomposition potential and overvoltage, factors affecting decomposition potential, Tafel's theory of overvoltage, Tafel's equation for hydrogen overvoltage, experimental determination of overvoltage (Numericals expected).	
	1.2 RENEWABLE ENERGY RESOURCES	**6L**
1.2.1 **1.2.2**	**Fuel Cells**- Principle, construction and working of Bacon's fuel cell, types and applications **Hydrogen as a Fuel -** Future fuel, production of hydrogen by direct electrolysis of water, advantages of hydrogen as a universal energy medium.	
II	**2.1 POLYMERS**	**8 L**
2.1.1 **2.1.2** **2.1.3** **2.1.4**	**Basic terms involved -** Monomer, degree of polymerization. **Classification of polymers -** Classification based on source, structure, thermal response and physical properties **Molar Mass of Polymers -** Number average, Weight average, Viscosity average molar mass, Monodispersity and Polydispersity Index (Numericals expected) **Methods of determining Molar Masses of polymers -** Viscosity method using Ostwald Viscometer, Sedimentation method	
	2.2 PHASE EQUILIBRIA II & THERMODYNAMIC RELATIONSHIPS	**7L**
2.2.1 **2.2.2** **2.2.3**	**Three component system** formation of one pair of partially miscible liquids **Maxwell relations–**derivation and application to ideal gases **Fugacity** - definition, experimental method of determination	
III	**BASICS OF QUANTUM CHEMISTRY**	**15L**

3.1 **3.2** **3.3** **3.4**	**Classical theory -** Introduction, limitations of classical mechanics, Black body radiation, photoelectric effect, Compton effect. **Quantum theory -** Introduction, Plank's theory of quantization, wave particle duality, de-Broglie's equation, Heisenberg's uncertainty principle (Numericals expected) **Progressive and Standing waves -** Introduction, boundary conditions, interpretation and properties of wave function, Schrodinger's time independent wave equation (No derivation expected) **Functions and Operators -** 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 (Numericals expected)	
IV	**MOLECULAR SPECTROSCOPY –IV**	**15L**
4.1 **4.2** **4.3**	**NMR-** Principle and theory, Nuclear spin, magnetic moment, nuclear 'g' factor, energy levels, Larmor precession, Relaxation processes in NMR (spin-spin relaxation and spin-lattice relaxation), chemical shift, δ scale, low resolution spectra. Instrumentation - NMR Spectrometer **ESR-** Principle, Fundamental equation, g-value - dimensionless constant or electron g - factor, hyperfine splitting, hyperfine structure, Instrumentation – ESR, spectrum of hydrogen and deuterium **Laser Spectroscopy** – Principle, types and applications	
	PRACTICALS **Course Objectives:** 1. To train the students to handle different instruments and maintain laboratory discipline 2. To carry out the experiments mentioned in the course and thereby be able to correlate the importance of the theory with the practical experiments 3. To interpret information from the graphs plotted **Course Outcome: Learner will be able to** 1. understand the handling of instruments and correlate practical experiments with theoretical knowledge 2. set up different types of electrochemical cells 3. practice laboratory safety measures and precautions to be taken while handling the instrument, electrodes and chemicals	**24 L**
	1. To determine the molecular weight of poly vinyl alcohol from viscosity measurements. 2. To determine the activity coefficient of Ag ions using a concentration cell without transference. 3. To study the phase diagram of the three-component system water – chloroform / toluene – acetic acid. 4. To titrate a mixture of weak acid and strong acid against a strong base and to determine the amount of each acid in the mixture conductometrically. 5. To plot the graphs of mathematical functions – linear, exponential and trigonometric and identify whether they are acceptable or non-acceptable 6. To determine the number of electrons in the redox reaction between ferrous ammonium sulphate and ceric sulphate potentiometrically 7. To determine acidic and basic dissociation constants of amino acid and hence to calculate the isoelectric point.	

Reference

Theory

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. Fundamental of Molecular Spectroscopy, 4th Edn. Colin N Banwell and Elaine McCash Tata McGraw Hill Publishing Co. Ltd. New Delhi, 2008.
4. Physical Chemistry, G.M. Barrow, 6th Edition (2007), Tata McGraw Hill Publishing Co. Ltd. New Delhi.
5. The Elements of Physical Chemistry, P.W. Atkins, 2nd Edition, Oxford Universtity Press Oxford.
6. Polymer Science, V.R. Gowariker, N.V. Viswanathan, Jayadev Sreedhar, New Age International (P) Ltd., Publishers, 2005.
7. Essentials of Nuclear Chemistry, Arnikar, Hari Jeevan, New Age International (P) Ltd., Publishers, 2011.
8. Physical Chemistry, Keith J Laidler, John H. Meiser, 2nd Edition, CBS publication and distributors Pvt. Ltd.

Practical

1. 1. Experiments in Physical Chemistry C.W. Garland, J.W. Nibler and D.P. Shoemaker, McGraw Hill New York 8th Edition (2003)
2. Practical Physical chemistry, Vishwanathan B. and Raghavan P.S. Viva Books (2017)
3. Experimental Physical Chemistry, V.D. Athawale and P. Mathur, New Age International Publishers, 2001

NAME OF THE COURSE	INORGANIC CHEMISTRY	
CLASS	TYBSc	
COURSE CODE	SBSCHE602	
NUMBER OF CREDITS	2.5	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	To build basic concepts of coordination chemistry using crystal field and molecular orbital theory
CO 2.	To introduce basic concepts of inorganic spectroscopy
CO 3.	To understand methods of preparation and reactions of organometallic compounds of main group elements
CO 4.	To understand properties of group 17 &18 elements and to learn preparation of interhalogen and pseudohalogens

COURSE LEARNING OUTCOMES: Learner will be able to

CLO 1.	calculate crystal field energies of given molecules and construct molecular orbital diagrams for coordination complexes
CLO 2.	calculate ground term symbols for simple inorganic molecules
CLO 3.	write general methods of preparations and reactions of organometallic compounds of main group elements
CLO 4.	compare and contrast properties of group 17&18 and write synthesis and assign structures to interhalogens and pseudohalogens

Unit	TOPIC	Lecture
I	**THEORY OF METAL LIGAND BOND – I**	
1.1	Introduction to Crystal field theory, splitting of d orbitals in octahedral, tetrahedral and square planar complexes. Distortions from octahedral geometry. Crystal field splitting parameter: calculation and factors affecting it. Spectrochemical series. Consequences of crystal field splitting. Limitations of CFT. Evidence for covalent bonding in complexes.	**11L**
1.2	Molecular orbital theory for coordination compounds, molecular orbital diagrams depicting sigma bonding only for $[Ti(H_2O)_6]^{3+}$ $[FeF_6]^{4-}$, $[Fe(CN)_6]^{4-}$, $[Co(NH_3)_6]^{3+}$, $[CoF_6]^{3-}$	**4L**
II	**THEORY OF METAL LIGAND BOND – II**	
2.1	**Stability of complexes:** Types of stability- thermodynamic and kinetic, factors affecting thermodynamic stability. Stability constants and inter-relationship.	**5L**
2.2	**Reactivity of complexes:** Types of reactions, inert and labile complexes. Ligand substitution reactions (associative and dissociative mechanism), acid and base hydrolysis and anation reactions.	**5L**
2.3	**Electronic spectra:** Origin, types of electronic transition in coordination compounds. Selection rules. Term and term symbols for ground state determination	**5L**
III	**ORGANOMETALLIC CHEMISTRY – II**	
3.1	**Organometallic compounds of the main group:** Introduction, general methods of preparation and reactions, application in medicine and agriculture.	**6L**
3.2	**Metallocenes with special reference to Ferrocene:** Introduction, methods of preparation, physical and chemical properties, structure on the basis of VBT.	**3L**
3.3	**Catalysis:** Overview of catalysis (homogenous and heterogenous catalysis), basic steps involved in homogeneous catalysis. Important catalytic reactions with mechanism (hydroformylation, coupling reaction, cross coupling reaction)	**6L**
IV	**Chemistry of group 17 & 18 elements.**	
4.1	**Comparative Chemistry of group 17 elements:** Introduction and general properties. Anomalous behavior of fluorine. Oxyacids of chlorine and structure (VSEPR). Inter halogens: Preparation, properties and structure (VSEPR). Pseudo halogens: Preparation, properties and structure (VSEPR)	**8L**
4.2	**Comparative Chemistry of group 18 elements:** Introduction, historical perspective and general properties. Isolation of gases. Application of inert gases. Compounds of Xenon (oxides, fluorides, oxyflourides) - preparation and structure (VSEPR).	**7L**

	PRACTICALS **Learning objectives** 1. To prepare ,characterize and estimate inorganic complexes 2. To learn to perform complexometric titrations for given metal ions 3. To estimate chlorine from a commercial sample **Learning outcomes: The learner will be able to** 1. synthesis ,analyze and calculate crystal field stabilization energy of inorganic complexes 2. estimate metal ions from a given sample complexometrically 3. analyze commercial sample for chlorine content by redox titration	**24L**
	1. Preparation of bisethylenediammine iron sulphate complex. 2. Preparation of tris acetylacetonato iron complex. 3. Estimation of iron (redox titration) in tris acetylacetonato iron complex. 4. Estimation of aluminium complexometrically. (Standardization of EDTA expected) 5. Estimation of chlorine (iodometrically) in a commercial sample of bleaching powder. 6. Controlled synthesis of copper oxalate hydrate complexes. 7. To determine the wavelength of maximum absorption and calculate the value of 10Dq for any two complexes spectrophotometrically.	

Reference

Theory

1. Concise Inorganic Chemistry, J.D. Lee, 4th Edn , ELBS
2. Inorganic Chemistry: Principles of Structure and Reactivity, James E. Huheey
3. Mechanisms of Inorganic Chemistry, Basolo F and Pearson R.C., John Wiley & Sons, NY,
4. Organometallic Chemistry: A Unified Approach, Ram Charan Mehrotra, New Age International.
5. Inorganic Chemistry, D. F. Shriver and P. W. Atkins, 3rd edition, Oxford University Press (1999)
6. Advanced Inorganic Chemistry, Cotton and Wilkinson, 3rd Edition.

Practical

1. Practical Inorganic Chemistry, Shikha Gulati, JL Sharma, Shagun Manocha, CBS Publishers and distributors.
2. Vogel Textbook of Quantitative Chemical Analysis G.H. Jeffery, J. Basset.
3. Advanced Experiments in Inorganic Chemistry, G. N. Mukherjee, 1st Edn, 2010, U.N. Dhur & Sons Pvt Ltd.

NAME OF THE COURSE	ORGANIC CHEMISTRY
CLASS	TYBSc
COURSE CODE	SBSCHE603
NUMBER OF CREDITS	2.5
NUMBER OF LECTURES PER WEEK	4
TOTAL NUMBER OF LECTURES	60

PER SEMESTER		
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:
Learner will understand the basic principles of

CO 1.	Molecular spectroscopy
CO 2.	stereochemical reactions
CO 3.	Biomolecules, polymers and polymerisation
CO 4.	Heterocyclic compounds of one heteroatom

COURSE LEARNING OUTCOMES: Learner will be able to

CLO 1.	interpret spectral data in identification of various organic molecules
CLO 2.	identify stereospecific and stereoselective reactions and compare the sterochemistry of the product.
CLO 3.	Convert open chain and Haworth structures of carbohydrates.identify the reducing, non reducing, mono, di and polysaccharides and the reactions. Predict method of synthesis for biomolecules.
CLO 4.	Predict the reactivity, and products reactions of heterocyclic compounds. Identify the monomer and polymer unit for various polymers and their uses, write a mechanism various methods of polymerization.

Unit	TOPIC	Lecture
I	**SPECTROSCOPY-I (UV-VIS, IR AND 1H NMR)**	**15L**
1.1	Introduction - Electromagnetic spectrum, units of wavelength and frequency	
1.2	UV-VIS spectroscopy - Basic theory, solvents, nature of UV-VIS spectrum, concept of chromophore, auxochrome, bathochromic shift, hypsochromic shift, hyperchromic and hypochromic effects, chromophore- chromophore and chromophore – auxochrome interactions. Calculation of absorption maxima by Woodward - Fischer Rule for conjugated polyenes. Applications of UV-VIS spectroscopy	
1.3	IR Spectroscopy- Basic theory, selection rule, nature of IR spectrum, characteristic vibrational frequencies of functional groups, fingerprint region. Applications of IR Spectroscopy.	
1.4	1H NMR Spectroscopy - Basic theory of 1H NMR, nature of 1H NMR spectrum, chemical shift (∂ unit), standard for 1H NMR, solvents used. Factors affecting chemical shift - inductive effect and anisotropic effect (with reference to C=C, C≡C, C=O and benzene ring). Spin- spin coupling and	
1.5	coupling constant. Application of deuterium exchange technique. Application of 1H NMR in structure determination Mass Spectrometry- Basic theory. Nature of mass spectrum. General	

1.6 1.7	rules of fragmentation. Importance of molecular ion peak, isotopic peaks, base peak, Nitrogen rule. Fragmentation of alkanes and aliphatic carbonyl compounds including Mclafferty rearrangement. Spectral characteristics of following classes of organic compounds, including benzene and mono substituted benzenes with respect to UV-VIS, IR, 1H NMR - a) alkanes b) alkenes and polyenes c) alkynes d) haloalkanes e) alcohols f) carbonyl compounds g) ethers h) carboxylic acids i) esters j) amines k) amides (broad regions characteristic of different groups are expected). Problems of structure elucidation of simple organic compounds using individual or combined use of the UV-VIS, IR, 1H NMR and Mass spectroscopic techniques. (Index of hydrogen deficiency expected).	
II	**2.1 STEREOCHEMISTRY- IV**	**7L**
2.1.1 2.1.2 2.1.3 2.1.4	Stereoselectivity and stereospecificity - Idea of enantioselectivity (ee) and diastereoselectivity (de), Topicity - enantiotopic and diastereotopic atoms, groups and faces. Substitution reactions - SN_1, SN_2, SNi (reaction of alcohol with thionyl chloride). Elimination reactions - E_2-Base induced dehydrohalogenation of 1-bromo-1, 2- diphenylpropane. Addition reactions to olefins - a) catalytic hydrogenation b) bromination (electrophilic anti addition) c) HX d) synhydroxylation with OsO_4 and $KMnO_4$ e) epoxidation followed by hydrolysis	
	2.2 NAME REACTIONS AND SYNTHETIC APPLICATIONS	**8L**
	a)Claisen Condensation b) Michael Reaction c) Oppenauer Oxidation d) Stobbe Condensation e) Wolff-Kishner Reduction f) McMurry Reaction	
III	3.1Carbohydrates	**10L**
3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6 3.1.7	Introduction - Sources, classification, reducing and non-reducing sugars, D and L- notations. Structures of Monosaccharides - Open chain structures of aldoses and ketoses, ring structures of aldohexoses, aldopentoses and ketohexoses. Inter conversions - open chain and Haworth forms of monosaccharides with 5 and 6 carbons Determination of open chain configurations of Monosaccharides - Configuration of D (+) Glucose and D (-) Fructose Stereoisomers of Monosaccharides - Enantiomers and diastereoisomers of monosaccharides, epimers, anomers, mutarotation (with mechanism) in D-Glucose. Chain lengthening and shortening reactions: Kiliani-Fischer synthesis, Wohl's method. Disaccharides – introduction and structures of sucrose and maltose. Glycosides - General structure giving indican as an example.	
	3.2 AMINO ACIDS AND PROTEINS	**3L**
3.2.1 3.2.2 3.2.3	Amino acids - Introduction, Classification, syntheses of amino acids- Strecker synthesis, Amidomalonate synthesis and Erlenmeyer Azalactone synthesis Polypeptides - Introduction, peptide bond, Merrifields solid phase peptide synthesis, Bergmann method Proteins - Structure, classification, properties, denaturation	

3.2.4	Separation and purification of proteins - Gel filtration chromatography, electrophoresis	
	3.3 NUCLEIC ACIDS	**2L**
3.3.1 3.3.2 3.3.3 3.3.4 3.3.5	Introduction, classification of nucleic acids. Structures of sugars and bases in nucleic acids. Structures of nucleosides and nucleotides in DNA and RNA Base pairing in nucleic acids Importance of nucleic acids - self duplication and protein synthesis	
IV	4.1 POLYMERS	**8L**
4.1.1 4.1.2 4.1.3 4.1.4 4.1.5 4.1.6 4.1.7	Introduction - General idea of monomers, polymers and polymerization, natural and synthetic polymers, homopolymers and copolymers, classification of polymers. Copolymers – alternating, block, random and graft. Mechanism of free radical, cationic and anionic addition polymerisation. Stereochemistry of polymers -Tacticity, role of Ziegler–Natta catalyst (coordination polymerization) in directing the tacticity in polypropylene (no mechanism). Elastomers - Natural and synthetic rubbers. Diene polymerization - 1,2-and 1,4-addition (cis and trans) polymerization of isoprene. 1,3-Butadiene- styrene copolymer. Preparation and uses of polymers- (a) Addition polymers - (i) polyethylene (ii) polypropylene (iii) PVC (iv) polystyrene (v) polyacrylonitrile (vi) polyvinylalcohol (vii) poly (tetrafluoroethelyene); b) Condensation polymers – (i) polyesters (ii) polyamides (Nylon-6, Nylon-66) (iii) polyurethans (iv) phenol-formaldehyde resin (v) urea- formaldehyde resin (vi) epoxy resin (vii) polycarbonates (viii) saran (ix) SAN (x) ABS Additives to polymers - Plasticizers, stabilizers and fillers Recyclable polymers - Biodegradable polymers and their uses. Biomedical uses of polymers. (*Identification of monomers in a given polymer and knowing the structure of a polymer from a given set of monomers is expected)	
	4.2 **HETEROCYCLIC CHEMISTRY**	**7L**
4.2.1 4.2.2 4.2.3 4.2.4	Introduction - Electronic structure and aromaticity of furan, pyrrole, thiophene and pyridine Synthesis - Synthesis of furans, pyrroles, and thiophenes by Paal Knorr synthesis. Pyridine by Hantzsch synthesis from 1,5-diketones Reactivity - Reactivity towards electrophilic substitution reactions- of furan, pyrrole, thiophene on the basis of stability of intermediate and pyridine on the basis of electron distribution. Nucleophilic substitution of pyridine on the basis of electron distribution Reactions of heterocycles - furan, pyrrole and thiophene: Halogenation, Nitration, sulphonation, Vilsmeierformylation reaction, Friedal-crafts reaction Furan - Diels-Alder reaction, ring opening of furan Pyrrole - Acidity and basicity of pyrrole- comparison of basicity of pyridine, pyrrole and pyrrolidine, Acid catalysed polymerisation of pyrrole Pyridine - Basicity, Comparison of basicity of pyridine pyrrole and piperidene Suphonation of pyridine, with and without catalyst.	

	Reduction. Oxidation of alkyl pyridines and action of sodamide (Chichibabin reaction)	
	PRACTICALS **Learning objective:** 1. To understand the method and concept of separation of a binary mixture quantitatively **by physical method** 2. To train the learners to perform qualitative analysis and identify a component 3. To understand the method of purification of the components. 4. To develop the skill of determining physical constant of compounds 5. To help learners to prepare synthetically useful organic compounds. 6. To acquaint learners with chromatographic techniques 7. To interpret spectrum Learning outcomes:Learners will be able to 1. identity the nature of a binary mixture and separate the mixture quantitatively. 2. To enable the students to develop skills in organic qualitative analysis 3. To enable students to purify compounds by distilling technique 4. To prepare organic compounds and understand the course of the reaction with the help of TLC 5. To elucidate the structure of a compound based on the spectral data 1. Organic Separation: Separation of a binary mixture: Type of mixture, separation and identification (micro scale) of one component through systematic scheme of identification. 2. Types: a) Volatile Liquid + Solid b) Volatile Liquid + Non-volatile liquid (Volatile ~ 6-8mL, Non-volatile ~ 4-6 mL) 3. Preparation of organic compounds: Preparation of organic compound as per the procedure given, measuring the mass of crude, purification of the separated product by crystallization and recording of the m.p. (Quantity of the reactant to be given: 1 g) 4. Preparations: a.2- Naphthol to Methyl-2-naphthyl ether b.Phthalic anhydride to Phthalimide c.p-Bromoacetanilide to p-bromoaniline. d.Phthalic anhydride to anthranilic acid (2 step preparation). ***Demonstration of TLC for any of the above reactions to understand the progress of the reaction** Students will identify the compound based on the spectra provided (NMR, IR and Mass) and plan a synthesis for the same compound	**24L**

Reference

Theory

1. Organic chemistry, T.W Graham, Solomons Craig, B Fryhle
2. Organic Chemistry, Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Wothers, Oxford University Press.
3. A Guidebook to mechanism in Organic Chemistry, Peter Sykes, 6th Edition, Pearson Education, New Delhi.
4. Organic Chemistry, 8th Edition John McMurry.
5. Stereochemistry By Nasipuri
6. Stereochemistry, P.S. Kalsi, 4th Edition, New age International Limited.
7. Name Reactions in Heterocyclic Chemistry-Jie Jack Li, Wiley Interscience publications, 2005.
8. Name Reactions- Jie Jack Li, 4th Edition, Springer Pub.
9. Lehninger Principles of Biochemistry, 7th Edition, David Nelson and Michael Cox, Publisher W.H Freeman
10. IUPAC Nomenclature by S.C.Pal
11. Chemistry of Natural Products, O.P.Agarwal
12. Chemistry of Natural Products, Chatwal Anand Vol I and II

Practical

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

NAME OF THE COURSE	ANALYTICAL CHEMISTRY	
CLASS	TYBSc	
COURSE CODE	SBSCHE604	
NUMBER OF CREDITS	2.5	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

CO 1.	**To study various types of classical methods of titration and to determine their end point graphically and by calculation.**
CO 2.	**To learn classical and instrumental methods of chromatography as a tool for separation and identification.**
CO 3.	**To understand the principle, instrumentation and application of polarography and amperometry**
CO 4.	**To understand the principle, instrumentation and applications of thermogravimetry, mass spectrometry, NAA in the field of analytical chemistry.**

COURSE LEARNING OUTCOMES: Learner will be able to

CLO 1.	**calculate the theoretical end point of titrations graphically and by calculations.**
CLO 2.	**comprehend theory, working and applications of TLc, PC and GC**
CLO 3.	**explain principle and working of polarography and amperometry and calculate polarographic parameters using Ilkovic equation for given data**
CLO 4.	**plot and interpret the thermogram for a given compound, fragmentation pattern in MS and explain applications of TGA, NAA and Ms in various fields.**

UNIT	TOPIC	Lecture
I	**CLASSICAL METHODS OF ANALYSIS (TITRIMETRY)**	
	1.1 REDOX TITRATIONS	**5L**
1.1.1 **1.1.2** **1.1.3**	Introduction to Redox titrations Construction of the titration curves and calculation of Esystem in aqueous medium in case of i) One electron system (Fe^{+2} Vs Ce^{+4}) ii) Multielectron system (Fe^{+2} Vs $MnO_4^-/Cr_2O_7^{-2}$) (*Numericals expected) Theory of redox indicators, use of diphenyl amine and ferroin as indicators	
	1.2 COMPLEXOMETRIC TITRATIONS	**5L**
1.2.1 **1.2.2** **1.2.3** **1.2.4** **1.2.5**	Introduction, construction of titration curves Use of EDTA as a titrant, absolute and conditional formation constant of metal EDTA complexes, effect of pH ion EDTA equilibria. Types of EDTA titrations Factors enhancing selectivity of EDTA as a titrant Metallochromic indicators: Theory, examples and applications	
	1.3 PRECIPITATION TITRATIONS	**5L**
1.3.1 **1.3.2** **1.3.3**	Argentimetric titrations, construction of the titration curves (Numericals expected) Volhard's method and Mohr's method Adsorption indicators (Fajan's method), theory and applications	
II	**CHROMATOGRAPHY II**	
	2.1 THIN LAYER CHROMATOGRAPHY	**4L**
2.1.1 **2.1.2** **2.1.3**	Introduction and Principle; Stationary and mobile phase, Sample application Methods of detection of developed spots, qualitative and quantitative analysis Applications - i) Determining purity of a given solute (ii) Following progress of a given reaction	

	2.2 PAPER CHROMATOGRAPHY	**4L**
2.2.1 **2.2.2**	Principle, Techniques and different modes of development - Ascending, descending and circular Applications - Separation of cations	
	2.3 GAS CHROMATOGRAPHY	**7L**
2.3.1 **2.3.2** **2.3.3** **2.3.4** **2.3.5** **2.3.6**	Introduction and Principle of Gas chromatography (GC); Theory and terms involved Instrumentation - Block diagram and components, Types of columns, Stationary phases in GSC and GLC; Detectors: TCD, FID and ECD Interpretation of gas chromatogram, terms involved - Retention time, retention volume, relative retention, resolution and HETP Applications - Qualitative and quantitative analysis Comparison between GSC and GLC GC in hyphenated techniques	
III	**ELECTROANALYTICAL TECHNIQUES**	
	3.1 POLAROGRAPHY	**11L**
3.1.1 **3.1.2** **3.1.3** **3.1.4** **3.1.5**	Difference between potentiometry and voltammetry, polarizable and non-polarizable electrodes Basic principle of polarography, H shaped polarographic cell, DME- construction, working, advantages and limitations. 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 aspect of polarography - Ilkovic's Equation -terms involved (No derivation) Quantification of Polarogram by - i) Wave height ii) Internal standard method (iii) Standard addition method Applications, Advantages and Limitations of Polarography	
	3.2 AMPEROMETRIC TITRATIONS	**4L**
3.2.1 **3.2.**	Principle of Amperometric titrations; Rotating Platinum Electrode - Construction, advantages and limitations Titration curves with examples of Amperometric titrations Advantages and limitations of Amperometric titrations	

2 3.2. 3		
IV	**MISCELLANEOUS METHODS**	
	4.1THERMAL METHODS	**7L**
4.1. 1 4.1. 2 4.1. 3 4.1. 4 4.1. 5	Introduction to various thermal methods -TGA, DTA, DSC and Thermometric titrations Thermogravimetric analysis (TGA) – Instrumentation - Block diagram of thermobalance, balance, furnace, temperature measurement and control, recorder) Factors affecting thermogram - Instrumental factors and sample characteristics Thermogram of $CaC_2O_4H_2O$ and $CuSO_4.5H_2O$ Applications: i) Determination of drying and ignition temperature range ii) Determination of percent composition of binary mixtures (Estimation of calcium and magnesium oxalate	
	4.2 RADIOANALYTICAL METHODS	**5L**
4.2. 1 4.2. 2 4.2. 3	Introduction, classification of radio analytical methods Neutron activation analysis (NAA) - Principle, basic theory, Calibration curve method Advantages, limitations and applications of NAA	
	4.3 MASS SPECTROMETRY	**3L**
4.3. 1 4.3. 2 4.3. 3	Introduction, principle and basic theory of Mass Spectroscopy (MS) Instrumentation- Schematic diagram, components of mass spectrometer Applications of MS	
	PRACTICALS **Learning Objectives:** **1. To train learners to prepare standard solutions of known concentration.** **2. To train learners to handle and standardize analytical instruments for its optimum use.** **3. To introduce the learner to various classical and instrumental methods of analysis to real life and commercial samples.** **Learning Outcomes: The learner will be able to** **1. decide suitability of an instrument for its use in analysis.** **2. learn to prepare and standardise solutions with the highest degree of accuracy.** **3. analyse different samples using various methods of chemical analysis.**	24L

	1. Estimation of Magnesium from talcum powder **2.** Determination of Vitamin C content of a given tablet by titration against NaOH by pH metry 3. Determination of percentage purity of a common salt using a cation exchanger (Amberlite IR120) 4. Determination of the amount of fluoride in the given solution colorimetrically 5. Determination of phosphoric acid in cola sample using pH metry 6. Estimation of glucose in honey by Wilstatter's method 7. Statistical Evaluation of data: Rejection of data and Test of significance.	

Reference

Theory

1. Fundamentals of analytical Chemistry, 8th Edition :Skoog , West, Holler and Crouch, India Edition
2. Analytical Chemistry –G.D. Christian, 6th Edition, John Wiley and Sons.
3. Instrumental Analysis - Skoog, Holler and Crouch (2007), Cenage Learning India Private Limited (2007)
4. Modern analytical Chemistry- David Harvey, 2000
5. Thermal Methods, James Todd-Analytical Chemistry by Open Learning
6. Analytical Chemistry-Krupadanam David, University Press; 2012
7. Instrumental Methods of Analysis-Willard, Merritt, Dean and Settle, 7th Edition.
8. Instrumental Methods of Chemical Analysis –Chatwal Anand, 5th Edition, 2005. Himalaya Publishing House.

Practical

1. Vogel's Quantitative Chemical Analysis, 3rd edition

NAME OF THE COURSE	APPLIED COMPONENT	
CLASS	TYBSc	
COURSE CODE	SBSAPC601	
NUMBER OF CREDITS		
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	75	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	25	75
PASSING MARKS	10	30

COURSE OBJECTIVES:

Learner will understand

CO 1.	the drug, discovery, design, development and metabolism of drugs
CO 2.	the various chemotherapeutic agents with respect to chemical structure, therapeutic action and uses.
CO 3.	the classification of dyes based on their structure and synthesis of dyes/drugs and their intermediates.
CO 4.	the use of the non-textile dyes, their properties and characteristics. The impact of the dyestuff industry on the environment and remediation processes

COURSE LEARNING OUTCOMES: Learner will be able to

CLO 1.	Explain the process of drug discovery design and development
CLO 2.	write the synthesis of drugs and use of a drug
CLO 3	Identify and classify the dye based on their structure and write the synthesis.
CLO 4	To explain the effect of the dyestuff industry on the environment and apply the appropriate remediation process

UNIT	TOPIC	Lect
I	**1.1 DRUG DISCOVERY, DESIGN AND DEVELOPMENT**	**15**
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	
1.1.6	Drug Metabolism - Introduction, Absorption, Distribution, Biotransformation, Excretion; Different types of chemical transformation of drugs with specific examples	
II	**CHEMOTHERAPEUTIC AGENTS**	
2.1	**Antibiotics and antivirals -** Definition; i) Amoxicillin (β- lactum antibiotics) ii) Cefpodoxime (Cephalosporins) iii) Doxycycline (Tetracyclines) iv) Levofloxacin (Quinolones) (Synthesis from 2,3,4 – Trifluro -1-nitrobenzene) v) Aciclovir/Acyclovir (Purines)	**2**
2.2	**Antimalarials -** Types and Symptoms of malaria; Pathological detection during window period (Life cycle of the parasites not to be discussed) ; i) Chloroquine (3-Amino quinolones) ii) Artemether(Benzodioxepins) Following combination to be discussed - Atremether-Lumefantrine (structure not expected)	**1**
2.3	**Antihelmintics and Antifungal agents -** Drugs effective in the treatment of	**2**

	Nematodes and Cestodes infestations; i) Diethyl carbamazine (Piperazines) ii) Albendazole (Benzimidazoles) (Synthesis from 2- Nitroaniline) iii) Clotrimazole (Imidazole) iv) Fluconazole (Triazole) (Synthesis from 1- Bromo – 2,4-difluorobenzene)	
2.4	**Antiamoebic Drugs -** Types of Amoebiasis - Metronidazole, Ornidazole, Tinidazole (Imidazole); Synthesis of Metronidazole from glyoxal by Debus Radziszewski imidazole route Following combination therapy to be discussed – CiprofloxacinTinidazole	**1**
2.5	**Antitubercular and Antileprotic Drugs -** Tuberculosis and leprosy – Types, Symptoms and diagnosis; General idea of Antibiotics used in their treatment; i) PAS (Amino salicylates) ii) Isoniazide (Hydrazides) iii) Pyrazinamide (Pyrazines) iv) (+) Ethambutol (Aliphatic diamines)(Synthesis from 1- Nitropropane) v) Dapsone(Sulphonamides) vi) Clofazimine (Phenazines) vii) Bedaquiline (Quinolines) Following combination therapy to be discussed - (a) Rifampin + Ethambutol + Pyrazinamide (b) Rifampin + Isoniazide + Pyrazinamide	**2**
2.6	**Antineoplastic Drugs -** Causes of cancer **-** malignancy; Brief idea of Immuno Stimulants and depressants; i) Lomoustine (Nitrosoureas) ii) Anastrozole(Triazoles) [Synthesis from 3,5-bis (bromomethyl) toluene] iii) Cisplatin (Chloroplatinum) iv) Vinca alkaloids - Vincristine, Vinblastine, Vindesine (structure not expected)	**2**
2.7	**Anti-HIV Drugs -** Idea of HIV pathogenicity, Symptoms of AIDS; i) AZT/Zidovudine ii) Lamivudine iii) DDI (Purines) iv) Nevirapine (dipyridodiazepinone)	**1**
2.8	**Drug Intermediates-** Synthesis and uses; i) p-[2'-(5-Chloro-2-methoxy benzamido) ethyl]-benzenesulphonamide from Methyl-5-chloro-2- methoxybenzene ii) 3-(p-Chlorophenyl)-3- hydroxypiperidine from 3-Chloroacetophenone iii) Epichlorohydrine from propene	**1**
2.9	**Nano particles in Medicinal Chemistry-** Introduction; Nano based drug delivery systems- drug delivery process and mechanism; i) Cellulose ii) Dendrimers iii) liposomes iv) polymeric micelle	**3**
	*Study of the above **chemotherapeutic agents** with respect to their chemical structure (not expected) chemical class, therapeutic uses, side effects and introduction to MDR wherever applicable.	
III	**CLASSIFICATION AND SYNTHESIS OF SELECTED DYES BASED ON CHEMICAL CONSTITUTION**	
3.1	a) Nitro Dye – i) Naphthol Yellow S b) uiAzo dyes – i) Monoazo dyes- Orange IV *(from sulphanilic acid) and Eriochrome Black T* (from β- naphthol) ii) Bisazo dyes- Congo Red* (from nitrobenzene) iii) Trisazo Dye- Direct Deep Black EW* (from benzidine)	**10**

	c) Diphenylmethane dye- i) Auramine O* (from N,N-dimethyl aniline) d) Triphenylmethane dye- i) Diamine series- Malachite Green* (from benzaldehyde) ii) Triamine series- Acid Magenta iii) Phenol series- Rosolic acid e) Heterocyclic Dye – i) Thiazine dyes- Methylene Blue ii) Azine dyes - Safranin T iii) Xanthene Dyes- Eosin* (from phthalic anhydride) iv) Acridine Dyes- Acriflavine f) Quinone Dyes- i) Naphthaquinone- Naphthazarin ii) Anthraquinone Dyes- Indanthrene Blue* (from anthraquinone) g) Indigoid Dyes- i) Indigo* (from aniline + monochloroacetic acid) h) Phthalocyanine Dyes- i) Monastral Fast Blue B **(*synthesis of the dyes is expected)**	
3.2	**DYES USED IN FOOD AND COSMETICS** - Properties of dyes used in food and cosmetics; Introduction to FDA and FSSAI; Commonly used food colours and their limits; Characteristics of dyes used in nail lacquers and lipsticks with some examples; Hair Dyes - Oxidative Hair coloration and non-oxidative Hair Dyes.	**5**
IV	**4.1 NON-TEXTILE USES OF DYES**	**8**
4.1.1 **4.1.2** **4.1.3** **4.1.4**	Biomedical uses of dyes - a) Dyes used in formulations (Tablets, capsules, syrups etc) – i) Indigo carmine ii) Sunset yellow iii) Tartrazine b) Biological staining agents – i) Methylene blue ii) Crystal violet iii) Safranine T c) Fluorescent stains – i) Lucifer Yellow CH/VS d) DNA markers – i) Bromophenol blue ii) Orange G iii) Cresol red e) Dyes as therapeutics – i) Mercurochrome ii) Acriflavine iii) Crystal Violet iv) Prontosil Colour photography - Additive and subtractive processes, dye transfer and synthesis Paper and leather dyes -Structural features and examples Miscellaneous dyes- Laser Dyes, Indicators, Security Inks, Coloured smokes and Camoflage colours	
4.2	**CHROMIC MATERIALS** - Thermochromism , Photochromism, electrochromism	**2**
	4.3 SYNTHETIC DYES - HEALTH AND ENVIRONMENTAL HAZARDS, REMEDIATION PROCESSES	**5**
4.3.1 **4.3.2** **4.3.3**	Impact of the textile and leather dye industry on the environment with special emphasis on water pollution. Toxicity of dyes with respect to food colours Effluent Treatment - Brief introduction to effluent treatment plants (ETP); Primary Remediation processes – Physical Processes- i) Sedimentation ii) Aeration iii) Sorption - activated charcoal, fly ash; Secondary Remediation processes – a) Biological Remediation – i) Biosorption ii) Biodegradation; b) Chemical Remediation processes - i) Oxidation Process (Chlorination) ii) Coagulation-flocculation-Precipitation	
	PRACTICALS **Course Objectives** 1. To prepare drug and drug intermediates on a bench scale 2. To learn the application of colorimeter/spectrophotometer in estimation of dyes. 3. To acquaint learners with chromatographic techniques as a method of	

	separation 4. To learn quantitative analysis of dyes. 5. To understand the importance of a monograph 6. To give the learner an exposure of the workings of an industry **Course Outcomes- The learner will be able to** 1. Perform a synthesis of drug or drug intermediate 2. Analyse commercial samples of dyes using a given method. 3. Perform quality control of a commercial sample of drug as per Indian Pharmacopoeia **Preparation of Drugs: (any three)** **1.** p-nitroacetanlide from acetanilide **2.** p-nitroaniline from p-nitroacetanilide **3.** Benzocaine from 4-aminobenzoic acid **4.** o-chlorobenzoic acid from anthranilic acid **Estimation and separation of Dyes: (any three)** **1.** Estimation of primary aromatic amine by diazotation **2.** Estmation of coupling component by diazonium salt solution (any one) a. β-Napthol b. Resorcinol **3.** Colorimetric estimation of Methyl Orange **4.** Separation of a mixture of dyes using TLC **5.** Separation of Azo, Basic and Vat dyes by chemical method (Two Mixtures) **Project work** Monograph of a Drug and its assay or Case Study **Industrial Visit Compulsory to a pharmaceutical / dye industry.**	

References

1. Chemistry of Synthetic Dyes, Vol I – VIII, Venkatraman K., Academic Press 1972
2. Chemistry of Synthetic Dyes and Pigments, Lubs H.A., Robert E Krieger Publishing Company, NY 1995
3. Colour Chemistry, Heinrich Zollinger
4. Colour Chemistry, Allen
5. Colour Chemistry, Robert M Christie, 2nd Edition, Royal Society of Chemistry, 2015
6. Synthetic dyes, Gurdeep R. Chatwal
7. Chemistry of Dyes and Principles of Dyeing, V.A. Shenai; Sevak Publication, Bombay
8. Natural and Synthetic Organic Chemistry, O.P.Agrawal
9. An introduction to drugs, Singh and Rangnekar
10. British Pharmacopoeia
11. Indian Pharmacopoeia
12. Pharmacology and pharmacotherapeutics, Iswariah and Guruswamy, 7th Edition, Vikas Publishers
13. Practical Organic Chemistry, A.I. Vogel

ASSESSMENT DETAILS:

(for all the theory papers)

Internal Assessment (50 marks)

Two activities to be conducted of 25 marks each

Activities could be Test/ assignment/ project

Semester End Examination – External Assessment (50marks)

- The duration of the paper will be two hours.
- All modules to be covered in the exam.

Practical Assessment
For Main practicals

- The total marks of the practical will be 200.
- The exam will be conducted in four sessions. Each session will have an experiment from each paper (50 marks x 4 = 200 marks)
- Attendance in all sessions is compulsory.
- The students are allowed to write the paper if the attendance for practical is more than 75%
- To appear in the practical exam, students must bring a properly certified journal.

For Applied Component practical

- The total marks of the practical will be 100.
- The exam will be conducted in two sessions.
- Attendance in all sessions is compulsory.
- The students are allowed to write the paper if the attendance for practical is more than 75%
- To appear in the practical exam, students must bring a properly certified journal