SOPHIA COLLEGE FOR WOMEN (AUTONOMOUS)

Affiliated to

UNIVERSITY OF MUMBAI

Programme:CHEMISTRY

Programme Code: SBSCHE

TYBSc

2019-20

(Choice Based Credit System with effect from the year 2018-19)

Programme Outline: TYBSc (SEMESTER V)

Course Code	Unit No	Name of the Unit	Credits
SBSCHE501		PHYSICAL CHEMISTRY	2.5
	1	Molecular Spectroscopy	
	2	2.1Chemical Thermodynamics 2.2 Colloidal kinetics	
	3	Nuclear Chemistry	
	4	4.1 Surface Chemistry 4.2 Colloidal Chemistry	
SBSCHE502		INORGANIC CHEMISTRY	2.5
	1	Molecular Symmetry and Chemical bonding	
	2	2.1Solid State Chemistry 2.2Super Conductivity	
	3	Chemistry of Inner Transition elements	
	4	4.1 Chemistry of non aqueous solvents 4.2 Comparative Chemistry of Group 16 4.3 Comparative Chemistry of Group 17	
SBSCHE503		ORGANIC CHEMISTRY	2.5
	1	1.1Mechanism of Organic reactions 1.2 Photochemistry	
	2	2. 1 Stereochemistry -I 2.2Agrochemicals 2.3Heterocyclic Chemistry	
	3	3.1 IUPAC 3.2 Synthesis of organic compounds	
	4	4.1 Spectroscopy -I 4.2 Natural products	
SBSCHE504		ANALYTICAL CHEMISTRY	2.5
	1	1.1 Quality in analytical chemistry 1.2 Chemical calculations 1.3 Sampling	
	2	2.1 Redox titrations 2.2 Complexometric titrations	
	3	3.1 Atomic Absorption Spectroscopy 3.2 Molecular, Fluorescence and Phosphorescence Spectroscopy 3.3 Turbidimetry and Nephelometry	
	4	4.1 Solvent extraction 4.2 High Performance Liquid Chromatography 4.3 High PerformanceThin layer Chromatography	
SBSCHEP5		PRACTICALS	6

Applied Component

Course Code	Title of the Paper	Unit	Topic	Credits
SBSAPC501	Drugs & Dyes	1	1.1 General introduction to drugs 1.2 Routes of drug administration and dosage form 1.3 Pharmacodynamic agents	2
		2	2.1 Analgesics, antipyretics & anti inflammatory drugs 2.2 Antihistaminic drugs 2.3 Cardiovascular drugs 2.4 Antidiabetic agents 2.5 Antiparkinson drugs 2.6 Drugs for respiratory system	
		3	3.1 Introduction to dye stuff industry 3.2 Substrates for dyes 3.3 Classification of dyes based on applications and dyeing methods	
		4	4.1 Colour and chemical constitution of dyes 4.2 Unit process and dye 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	1.1 Electrochemistry 1.2 Applied Electrochemistry	
	2	Polymers	
	3	3.1 Basics of quantum mechanics 3.2 Renewable energy resources	
	4	4.1 NMR spectroscopy 4.2 ESR spectroscopy	
SBSCHE602		INORGANIC CHEMISTRY	2.5
	1	Theories of metal ligand bond-I	
	2	Theories of metal ligand bond-II	
	3	Organometallic chemistry	
	4	4.1 Metallurgy 4.2 Chemistry of Group 18 4.3 Introduction to bioinorganic chemistry	

SBSCHE603		ORGANIC CHEMISTRY	2.5
	1	1.1 Stereochemistry -II 1.2 Amino acids and proteins	
	2	2.1 Molecular rearrangements 2.2 Carbohydrates	
	3	3.1 Spectroscopy -II 3.2 Nucleic acids	
	4	4.1 Polymers 4.2 Catalyst and reagents	
SBSCHE604		ANALYTICAL CHEMISTRY	2.5
	1	1.1 Polarography 1.2 Amperometric titrations	
	2	2.1 Gas Chromatography 2.2 Ion exchange chromatography	
	3	Food and cosmetic analysis	
	4	4.1 Thermal methods 4.2 Analytical method validation	
SBSCHEP6		PRACTICALS	6

Applied Component

Course Code	Title of The Paper	Unit	Topic	Credits
SBSAPC601	Drugs & Dyes	1	1.1 Drug discovery,design and development 1.2 Drug metabolism 1.3 Chemotherapeutic agents	2
		2	2.1 Antiamoebic drugs 2.2 Anti TB and antileprotic drugs 2.3 Anti neoplastic drugs 2.4 Anti HIV drugs 2.5 Drug intermediates 2.6 Nanoparticles in medicine 2.7 drugs and environmental aspects	
		3	3.1 Classification of dyes based on Chemical constitution and synthesis of selected dyes 3.2 Health and environmental hazards of synthetic dyes and their remediation process	
		4	4.1 Non textile uses of dyes 4.2 Pigments 4.3 Dye stuff industry-Indian perspective	
SBSAPCP601	Applied component Practical	-		2

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 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.	Understand the fundamental principles of molecular spectroscopy, including the interaction of electromagnetic radiation with matter.
CO 2.	To study and apply thermodynamic principles and predict the behavior of gases, liquids, and solids under different conditions.
CO 3.	Understand the basic principles of nuclear chemistry, including the structure of the atomic nucleus, nuclear stability, and radioactive decay processes.
CO 4.	To study the processes of adsorption and desorption at solid surfaces, including physical adsorption, chemisorption, and Langmuir adsorption isotherms

COURSE LEARNING OUTCOMES: Learner will be able to

CLO 1.	Demonstrate a thorough understanding of the fundamental principles of molecular spectroscopy, including the interaction of electromagnetic radiation with matter.
CLO 2.	Solve thermodynamic calculations, including determining enthalpy changes, entropy changes, and Gibbs free energy changes.
CLO 3.	Understand the fundamental principles of nuclear chemistry, including nuclear structure, radioactive decay processes, and nuclear reactions.
CLO 4.	Understand the processes of adsorption and desorption at solid surfaces, including physical and chemical adsorption mechanisms.

UNIT	TOPIC	Lectures
I	**MOLECULAR SPECTROSCOPY (3&6 units)**	**15L**
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 CHEMICAL THERMODYNAMICS (3&6 units)**	**10L**
2.1.1	Colligative properties: Vapour pressure and relative lowering of vapour pressure. Measurement of lowering of vapour pressure - Static and Dynamic method.	
2.1.2	Solutions of Solid in Liquid: 2.1.2.1 Elevation in boiling point of a solution, thermodynamic derivation relating elevation in boiling point of the solution and molar mass of non-volatile solute. 2.1.2.2 Depression in freezing point of a solution, thermodynamic derivation relating the depression in the freezing point of a solution and the molar mass of the non-volatile solute. Beckmann Method and Rast Method.	
2.1.3	Osmotic Pressure : Introduction, thermodynamic derivation of Van't Hoff equation, Van't Hoff Factor. Measurement of Osmotic Pressure - Berkeley and Hartley's Method, Reverse Osmosis.	

	2.2 CHEMICAL KINETICS	**5L**
2.2.1	Collision theory of reaction rates : Application of collision theory to 1. Unimolecular reaction Lindemann theory and 2. Bimolecular reaction. (derivation expected for both)	
2.2.2	Classification of reactions as slow, fast and ultra -fast. Study of kinetics of fast reactions by Stop flow method and Flash photolysis (No derivation expected).	
III	**NUCLEAR CHEMISTRY(6 units)**	**15L**
3.1	Introduction: Basic terms-radioactive constants (decay constant, half life and average life) and units of radioactivity	
3.2	Detection and Measurement of Radioactivity: Types and characteristics of nuclear radiations, behaviour of ion pairs in electric field, detection and measurement of nuclear radiations using G. M. Counter and Scintillation Counter.	
3.3	Application of use of radioisotopes as Tracers : chemical reaction mechanism, age determination - dating by C^{14}.	
3.4	Nuclear reactions: nuclear transmutation (one example for each projectile), artificial radioactivity, Q - value of nuclear reaction, threshold energy.	
3.5	Fission Process : Fissile and fertile material, nuclear fission, chain reaction, factor controlling fission process. multiplication factor and critical size or mass of fissionable material, nuclear power reactor and breeder reactor.	
3.6	Fusion Process : Thermonuclear reactions occurring on stellar bodies and earth.	
IV	**4.1 SURFACE CHEMISTRY(6 units)**	**6L**
4.1.1	Adsorption: Physical and Chemical Adsorption, types of adsorption isotherms . Langmuir's adsorption isotherm (Postulates and derivation expected). B.E.T. equation for multilayer adsorption, (derivation not expected). Determination of surface area of an adsorbent using B.E.T. equation.	

	4.2 COLLOIDAL CHEMISTRY	**9L**
4.2.1	Introduction to colloids - Emulsions, Gels and Sols	
4.2.2	Electrical Properties : Origin of charges on colloidal particles, Concept of electrical double layer, zeta potential, Helmholtz and Stern model. Electro-kinetic phenomena - Electrophoresis, Electro-osmosis, Streaming potential, Sedimentation potential; Donnan Membrane Equilibrium.	
4.2.3	Colloidal electrolytes : Introduction, micelle formation,	
4.2.4	Surfactants: Classification and applications of surfactants in detergents and the food industry.	

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, Kolkata.
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 University 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.

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 & learn the preparation and properties of superconductors
CO 3.	To familiarize with chemistry of inner transition elements
CO 4.	To understand the properties of Group 16 & 17

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 & write synthesis, properties and application of superconductors
CLO 3.	compare properties of inner transition elements and transition elements
CLO 4.	differentiate the properties of group 16 & 17

UNIT	TOPIC	Lectures
1	**Molecular Symmetry and Chemical Bonding(3&6 units)**	
	1.1 Molecular Symmetry	**6L**
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) C2V (iv) C3v (v) C2h and (vi) D3h	
	1.2 Molecular Orbital Theory for heteronuclear diatomic molecules and polyatomic species	**9L**
1.2.1	Comparison between homonuclear and heteronuclear diatomic molecules.	
1.2.2	Heteronuclear diatomic molecules like CO, NO and HCl, appreciation of modified MO diagram for CO.	
1.2.3	Molecular orbital theory for H_3 and H_3^+ (correlation diagram expected).	
1.2.4	Molecular shape to molecular orbital approach in AB2 molecules. Application of symmetry concepts for linear and angular species considering σ- bonding only.(Examples like : i) BeH_2, ii) H_2O).	
2	**SOLID STATE CHEMISTRY (3&6 units)**	
	2.1 Structures of Solids	**11L**
2.1.1	Explanation of terms viz.crystal lattice, lattice point, unit cell and lattice constants.	
2.1.2	Closest packing of rigid spheres (hcp,ccp), packing density in simple cubic, bcc and fcc lattices. Relationship between density, radius of unit cell and lattice parameters.	
2.1.2	Stoichiometric Point defects in solids (discussion on Frenkel and Schottky defects expected).	
	2.2 Superconductivity	**4L**
2.2.1	Discovery of superconductivity.	
2.2.2	Explanation of terms like superconductivity, transition temperature, Meissner effect.	

2.2.3	Different types of superconductors viz.conventional superconductors, alkali metal fullerides, high temperature superconductors.	
2.2.4	Brief application of superconductors.	
3	**CHEMISTRY OF INNER TRANSITION ELEMENTS (6 units)**	**15L**
3.1	Introduction: Position in periodic table and electronic configuration of lanthanides and actinides.	
3.2	Chemistry of Lanthanides with reference to (i) lanthanide contraction and its consequences (ii) Oxidation states (iii) Ability to form complexes (iv) Magnetic and spectral properties	
3.3	Occurrence, extraction and separation of lanthanides by (i) Ion Exchange method and (ii) Solvent extraction method (Principles and technique)	
3.4	Applications of lanthanides	
4	**SOME SELECTED TOPICS (6 units)**	
	4.1 Chemistry of Non-aqueous Solvents	**5L**
4.1.1	Classification of solvents and importance of non-aqueous solvents.	
4.1.2	Characteristics and study of liquid ammonia, dinitrogen tetra oxide as non-aqueous solvents with respect to : (i) acid-base reactions and (ii) redox reactions.	
	4.2 Comparative Chemistry of Group 16	**5L**
4.2.1	Electronic configurations, trends in physical properties, allotropy	
4.2.2	Manufacture of sulphuric acid by Contact process	

	4.3 Comparative Chemistry of Group 17	**5L**
4.3.1	Electronic configuration , General characteristics, anomalous properties of fluorine, comparative study of acidity of oxyacids of chlorine w.r.t acidity, oxidising properties and structures(on the basis of VSEPR theory)	
4.3.2	Chemistry of interhalogens with reference to preparations, properties and structures (on the basis of VSEPR theory).	

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.

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.	System of naming organic compounds and basic principles of spectroscopy
CO 2.	Mechanisms of reactions and name reactions, catalysts and reagents involved in reactions, preparation and reactions of organometallic compound and basic principles of photochemistry with some of the reactions
CO 3.	Stereochemistry of compounds without stereogenic center and cycloalkanes and applications of agrochemicals
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 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.	Understand the application of agrochemicals in day to day life and predict the product formation in heterocycles
CLO 4.	Identify and classify the natural products, determine the structure of some natural products and interpret spectral data

UNIT	**TOPIC**	**Lectures**
I	**1.1 MECHANISM OF ORGANIC REACTIONS (3&6 units)**	**10L**
1.1.1 1.1.2 1.1.3 1.1.4	The basic terms & concepts: bond fission, reaction intermediates, electrophiles & nucleophiles, ligand, base, electrophilicity vs. acidity & nucleophilicity vs basicity. Neighbouring group participation in nucleophilic substitution reactions**:** participation of lone pair of electrons, kinetics and stereochemical outcome. Acyl nucleophilic substitution (Tetrahedral mechanism): Acid catalyzed esterification of carboxylic acids (AAC2) and base promoted hydrolysis of esters (BAC2). Pericyclic reactions, classification and nomenclature 1.1.4.1 Electro cyclic 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	
1.2.1 1.2.2 1.2.3	**1.2 Photochemistry** Introduction: Difference between thermal and photochemical reactions. Jablonski diagram, singlet and triplet states, allowed and forbidden transitions, fate of excited molecules, photosensitization. Photochemical reactions of olefins: photoisomerization, photochemical rearrangement of 1,4- dienes (di- π methane) Photochemistry of carbonyl compounds: Norrish I, Norrish II cleavages. Photo reduction (e.g. benzophenone to benzpinacol)	**5L**

II	**2.1 Stereochemistry I (3&6 units)**	**5L**
2.1.1 2.1.2	Molecular chirality and elements of symmetry: Mirror plane symmetry, inversion center, rotation -reflection (alternating) axis Chirality of compounds without a stereo genic center: cumulenes and biphenyls.	
2.2.1 2.2.2 2.2.3 2.2.4	**2.2 Agrochemicals** General introduction & scope, meaning & examples of insecticides, herbicides, fungicide, rodenticide, pesticides, plant growth regulators. Advantages and disadvantages of agrochemicals Synthesis & application of IAA & Endosulfan Biopesticide- Neem oil & Karani	**4L**
2.3.1 2.3.2 2.3.3 2.3.4	**2.3 Heterocyclic chemistry:** Reactivity of pyridine-N-oxide, quinoline and iso-quionoline. Preparation of pyridine-N-oxide, quinoline (Skraup synthesis) and iso-quinoline (Bischler- Napieralski synthesis). Reactions of pyridine-N-oxide: halogenation, nitration and reaction with $NaNH_2$/liq.NH_3, n-BuLi. Reactions of quinoline and isoquinoline; oxidation,reduction,nitration,halogenation and reaction with $NaNH_2$/liq.NH_3,n-BuLi.	**6L**
III 3.1.1 3.1.2 3.1.3 3.1.4	**3.1 IUPAC (6 units)** **Systematic nomenclature** of the following classes of compounds (including compounds upto two substituents / functional groups): Bicyclic compounds – spiro, fused and bridged (upto 11 carbon atoms) – saturated and unsaturated compounds. Biphenyls Cummulenes (upto 3 double bonds) 3.1.4 Quinolines and isoquinolines	**5L**
	3.2 Synthesis of organic compounds	**10L**
3.2.1 3.2.2 3.2.3 3.2.4	Introduction: Linear and convergent synthesis, criteria for an ideal synthesis, concept of chemo selectivity and regioselectivity with examples, calculation of yields. Multicomponent Synthesis: Mannich reaction and Biginelli reaction. Synthesis with examples(no mechanism) Green chemistry and synthesis: Introduction: Twelve principles of green chemistry, concept of atom economy and E-factor, calculations and their significance, numerical examples. Planning of organic synthesis i)synthesis of nitroanilines. (*o&p*) ii) synthesis of halobenzoic acid. (*o&p*)	

	iii) Alcohols (primary / secondary / tertiary) using Grignard reagents. iv) Alkanes (using organo lithium compounds)	
IV 4.1.1 4.1.2 4.1.3	**4.1 Spectroscopy I(6 units)** Introduction: Electromagnetic spectrum, units of wavelength and frequency 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-auxochrome 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.	**5L**
4.2.1 4.2.2 4.2.3 4.2.4 4.2.5	**4.2 Natural Products:** Terpenoids: Introduction, Isoprene rule, special isoprene rule and the gem-dialkyl rule. Citral: a) Structural determination of citral. b) Synthesis of citral from methyl heptenone c) Isomerism in citral. (cis and trans form). Alkaloids Introduction and occurrence. Hofmann's exhaustive methylation and degradation in**:** simple open chain and N – substituted monocyclic amines. Nicotine: a) Structural determination of nicotine. (Pinner's work included) b) Synthesis of nicotine from nicotinic acid c) Harmful effects of nicotine Hormones: Introduction, structure of adrenaline (epinephrine), physiological action of adrenaline. Synthesis of adrenaline from a) Catechol b) p-hydroxybenzaldehyde(Ott's synthesis)	**10L**

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, 4thEdition, 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

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	Lectures
I	**INTRODUCTION TO QUALITY CONCEPTS,CHEMICAL CALCULATIONS AND SAMPLING (3 & 6 UNITS)**	
1.1	**Quality in Analytical Chemistry**	**5L**
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)**	**4L**
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**	**6L**
1.3.1	Purpose, significance and difficulties encountered in sampling	
1.3.2	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.	
1.3.3	Sampling of liquids: Homogeneous and heterogeneous, Static and flowing liquids.	
1.3.4	Sampling of gases: Ambient and stack sampling: Apparatus and methods for sampling of gases.	
1.3.5	Collection, preservation and dissolution of the sample.	
II	**CLASSICAL METHODS OF ANALYSIS (TITRIMETRY) (3 & 6 UNITS)**	

2.1	**Redox Titrations (Numerical and word Problems are expected)**	**8L**
2.1.1	Introduction	
2.1.2	Construction of the titration curves and calculation of Esystem in aqueous medium in case of:(1) One electron system (2) Multielectron system	
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**	**7L**
2.2.1	Introduction, construction of titration curve	
2.2.2	Use of EDTA as titrant and its standardisation, absolute and conditional formation constants of metal EDTA complexes, Selectivity of EDTA as a titrant. Factors enhancing selectivity with examples. Advantages and limitations of EDTA as a titrant.	
2.2.3	Types of EDTA titrations.	
2.2.4	Metallochromic indicators, theory, examples and applications	
III	**OPTICAL METHODS(6 UNITS)**	
3.1	**Atomic Spectroscopy: Flame Emission spectroscopy(FES) and Atomic Absorption Spectroscopy(AAS)**	**7L**
3.1.1	Introduction, Energy level diagrams, Atomic spectra, Absorption and Emission Spectra	
3.1.2	Flame Photometry – Principle, Instrumentation (Flame atomizers, types of Burners, Wavelength selectors, Detectors)	
3.1.3	Atomic Absorption Spectroscopy – Principle, Instrumentation (Source, Chopper, Flame and Electrothermal Atomiser)	
3.1.4	Quantification methods of FES and AAS – Calibration curve method, Standard addition method and Internal standard method.	
3.1.5	Comparison between FES and AAS	

3.1.6	Applications, Advantages and Limitations	
3.2	**Molecular Fluorescence and Phosphorescence Spectroscopy**	**4L**
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**	**4L**
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	
IV	**METHODS OF SEPARATION – I (6 UNITS)**	
4.1	**Solvent Extraction**	**6L**
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’scounter Current extraction: Principle,apparatus and applications	
4.1.4	Solid phase extraction: Principle, process and applications with special reference to water and industrial effluent analysis.	
4.1.5	Comparison of solid phase extraction and solvent extraction.	

4.2	**High Performance Liquid chromatography (HPLC)**	**6L**
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 application	
4.3	**High Performance Thin Layer Chromatography (HPTLC)**	**3L**
4.3.1	Introduction and Principle.Stationary phase, Sample application and mobile phase	
4.3.2	Detectors a) Scanning densitometer- Components.Types of densitometer- Single beam and Double beam b) Fluorometric Detector	
4.3.3	Advantages, disadvantages and applications	
4.3.4	Comparison of TLC and HPTLC	

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.

NAME OF THE COURSE	CHEMISTRY PRACTICALS	
CLASS	TYBSc	
COURSE CODE	SBSCHEP5	
NUMBER OF CREDITS	6	
NUMBER OF LECTURES PER WEEK	(4X4)16	
TOTAL NUMBER OF LECTURES PER SEMESTER	(24X4)96	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	--	200
PASSING MARKS	--	80

PHYSICAL CHEMISTRY PRACTICALS
COURSE OBJECTIVES:

CO 1.	To train the students to handle different instruments and maintain laboratory discipline
CO 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 LEARNING OUTCOMES: Learner will be able to

CLO 1.	Understand the handling of instruments and correlate practical experiments with theoretical knowledge
CLO 2.	Set up different electrochemical cells
CLO 3.	Practice laboratory safety measures and precautions to be taken while handling the instrument, electrodes and different chemicals

Practicals:

1. To determine the molecular weight of compound by Rast Method
2. To determine the order between K2S2O8 and KI by fractional change method. (3&6 units)
3. To investigate the adsorption of acetic acid on activated charcoal and test the validity of Freundlich adsorption isotherm.
4. To determine the solubility and solubility product of AgCl potentiometrically using chemical cell.(3&6 units)
5. To determine the velocity constant of alkaline hydrolysis of ethyl acetate by conductometric method.
6. To determine acidic and basic dissociation constants of amino acid and hence to calculate isoelectric point.(3&6 units)

Reference:

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

INORGANIC CHEMISTRY PRACTICALS
COURSE OBJECTIVES:

CO 1.	To train students to prepare inorganic complexes
CO 2.	To determine the percentage purity of inorganic salts

COURSE LEARNING OUTCOMES: Learner will be able to

CLO 1.	prepare inorganic complexes
CLO 2.	analyze inorganic salts for their purity

Inorganic preparations

1. Preparation of Potassium diaquobis- (oxalato)cuprate (II)(3&6 units)
2. Preparation of Ferrous ethylene diammonium sulphate.
3. Preparation of bisacetylacetonatocopper(II)

Determination of percentage purity of the given water soluble salt and qualitative detection w.r.t added cation and/or anion (qualitative analysis only by wet tests).(3&6 units)

(Any three salts of transition metal ions)

References:

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

ORGANIC CHEMISTRY PRACTICALS
COURSE OBJECTIVES:

CO 1.	To understand the method and concept of separation of a binary mixture quantitatively
CO 2.	To train the learners to perform qualitative analysis and identify a component
CO 3.	To understand the method of purification of the components.
CO 4.	To develop the skill of determining physical constant of compounds

COURSE LEARNING OUTCOMES: Learner will be able to

CLO 1.	To identify the nature of a binary mixture and separate the mixture quantitatively.
CLO 2.	To enable the students to develop skills in organic qualitative analysis
CLO 3.	To enable students to purify compounds by recrystallization technique

Organic Separation**(3&6 units)**

Separation of Binary solid-solid mixture (2.0 gms mixture to be 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 neutral (thiourea) and water insoluble neutral compounds (anilides , amides, m-DNB, hydrocarbons)
3. After correct determination of chemical type, the separating reagent should be decided by the student for separation.

*No identification for 3 unit students

4. Follow separation scheme with the bulk sample of binary mixture.
5. After separation into component A and component B, one component (decided by the examiner) is to be analyzed and identified with m.p..

Reference:

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

ANALYTICAL CHEMISTRY PRACTICALS
COURSE OBJECTIVES:

CO 1.	To train learners to prepare standard solutions of known concentration.
CO 2.	To train learners to handle and standardize analytical instruments for its optimum use.
CO 3.	To introduce the learner to various classical and instrumental methods of analysis to real life and commercial samples.

COURSE LEARNING OUTCOMES: Learner will be able to

CLO 1.	decide suitability of an instrument for its use in analysis.
CLO 2.	to prepare and standardise solutions with the highest degree of accuracy.
CLO 3.	analyse different samples using various methods of chemical analysis

1. Spectrophotometric estimation of fluoride

2 Estimation of magnesium content in Talcum powder by complexometry, using standardized solution of EDTA

3 Determination of COD of water sample.

4 To determine potassium content of a Fertilizer by Flame Photometry (Calibration curve method).

5 To determine the amount of persulphate in the given sample solution by back titration with standard Fe (II) ammonium sulphate solution.

6 To determine the amount of sulphate in given water sample turbidimetrically.

Reference:

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

NAME OF THE COURSE	APPLIED COMPONENT	
CLASS	TYBSc	
COURSE CODE	SBSAPC501**(3&6 units)**	
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	Definition, requirement and classification of drugs (based on Therapeutic action)	
1.1.2	Nomenclature of drugs- generic, brand and systematic name.	
1.1.3	Medicinal terms- Pharmacon, Pharmacophore, Prodrug, Half-life efficiency, LD_{50}, ED_{50}, Therapeutic index.	
1.1.4	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	Oral and parenteral routes with advantages and disadvantages.	
1.2.2	Formulations, different dosage forms (emphasis on sustained release formulations.)	
1.2.3	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]	
II	**2.1 ANALGESICS, ANTIPYRETICS AND ANTI-INFLAMMATORY DRUGS**	**3**
2.1.1	Analgesics and Antipyretics – i) Morphine (Phenanthrene alkaloids) ii) Tramadol (Cyclohexanols) - Synthesis from salicylic acid iii) Aspirin (Salicylates)	
2.1.2	iv) Paracetamol (p-Amino phenol) Anti-inflammatory Drugs - Mechanism and inflammatory conditions; i) Steroids: Prednisolone, Betamethasone ii) Sodium Diclofenac iii) Aceclofenac (N- Aryl anthranilic acid) - 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	**3.1 INTRODUCTION TO THE DYE-STUFF INDUSTRY**	**5L**
3.1.1	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	
3.1.2.	Natural & Synthetic dyes 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)	
 3.2.1 3.2.2 3.2.3 3.2.4 3.2.5	**3.2 Substrates for Dyes : Types of fibres** Natural: cellulosic and proteinaceous fibres, examples – wool, silk and cotton structures and names of dyes applied on each of them. Semi – synthetic: definition and examples [structures not expected] Synthetic: Nylon, Polyesters and Polyamides structures and names of dyes applied on each of them Blended fabrics: definition and examples [structures not expected] Binding forces of dyes on substrate: ionic forces, covalent linkages, hydrogen bonding, vander-walls forces	**3L**
 3.3.1	**3.3 Classification of dyes based on applications and dyeing methods** Dyeing methods	**7L**

 3.3.2 3.3.3	Basic Operations involved in dyeing process: i. Preparation of fibres ii. Preparation of dyebath iii. Application of dyes Dyeing Method of Cotton Fibres: (i) Direct dyeing (ii) Vat dyeing (iii) Mordant dyeing (iv) Disperse dyeing Classification of dyes based on applicability on substrates (examples with structures) (a) Acid Dyes- Orange II, (b) Basic Dyes-methyl violet, (c) Direct cotton Dyes- Benzofast Yellow 5GL (d) Azoic Dyes – Diazo components; Fast yellow G, Fast orange R. Coupling components. Naphthol AS, Naphthol ASG (e) Mordant Dyes-Eriochrome Black A, Alizarin. (f) Vat Dyes- Indanthrene brown RRD, (g) Sulphur Dyes- Sulphur Black T (no structure) (h) Disperse Dyes-Celliton Fast brown 3R, (i) Reactive Dyes- Cibacron Brilliant Red B Optical Brighteners: General idea, important characteristics of optical brighteners and their classes [Stilbene, Coumarin, Heterocyclic vinylene derivatives, Diaryl pyrazolines, Naphthylamide derivatives] general structure of each class.	
IV	**4.1Colour and Chemical Constitution of Dyes**	**4L**
	Absorption of visible light, Colour of wavelength absorbed, Complementary colour. Relation between colour and chemical constitution. (i)Armstrong theory (quinonoid theory) and its limitations. (ii)Witt's Theory: Chromophore, Auxochrome, Bathochromic & Hypsochromic Shift, Hypochromic & Hyperchromic effect (iii)Valence Bond theory, comparative study and relation of colour in the following classes of compounds/dyes: Benzene, Nitrobenzene, Nitroanilines, Nitrophenols, Benzoquinones, Azo, Triphenyl methane, Anthraquinones. (iv)Molecular Orbital Theory.	
	4.2 Unit process and Dye Intermediates	**11L**
4.2.1 4.2.2	Unit processes: definition and brief ideas of below unit processes: (a) Nitration (b) Sulphonation (c) Halogenation (d) Diazotization: (3 different methods & its importance) (e) Ammonolysis (f) Oxidation NB: Definition, Reagents, Examples of each unit processes mentioned above with reaction conditions (mechanism is not expected) Preparation of Intermediates <u>Benzene derivatives</u>: Benzenesulphonic acid; 1,3-Benzenedisulphonic acid; sulphanilic acid; o-, m-, p-chloronitrobenzenes; o-, m-, p-nitroanilines; o-, m-, p-phenylene diamines; Naphthol ASG <u>Naphthalene Derivative</u>: Schaeffer acid; Tobias acid; Naphthionic acid; N.W. acid; cleve-6-acid; H-acid; Naphthol AS <u>Anthracene Derivative</u>: 1-Nitroanthraquinone; 1-Aminoanthraquinone Anthraquinone-2-sulphonic acid; Benzanthrone	3L 8L

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

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(3&6 units)**	
1.1.1 1.1.2	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). Classification of cells - Chemical cells with and without transference, Electrode concentration cells and Electrolyte concentration cells with and without transference (Numericals expected)	7L
	1.2 APPLIED ELECTROCHEMISTRY	**8L**
1.2.1 1.2.2	**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).	
	1.3 RENEWABLE ENERGY RESOURCES	**6L**
1.3.1 1.3.2	**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	**POLYMERS(3&6 units)**	**15L**
2.1.1 2.1.2 2.1.3 2.1.4 2.1.5	**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 **Light Emitting Polymers :** Introduction, Characteristics, Method of preparation and applications	

2.1.6	**Antioxidants and Stabilizers :** Antioxidants , Ultraviolet stabilizers, Colourants, Antistatic agents and Curing agents.	
	2.2 PHASE EQUILIBRIA II & THERMODYNAMIC RELATIONSHIPS	**7L**
2.2.1	**Three component system** formation of one pair of partially miscible liquids	
2.2.2	**Maxwell relations**–derivation and application to ideal gases	
2.2.3	**Fugacity** - definition, experimental method of determination	
III	**3.1 BASICS OF QUANTUM CHEMISTRY(6 units)**	**10L**
3.1.1	**Classical theory -** Introduction, limitations of classical mechanics, Black body radiation, photoelectric effect, Compton effect.	
3.1.2	**Quantum theory -** Introduction, Plank's theory of quantization, wave particle duality, de-Broglie's equation, Heisenberg's uncertainty principle (Numericals expected)	
3.1.3	**Progressive and Standing waves -** Introduction, boundary conditions, interpretation and properties of wave function, Schrodinger's time independent wave equation (No derivation expected)	
3.1.4	**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)	
	3.2 RENEWABLE ENERGY RESOURCES	
3.2.1	**Fuel Cells**- Principle, construction and working of Bacon's fuel cell, types and applications	**5L**
3.2.2	**Solar energy**: Solar cells, Photovoltaic effect, Differences between conductors,semiconductors ,insulators and its band gap, Semiconductors as solar energy converters, Silicon solar cell	
3.2.3	**Hydrogen as a Fuel -** Future fuel, production of hydrogen by direct electrolysis of water, advantages of hydrogen as a universal energy medium.	
IV	**4.1 NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY(6 units)**	7L
4.1.1	**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.	
4.1.2	Instrumentation - NMR Spectrometer	
	4.2 ELECTRON SPIN RESONANCE SPECTROSCOPY	**8L**
4.2.1	**Principle,** Fundamental equation, g-value - dimensionless constant or electron g -factor, hyperfine splitting, hyperfine structure.	
4.2.2	**Instrumentation** – ESR, spectrum of hydrogen and deuterium	

Reference

Theory

1. Physical Chemistry, Ira Levine, 5th Edition, 2002 Tata McGraw Hill Publishing Co. Ltd.
2. Physical Chemistry, P.C. Rakshit, 6thEdition, 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.

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 18 elements and to be introduced to supercritical liquids

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.	write properties of group 18 and apply the knowledge of supercritical fluids for industrial purpose

Unit	TOPIC	Lecture
I	**THEORY OF METAL LIGAND BOND – I(3&6 units)**	**15L**
1.1 1.2 1.3 1.4 1.5 1.6 1.7	Limitations of Valence Bond Theory. Crystal Field Theory and effect of crystal field on central metaLS valence orbitals in various geometries from linear to octahedral(from coordination number 2 to coordination number 6) Splitting of *d* orbitals in octahedral, square planar and tetrahedral crystal fields. Distortions from the octahedral geometry : (i) effect of ligand field and (ii) Jahn-Teller distortions. Crystal field splitting parameters Δ ; its calculation and factors affecting it in octahedral complexes, Spectrochemical series. Crystal field stabilization energy(CFSE), calculation of CFSE for octahedral complexes with d^0 to d^{10} metal ion configurations. Consequences of crystal field splitting on various properties such as ionic radii, hydration energy and enthalpies of formation of metal complexes of the first transition series. Limitations of CFT : Evidences for covalence in metal complexes (i) intensities of d-d transitions, (ii) ESR spectrum of $[IrCl6]^{2-}$ (iii) Nephelauxetic effect.	
II	**THEORY OF METAL LIGAND BOND – II(3&6 units)**	**15L**
2.1 2.2 2.3 2.4	**Molecular orbital Theory for coordination compounds:** Identification of central metal and their symmetry suitable for formation of sigma bonds with ligand.Construction of ligand group orbitals. Construction of Molecular orbitals of octahedral ML6 complexes.Effect of pi bonding on complexes. Examples like $[FeF6]^{-4}$, $[Fe(CN)6]^{-4}$, $[FeF6]^{-3}$, $[Fe(CN)6]^{-3}$, $[CoF6]^{-3}$, $[Co(NH3)6]^{+3}$ **Stability of metal complexes:**Types of stability- thermodynamic and kinetic, factors affecting thermodynamic stability. Stability constants and inter-relationship. **Reactivity of complexes:** Types of reactions, inert and labile complexes. Ligand substitution reactions (associative and dissociative mechanism), acid and base hydrolysis and anation reactions. **Electronic spectra:** Origin, types of electronic transition in coordination compounds. Selection rules. Term and term symbols for ground state determination	5L 5L 5L
III	**ORGANOMETALLIC CHEMISTRY – II(6 units)**	
3.1 3.2 3.3	**Organometallic compounds of the main group:** Introduction, general methods of preparation and reactions, application in medicine and agriculture. **Metallocenes with special reference to Ferrocene:** Introduction, methods of preparation, physical and chemical properties, structure on the basis of VBT. **Catalysis:** Comparison between homogeneous and heterogeneous catalysis Basic steps involved in homogeneous catalysis Mechanism of Wilkinson's catalyst in hydrogenation of alkenes.	**6L** **5L** **4L**
IV	**Chemistry of group 17 & 18 elements.(3&6 units)**	

4.1	**Metallurgy:**Types of metallurgies,General steps of metallurgy; Concentration of ore, calcinations, roasting,reduction and refining.Metallurgy of copper: occurrence, physicochemical principles, Extraction of copper from pyrites& refining by electrolysis.	**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**
4.3	**Introduction to Bioinorganic Chemistry:**Essential and non essential elements in biological systems.Biological importance of metal ions such as Na$^+$,K$^+$,Fe^{+2}/Fe^{+3} and Cu^{+2}(Role of Na$^+$ and K$^+$ w.r.t ion pump)	

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.

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 PER SEMESTER	60	
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.	Mechanisms of reactions and name reactions, catalysts and reagents involved in reactions (including selectivity), preparation and reactions of organometallic compound

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.	To identify and write the mechanism of reactions studied with different substrates, apply various catalysts and reagents for interconversion of functional groups Identify the monomer and polymer unit for various polymers and their uses, write a mechanism various methods of polymerization.

Unit	**TOPIC**	**Lecture**
I	**1.1 STEREOCHEMISTRY-II(3&6 units)**	**10L**
1.1.1	Stereoselectivity and stereospecificity: Idea of enantioselectivity (ee) and diastereoselectivity (de) , Topicity : enantiotopic and diasterotopic atoms, groups and faces.	
1.1.2	Stereochemistry of – i) Substitution reactions : SNi (reaction of alcohol with thionyl chloride) ii) Elimination reactions: E2–Base induced dehydrohalogenation of1-bromo-1,2-diphenylpropane. iii) Addition reactions to olefins: a)bromination b) syn hydroxylation c)epoxidation	
	1.2 AMINO ACIDS AND PROTEINS	**5L**
1.2.1	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, Gabriel phthalamide synthesis.	
1.2.2	Polypeptides and Proteins: nature of peptide bond. Nomenclature and representation of polypeptides (di-and tri-peptides) with examples Merrifield solid phase polypeptide synthesis. Protiens:general idea of primary,secondary,tertiary & quaternary structure	
1.2.3		
II	**2.1 MOLECULAR REARRANGEMENTS(3&6 units)**	**5L**
2.1.1	Mechanism of the following rearrangements with examples and stereochemistry wherever applicable.	
2.1.2	Migration to the electron deficient carbon: Pinacol-pinacolone rearrangement. 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	**10L**
2.2.1	Introduction - Sources, classification, reducing and non-reducing sugars, D and L- notations.	
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, NaBH4 (c) oxidation: bromine water, HNO3, HIO4 (d) acetylation (e) methylation:(d) and (e) with cyclic pyranose forms	
2.2.7	Glycosides - General structure	
III	**3.1 SPECTROSCOPY(6 units)**	**10L**
3.1.1	IR Spectroscopy: Basic theory, nature of IR spectrum, selection rule, fingerprint region.	
3.1.2	PMR Spectroscopy: Basic theory of PMR, nature of PMR spectrum, chemical shift (δ 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 technique. 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	**5L**
	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.	
IV	**4.1 POLYMERS (6 units)**	**8L**
4.1.1	Introduction: terms monomer, polymer, homopolymer, copolymer, thermo plastics and thermosets.	
4.1.2	Addition polymers: polyethylene, polypropylene, teflon, polystyrene, PVC, Uses.	
4.1.3	Condensation polymers: polyesters, polyamides,	

	polyurethanes, polycarbonates, phenol formaldehyde resins.Uses	
4.1.4	Stereochemistry of polymers: Tacticity, mechanism of stereochemical control of polymerization using Ziegler Natta catalysts.	
4.1.5	Natural and synthetic rubbers: Polymerisation of isoprene: 1,2 and 1,4 addition(cis and trans), Styrene butadiene copolymer.	
4.1.6	Additives to polymers: Plasticisers, stabilizers and fillers.	
4.1.7	Biodegradable polymers: Classification and uses. polylactic acid structure, propertiesand use for packaging and medical purposes. (Note : Identification of monomer in a given polymer & structure of polymer for a given monomer is expected. condition for polymerization is not expected)	
	4.2 CATALYST & REAGENTS	**7L**
4.2.1	Study of the following catalysts and reagents with respect to functional group transformations and selectivity (no mechanism). Catalysts: Catalysts for hydrogenation: a. Raney Nickel b. Pt and PtO$_2$ (C=C, CN, NO2, aromatic ring) c. Pd/C : C=C, COCl→CHO (Rosenmund) d. Lindlar catalyst: alkynes	
4.2.2	Reagents**:** a. LiAlH$_4$ (reduction of CO, COOR, CN,NO2) b. NaBH$_4$ (reduction of CO) c. SeO$_2$ (Oxidation of CH2 alpha to CO) d. mCPBA (epoxidation of C=C) e. NBS (allylic and benzylic bromination)	
	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. . 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. prepare organic compounds Separation of Binary liquid-liquid and liquid- solid mixture.(6 units) 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	**24L**

	and non volatile liquids like chlorobenzene , bromobenzene, aniline, N,N dimethylaniline, 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 binary mixture to be carried out by distillation method using microscale technique. 6. After separation into component A and component B, the compound to be identified can be decided by examiner. Organic Preparations(3&6 units) 1. N-acetyl derivative 2. Nitro derivative 3. Hydrolysis of p-nitroacetanilide 4. Acid derivative	

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, 4thEdition, 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, thermogravimetry and NAA
CO 4.	To learn the composition of food & cosmetics and understand the methods of their analysis

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 the principle and working of polarography, amperometry, thermogravimetry, and NAA. To be able to calculate polarographic parameters using Ilkovic equation for given data.
CLO 4.	explain the composition of food & cosmetics and suggest methods of their analysis

Unit	**Topic**	**Lecture**
I	**ELECTRO ANALYTICAL TECHNIQUES (3 & 6 UNITS)**	
1.1	**Polarography (Numerical and word problems are expected)**	**11L**
1.1.1	Difference between potentiometry and voltammetry, Polarizable and nonpolarizable electrodes	

1.1.2	Basic principle of polarography Hshaped 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 E1/2, Factors affecting E1/2 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	
1.2	**Amperometric Titrations**	**4L**
1.2.1	Principle, Rotating Platinum Electrode(Construction, advantages and limitations)	
1.2.2	Titration curves with example	
1.2.3	Advantages and limitations	
II	**METHODS OF SEPARATION - II (3 & 6 UNITS)**	
2.1	**Gas Chromatography** (**Numerical and word problems are expected**)	**9L**
2.1.1	Introduction, Principle, Theory 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**	**6L**
2.2.1	Introduction, Principle.	
2.2.2	Types of Ion Exchangers , Ideal properties of resin	
2.2.3	Ion Exchange equilibria and mechanism, selectivity coefficient and separation factor.Factors affecting separation of ions	
2.2.4	Ion exchange capacity and its determination for cation and anion exchangers.	
2.2.5	Applications of Ion Exchange Chromatography with reference to Preparation of demineralised water, Separation of amino acids	
III	**FOOD AND COSMETICS ANALYSIS (6 UNITS)**	
3.1	**Introduction to food chemistry**	**10L**
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**	**5L**
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	
IV	**THERMAL METHODS AND ANALYTICAL METHOD VALIDATION (6 UNITS)**	
4.1	**Thermal Methods**	**12L**
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)forCaC_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 oxalates)	
4.1.3	**Differential Thermal Analysis (DTA):** Principle**,** Instrumentation, and Reference material used Differential thermogram (DTA curve) CaC_2O_4 .H_2O and $CuSO_4.5H_2O$ Applications Comparison between TGA and DTA.	
4.1.4	**Thermometric Titrations –** Principle and Instrumentation Thermometric titrations of : 1) HCl v/s NaOH 2) Boric acid v/s NaOH 3) Mixture of Ca^{+2} and Mg^{+2} v/s EDTA 4) Zn^{+2} with Disodium Tartarate**.**	
4.2	**Analytical Method Validation**	**3L**
4.2.1	Introduction and need for validation of a method	
4.2.2	Validation Parameters: Specificity, Selectivity, Precision, Linearity, Accuracy and Robustness	

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.

NAME OF THE COURSE	APPLIED COMPONENT	
CLASS	TYBSc	
COURSE CODE	SBSAPC601(3&6 units)	
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**	**6L**
1.1.1 1.1.2 1.1.3 1.1.4 1.1.5 1.1.6	Discovery of a lead compound - Screening, drug metabolism studies and clinical observation, Lipinski's rule of 5 Medicinal properties of compounds from Natural Sources - Anti-infective and anticancer properties of Turmeric (Curcumin) Development of drug - The Pharmacophore identification, modification of structure or functional group, Structure activity relationship (Sulphonamides). Structure modification to increase potency - Homologation, Chain branching and extension of the structure Computer assisted drug design Drug Metabolism - Introduction, Absorption, Distribution, Biotransformation, Excretion; Different types of chemical transformation of drugs with specific examples	
	1.2 Drug Metabolism Introduction, Absorption, Distribution, Biotransformation, Excretion; Different types of chemical transformation of drugs with specific examples	**3L**
	1.3 Chemotherapeutic Agents: Study of the following chemotherapeutic agents with respect to their chemical structure, chemical class, therapeutic uses, side effects and introduction to MDR wherever applicable.	**6L**
1.3.1	**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)	2L
1.3.2	**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)	1L
1.3.3	**Antihelmintics and Antifungal agents -** Drugs effective in the treatment of 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)	2L
II	**CHEMOTHERAPEUTIC AGENTS CONTINUED**	
2.1	**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	**1L**

2.2	**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	**3L**
2.3	**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)	**2L**
2.4	**Anti-HIV Drugs -** Idea of HIV pathogenicity, Symptoms of AIDS; i) AZT/Zidovudine ii) Lamivudine iii) DDI (Purines) iv) Nevirapine (dipyridodiazepinone)	**1L**
2.5	**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	**3L**
2.6	**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	**4L**
2.7	**Drugs and Environmental Aspects** · Impact of Pharma-industry on environment, · International regulation for human experimentation with reference to: “The Nuremberg Code” and “The Helsinki Declaration”	**2L**
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) 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)	**12L**
3.2	**Health and Environmental Hazards of Synthetic Dyes and their Remediation Processes**	**3L**
    3.2.1 3.2.2 3.2.3	Impact of the textile and leather dye Industry on the environment with special emphasis on water pollution Health Hazards**:** Toxicity of dyes w.r.t food colours. Brief introduction to effluent treatment plants (ETP) Primary Remediation processes:(Physical Processes) Sedimentation, Aeration, Sorption (activated charcoal, fly ashetc.) Secondary Remediation processes: Biological Remediation – Biosorption, bioremediation and biodegradation Chemical Remediation: Oxidation Processes (chlorination), Coagulation-flocculation-Precipitation	
IV	**4.1 NON-TEXTILE USES OF DYES**	**8L**
	Biomedical uses of dyes i) Dyes used in formulations (Tablets, capsules, syrups etc) Indigo carmine, Sunset yellow, Tartrazine ii) Biological staining agents Methylene blue, Crystal violet and Safranine T iii) DNA markers Bromophenol blue, Orange G, Cresol red iv) Dyes as therapeutics Mercurochrome, Acriflavine, Crystal Violet, Prontosi **Dyes used in food and cosmetics:** i) Properties of dyes used in food and cosmetics ii) Introduction to FDA and FSSAI iii) Commonly used food colours and their limits **Paper and leather dyes** i) Structural features of paper and leather ii) Dyes applicable to paper and leather	

	Miscellaneous dyes i)Hair dyes ii)Laser dyes iii)Indicators iv)Security inks v)Coloured smokes and camouflage colours	
4.2	**PIGMENTS** Definition of pigments, examples, properties of pigments, difference between dyes and pigments. Definition of Lakes and Toners	**3L**
 4.3.1 4.3.2	**4.3 Dyestuff Industry - Indian Perspective** Growth and development of the Indian Dyestuff Industry Strengths, Weaknesses, Opportunities and Challenges of the Dyestuff industry in India Make in India - Future Prospects of the Dye Industry	**4L**

NAME OF THE COURSE	APPLIED COMPONENT PRACTICALS	
CLASS	TYBSc	
COURSE CODE	SBSAPCP601	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	24	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	--	100
PASSING MARKS	--	40

APPLIED COMPONENT CHEMISTRY PRACTICALS
COURSE OBJECTIVES:

CO 1.	To prepare drug and drug intermediates on a bench scale
CO 2.	To learn the application of colorimeter/spectrophotometer in estimation of dyes.
CO 3.	To acquaint learners with chromatographic techniques as a method of separation
CO 4.	To learn quantitative analysis of dyes.
CO 5.	To understand the importance of a monograph
CO 6.	To give the learner an exposure of the workings of an industry

COURSE LEARNING OUTCOMES: Learner will be able to

CLO 1.	Perform a synthesis of drug or drug intermediate
CLO 2.	Analyse commercial samples of dyes using a given method.
CLO 3.	Perform quality control of a commercial sample of drug as per Indian Pharmacopoeia

1. Perform a synthesis of drug /drug intermediate and dye/dye intermediate
2. separate dyes using chromatographic techniques
3. Perform quality control of a commercial sample of drug as per Indian Pharmacopoeia

1. O-Methylation of β-naphthol.
2. Preparation of Paracetamol from p-aminophenol.
3. Preparation of Fluorescein
4. TLC of a mixture of dyes (safranine-T, Indigo carmine, methylene blue)

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 (25 marks)
Part 1: Test or assignment (**20 Marks**)

Part 2: Attendance – **05 marks**

Semester End Examination – External Assessment (75 marks)

- The duration of the paper will be two and half hours.
- There shall be five compulsory questions from all modules of the syllabus

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.