JAI HIND COLLEGE
BASANTSING INSTITUTE OF SCIENCE
&
J.T.LALVANI COLLEGE OF COMMERCE
(AUTONOMOUS)

"A" Road, Churchgate, Mumbai - 400 020, India.

Affiliated to
University of Mumbai

Program : B.Sc.

Proposed Course for : T.Y. B.Sc. Chemistry

Credit Based Semester and Grading System (CBCS) with effect from the academic year 2019-20

T.Y. B.Sc. Chemistry Syllabus

Academic year 2018-2019

Semester VI			
Course Code	**Course Title**	**Credits**	**Lectures /Week**
SCHE601	Advanced Physical Chemistry-II	4	4
SCHE602	Advanced Inorganic Chemistry-II	4	4
SCHE603	Advanced Organic Chemistry-II	4	4
SCHE604	Advanced Analytical Chemistry-II	4	4
SCHE6PR1	Practical Coursework in Physical and Inorganic Chemistry-II	4	8
SCHE6PR2	Practical Coursework in Organic and Analytical Chemistry-II	4	8
SCHE6AC	Pharmaceutical Chemistry and Paints & Pigments-II	2.5	4
SCHE6ACPR	Practical Coursework in Pharmaceutical Chemistry and Paints & Pigments-II	2.5	4

Semester VI – Theory

SCHE601	**Advanced Physical Chemistry - II**	**4 Credits**
Learning Objectives	➢ To understand Lewis concept of activity and activity coefficient of an electrolyte and its expressions for various types of electrolytes. ➢ To learn the concept of overvoltage and understand method of its determination using Tafel's theory. ➢ To have an understanding of polymers its classification and various method of determination of its molecular weight. ➢ To understand use of polymers as Light emitting polymers, fillers and stabilizers. ➢ To introduce the basics of quantum mechanics and the concept of operators. ➢ To have indepth knowledge of fuel for future, its advantages and limitations. ➢ To learn branches of spectroscopy as NMR & ESR , its instrumentation and applications.	
Course description	**Electrochemistry, Polymers, Quantum chemistry, Renewable energy resources and NMR**	
	THEORY	**45 lectures**
Sub Unit	**Unit – I: -ELECTROCHEMISTRY**	**15 L**
1.	**ELECTROCHEMISTRY**	**10L**
	a. **Activity and Activity Coefficient:** Lewis concept, ionic strength, Mean ionic activity and mean ionic activity coefficient of an electrolyte, expression for activities of electrolytes. Debye-Huckel limiting law (No derivation). b. **Classification of cells:**Chemical cells and Concentration cells. i. Chemical cell without transference ii.Concentration cells with and without transference (derivations are expected) iii. Origin of liquid -liquid junction potential. c. **Applications of EMF Measurements** : i.Determination of liquid-liquid junction potential ii. Mean ionic activity coefficient of electrolyte iii.Solubility and k_{sp} of sparingly soluble salts using chemical and concentration cell. iv. Determination of formula of Ag- ammonia complex.	
2.	**APPLIED ELECTROCHEMISTRY** a. **Polarization**: concentration polarization and it's elimination	**5L**

	b. **Decomposition Potential andOvervoltage** : **i**.Introduction- Experimental determination of decomposition potential ii.Factors affecting decomposition potential. iii.Tafel's equation for hydrogen overvoltage, experimental determination of over -voltage	
Sub Unit	**Unit – II:-POLYMERS**	**15 L**
1.	**POLYMERS**	**15 L**
	a. **Basic terms:** macromolecule, monomer, repeat unit, degree of polymerization. b. **Classification of polymers:** Classification based onsource, structure, thermal response and physical properties. c. **Molar masses of polymers:** Numberaverage, Weight average, Viscosity average molar mass, Monodispersity and Polydispersity d. **Methods of determining molar masses of polymers :** i. Ultra-centrifuge method ii. Viscosity method. (Derivation Expected) e. **Fillers and Stabilizers:** i. Fillers and Reinforcement ii. Plasticizers iii. Antioxidants and Thermal Stabilizers iv. Ultraviolet stabilizers v. Fire retardants vi. Colourants vii. Antistatic agents and Curing agents. f. **Light Emitting Polymers:** Introduction, Characteristics, Method of preparation and applications. g. **Biodegradable polymers**	
Sub Unit	**Unit – III:- BASICS OF QUANTUM CHEMISTRY & RENEWABLE ENERGY RESOURCES**	**15 L**
1.	**QUANTUM CHEMISTRY**	**10L**
	a. **Classical mechanics**: Introduction, limitations of classical mechanics, Black body radiation, photoelectric effect, Compton effect. b. **Quantum mechanics :** i. Introduction	

	ii. Planck's theory of quantization iii. Wave particle duality iv. de –Broglie's equation v. Heisenberg's uncertainty principle. c. **Progressive and standing waves-** i. Introduction ii. Boundary conditions iii. Schrodinger's time independent wave equation (No derivation expected) iv. Interpretation and properties of wave function. d. **Postulates of quantum mechanics**: i. State function and its significance ii. Concept of operators - definition, addition, subtraction and multiplication of operators, commutative and non - commutative operators, linear operator, Hamiltonian operator, Eigen function and Eigen value.	
2.	**RENEWABLE ENERGY RESOURCES**	**5 L**
	a. **Renewable energy resources**:Introduction. b. **Solar energy**: i. Solar cells-Photovoltaic effect ii. Semiconductors as solar energy converters iii. Silicon solar cell c. **Fuel cells:** i. Choice of fuel and oxidant ii. Bacon's H_2 and O_2 fuel cell. d. **Hydrogen :** i. Fuel of the future- Production of hydrogen by direct electrolysis of water ii. Advantages of hydrogen as a universal energy medium	
Sub Unit	**Unit IV: NMR & ESR**	**15 L**
1.	**NMR -Nuclear Magnetic Resonance Spectroscopy**	**8L**
	a. Principle b. Nuclear spin, magnetic moment, nuclear 'g' factor, energy levels c. Larmor precession d. Relaxation processes in NMR (spin-spin relaxation and spin - lattice relaxation). e. Instrumentation- NMR Spectrometer f. Chemical shift g. Shielding and Deshielding of protons h. Low and high resolution NMR spectrum of methanol and ethanol.	

2.	**Electron Spin Resonance Spectroscopy**	**7L**
	Electron Spin Resonance Spectroscopy – a. Principle b. Fundamental equation, g-value -dimensionless constant or electron g-factor c. Hyperfine splitting. d. Instrumentation-ESR spectrometer e. ESR spectrum of hydrogen and deuterium.	
	References	
	1. Physical Chemistry, Ira Levine, 5th Edition, 2002 Tata McGraw Hill Publishing Co.Ltd. 2. Physical Chemistry, P.C. Rakshit, 6th Edition, 2001, Sarat Book Distributors, Kolkota. 3. Physical Chemistry, R.J. Silbey, & R.A. Alberty, 3rd edition , John Wiley & Sons, Inc [part 1] 4. Physical Chemistry, G. Castellan, 3rd edition, 5th Reprint, 1995 Narosa Publishing House. 5. Modern Electrochemistry, J.O.M Bockris& A.K.N. Reddy, Maria Gamboa – Aldeco 2nd Edition, 1st Indian reprint,2006 Springer 6. Fundamental of Molecular Spectroscopy, 4th Edn., Colin N Banwell and Elaine M McCashTata McGraw Hill Publishing Co. Ltd. New Delhi, 2008. 7. Classical Methods ,Vol 1 Analytical Chemistry by Open Learning D. Cooper & C. Devan,1991 John Wiley & Sons 8. Physical Chemistry, G.M. Barrow, 6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi. 9. The Elements of Physical Chemistry, P.W. Atkins, 2nd Edition, Oxford Universtity Press Oxford 10.Physical Chemistry, G.K. Vemullapallie, 1997, Prentice Hall of India, Pvt.Ltd. New Delhi. 10. Principles of Physical Chemistry B.R. Puri, L.R. Sharma, M.S. Pathania, VISHAL PUBLISHING Company, 2008. 11. Textbook of Polymer Science, Fred W Bilmeyer, John Wiley & Sons (Asia) Ple. Ltd., Singapore, 2007. 13. Polymer Science, V.R. Gowariker, N.V. Viswanathan, JayadevSreedhar, New Age International (P) Ltd., Publishers, 2005.	

Course: SCHE502	**Advanced Inorganic Chemistry - II (Credits: 4 Lectures/Week: 4)** **Course description:**	
	Objectives: 1. To understand how the transition metals splits the d-orbital in presence of ligand field. 2. To understand the MOT of the complexes of transition elements with octahedral geometry. 3. To a systematic introductory treatment of organometallic compounds, emphasising synthesis, properties, structure and reactivity. 4. To learn through bioinorganic chemistry as to how nature selects specific elements to carryout various biological processes. **Outcomes:** 1. Students would be able to categorize the inorganic elements according to their roles in the biological system and identify the general aspects of storage and transport of metal-ions. 2. Students would also be to draw MOTs of the complexes with different ligand field. 3. Students would be able to know the reactivity of organometallic compounds including their application in synthesis. 4. Students would be able to solve problems in coordination chemistry w.r.t predicting the shape of the complex , CFSE value calculations,etc	
Unit I	**Coordination Chemistry** 1.1 **Crystal Field Theory (CFT)** 1.1.1 Basic tenets of Crystal field theory and effect of crystal field on central metal valence orbitals. 1.1.2 Splitting of d orbitals in octahedral, tetrahedral and square planar complexes. 1 1.1.3 Crystal field splitting energy ($10D_q$) for octahedral complexes and factors affecting the magnitude of D_q. 1.1.4 Crystal field stabilization energy (CFSE), calculation of CFSE, for octahedral and tetrahedral complexes with d^1 to d^{10} metal ion configurations. 1.1.5Tetragonal distortion of octahedral complexes(Jahn-Teller distortion) 1.1.6 Effect of crystal field splitting on i) Ionic radius and ii) Lattice energy. 1.1.6 Consequences of crystal field splitting on various properties such as ionic radii, hydration energy, lattice energy, enthalpies of formation, colour and magnetic properties. 1.1.7 Experimental evidence for co - valence in co -ordination compounds.(i) ESR spectrum of $[IrCl_6]^{-2}$ (ii) NMR spectrum of tris (acetyl acetanato) vanadium complex, (iii) Intensities of dd transitions, and (iv) Nephelauxetic effect. 1.2 **Molecular Orbital Theory for coordination compounds**. 1.2.1 Identification of the central metal orbitals and their symmetry suitable for formation of σ bonds with ligand orbitals. 1.2.2 Construction of ligand group orbitals.	**15 L**

	1.2.3 Construction of σ molecular orbitals for ML_n complex. 1.2.4 Application to octahedral complexes in case of (i) $[Ti(H\ 2O)]^{+3}$ (ii) Fluoro complexes of Fe(II) and Fe (III) and (iii) Cyano complexes of Fe(II) and Fe (III). Effect of pi -bonding a ligand field splitting parameter in M → L and L → M interactions.	
Unit II	**<u>Properties of Coordination compounds</u>** 2.1 **Stability of Complexes** 2.1.1 Thermodynamic stability and kinetic stability of complexes with examples. 2.1.2 Stability constants: Stepwise and overall constants and their inter - relationship. 2.1.3 Factors affecting thermodynamic II stability. 2.1.4 Potentiometric method of determination of stability constants with example of silver -ammonia complex. 2.2 Substitution Reactions in Octahedral Complexes 2.2.1 Introduction, types of reactions in complexes. 2.2.2 Ligand substitution reactions: basic mechanisms. 2.2.3 Inert and labile complexes and electronic configurations and lability of complexes. 2.2.4 Acid hydrolysis, base hydrolysis and anation reactions. 2.3 Electronic Spectra 2.3.1 Types of electronic transitions like intra –ligand transitions, charge transfer transitions and intra -metal transitions and (d-d or ligand field transitions for transition metals). 2.3.2 Rules for electronic transitions: Spin and Orbital or Laporte selection rules. Orgel Diagrams for D Terms (i.e. d^1 , d^4 and d^6 d^9 electronic configurations) and its use in interpretation of visible electronic absorption spectra of these configurations	**15 L**
Unit III	**<u>Organometallic Chemistry</u>** 3.1 Organometallic Compounds of main group metals 3.1.1 **Introduction**: General synthetic methods: (i) Oxidative addition, (ii) Metal - Metal exchange (Transmetallation), (iii) Carbanion -Halide exchange, (iv) Metal Hydrogen exchange and (v) Methylene insertion reactions. 3.1.2 **Chemical reactions**: (i) Reactions with oxygen, (ii) Alkylation and arylation reactions (iii) Reactions with protic reagents and (iv) Complex formation III reactions. 3.2 **Organometallic compounds of transition metals** 3.2.1 Synthesis, structure, reactions and of ferrocene. 3.2.2 Bonding in ferrocene on the basis of VBT. 3.2.3 Bonding in Re and Mo halide complexes. 3.3 **Catalysis by transition metal complexes:** 3.3.1 Catalysis with reference to: (i) hydrogenation of alkenes(Wilkinson's catalyst) (ii) hydroformylation reaction(Roelen catalyst) (iii) polymerization reaction(Ziegler-Natta catalyst)	**15L**
	<u>Some Selected Topics</u>	**<>L**

Unit IV	4.1 **Inorganic Polymers** 4.1.1Various methods of classification with examples. 4.1.2 Chemistry of borazine with reference to preparation, properties, structures, bonding and applications. 4.2 **Inorganic Pharmaceuticals** 4.4.2 Gastrointestinal agents viz., (i) antacids (aluminium hydroxide, milk of magnesia, sodium bicarbonate and (ii) cathartics (magnesium sulphate and sodium phosphate). Topical agents viz., (i) protectives and adsorbents (talc, calamine), (ii) antimicrobial agents (potassium permanganate, tincture iodine, boric acid) and astringents (alum) 4.3 **Nanomaterials** 4.3.1 Introduction and importance of nanomaterials. 4.3.2 Properties (Comparison between bulk and nanomaterials): (i) Optical properties, (ii) Electrical conductivity, and (iii) Mechanical properties. 4.3.3 Forms of nanomaterials: nanofilms, nanolayers, nanotubes, nanowires, and nanoparticles. 4.3.4 Chemical methods of preparation: (i) Colloidal route, and (ii) Solgel method. 4.4**Bioinorganic chemistry** Introduction, essential and non-essential elements in biological systems, Role of metal ions such as Na(I), K(I), Fe(II)/(III) and Cu(II) in biological systems; Introduction to biological roles of metalloenzymes w.r.t. myoglobin, hemoglobin, Structure and function; dioxygenbinding, transfer and utilization.	**15 L**

Additional References:

1. Coordination chemistry, D. Banerjea, Tata McGraw Hill, New Delhi, (1993).
2. Elements of bioinorganic chemistry, G. N. Mukherjee and A. Das, Dhuri and Sons, Calcutta, (1988)
3. Inorganic chemistry, D. F. Shriver and P. W. Atkins, 3 rd Ed., Oxford University Press, (1999)
4. Bioinorganic chemistry, R. W. Hay, Ellis Harwood, England, (1984)
5. Basic principles in inorganic chemistry, Puri, Sharma and Kalia.
6. Concise inorganic chemistry, J.D.Lee
7. Inorganic chemistry, G.L. Miessler and D.A. Tarr, 2 nd edition, New jersey, Prentice-Hall, 2000.

Course: SCHE603	**Organic Chemistry - II (Credits: 4 Lectures/Week: 4)** **Course description:** **Nomenclature and Stereochemistry of Organic compounds, Mechanism of Organic reactions, Photochemistry, Pericyclic reactions and Organometallic Chemistry**	
	Objectives: ➢ To understand the stereochemical implications of organic reactions ➢ To write the uses of catalysts and reagents in different organic reactions ➢ To familiarize the learner with the chemistry of biomolecules ➢ To correlate reactivity of specified heterocycles with their reactions ➢ To study the structural elucidation of certain natural products ➢ To be aware of the physiological importance of certain natural products ➢ To acquaint the learner with the basic principles of different spectroscopic techniques ➢ **Learning Outcomes:** ➢ To predict the stereochemical outcome of an organic reaction based on its mechanism ➢ To remember the specific applications of different catalysts and reagents in organic reactions ➢ To write the different conformational structures of carbohydrates and their reactions ➢ To recount the synthesis of amino acids ➢ To establish the relationship between nucleic acids, nucleosides, nucleotides ➢ To justify the reactivity of the specified heterocyclic compounds ➢ To draw a logical conclusion between the structure of natural products and its reactions ➢ To recount the physiological significance of certain natural products ➢ To identify the correct spectroscopic technique for structure elucidation ➢ To establish the structure of an organic compound based on spectroscopic data	
Unit I	**Unit – I:Stereochemistry II; Catalysis & reagents in organic synthesis** **1. Stereochemistry of Organic Compounds II:** **a) Stereoselectivity & stereospecificity:** i. Enantioselectivity (ee) ii. Diastereoselectivity (de) **b) Topicity (Addition substitution criteria):** i. Homotopic atoms/groups/faces ii. Heterotopic atoms/groups/faces (enantiotopic&diastereotopic) **c) Dynamic Stereochemistry of:** i. Substitution reaction: S_N^i (reaction of alcohol with thionyl	**15L** **10**

	chloride) ii. Walden inversion: S_N^2 reaction iii. Elimination reaction: E_2- base induced dehydrohalogenation of 1-bromo-1,2-diphenylpropane iv. Addition reaction of olefins: A. bromination (electrophilic anti addition) B. syn hydroxylation with OsO_4& $KMnO_4$ C. epoxidation followed by hydrolysis **2. Catalysis & Reagents in Organic Synthesis:** Study of the following catalysts and reagents with respect to functional group transformation, selectivity & stereochemistry: **a) Catalysts for hydrogenation** i. Raney Nickel ii. Pt & PtO_2 (>C=C<; -CN; $-NO_2$; aromatic ring) iii. Lindlar catalyst: alkynes **b) Reagents** i. $LiAlH_4$ (reduction of >CO, -COOR, -CN; $-NO_2$) ii. $NaBH_4$ (reduction of >CO) iii. SeO_2 (oxidation of $-CH_2-$ alpha to >CO) iv. mCPBA (epoxidation of >C=C<) v. NBS (allylic and benzylic bromination)	**5**
Unit II	**Unit – II: Chemistry of Biomolecules** **1. Carbohydrates** **a) Introduction:** classification, reducing & non-reducing sugars, DL notation **b)** Structures of monosaccharides: i. Fischer projection (4-6 carbon monosaccharides) ii. Haworth formula (furanose & pyranose forms of pentoses and hexoses) iii. Interconversion: open chain and Haworth form with 5 & 6 carbons **c)** Anomeric carbon atom;mutarotation and its mechanism **d)** Conformation of D-glucose: Chair conformation of D-glucose with relative stabilities of α & β forms. **e)** Stereoisomerism in D-gluocose: enantiomer, diastereomers, epimers & anomers **f)** Chain lengthening & shortening reactions: i. Modified Killiani-Fischer synthesis (D-arabinose to D-glucose & D-mannose) ii. Wohl method (D-glucose to D-arabinose) **g)** Reactions of D-glucose and D-fructose: i. Osazone formation ii. Reduction: H_2/Ni, $NaBH_4$ iii. Oxidation: Br_2 water, HNO_3, HIO_4 iv. Acetylation (With cyclic pyranose form) v. Methylation (With cyclic pyranose form) **h)** Glycosides: general structure, formation of alkyl glycosides and anomeric effect **i)** Disaccharides: structures of sucrose and maltose (cyclic forms:	**15L** **9**

	Haworth & chair) **j)** Polysaccharides **2. Amino acids & proteins:** **a)** α-amino acids: i. Introduction: structure & configuration ii. Essential/Non-essential amino acids iii. Classification on the basis of side chain iv. Physical properties: Isoelectric point &zwitter ion v. Synthesis: Strecker, amidomalonate, Gabriel phthalimide, azlactone synthesis. vi. Resolution of amino acids **b)** Proteins: i. Peptide bond: nature, nomenclature of di & tri peptides ii. Structure of proteins: primary, secondary, tertiary & quaternary **3. Nucleic acids:** **a)** Structure of nucleotides & nucleosides in DNA & RNA **b)** Structure of DNA & RNA including base pairing	**4** **2**
Unit III	**Unit III: Heterocyclic & Natural Product Chemistry** **1. Heterocyclic Chemistry-II:** **a.** Pyridine-N-oxide i. Preparation ii. Reactivity (comparison with pyridine) iii. Reactions: halogenation, nitration & reaction with $NaNH_2$/liq. NH_3, n-BuLi **b.** Quinoline i. Preparation: Skraup synthesis ii. Reactions: oxidation, reduction, nitration, halogenation & reaction with $NaNH_2$/liq. NH_3, n-BuLi **2. Natural Products** **a.** Terpenoids: Introduction, Isoprene rule, special isoprene rule and the gem-dialkyl rule **b.** Citral: i. Structural determination of citral ii. Synthesis of citral from methyl heptenone iii. Isomerism in citral (cis and trans forms) **c.** Alkaloids: introduction and occurrence: Hofmann's degradation in: simple open chain & N-substituted monocyclic amines. **d.** Nicotine: i. Structural determination of nicotine (Pinner's work included) ii. Synthesis of nicotine from nicotinic acid iii. Harmful effects of nicotine **e.** Hormones: i. Introduction ii. Structure of adrenaline (epinephrine)	**15L**

	iii. Physiological action of adrenaline iv. Synthesis of adrenaline from- (a) catechol & (b) p-hydroxybenzaldehyde (Ott's synthesis)	
Unit IV	**Unit IV: Spectroscopy of Organic Compounds** **1. Introduction:** electromagnetic spectrum, units of wavelength & frequency **2. UV-visible spectroscopy:** i. Basic theory, solvents & nature of spectrum ii. Concept of chromophore &auxochrome iii. Chromophore-chromophore & chromophore-auxochrome interaction iv. Bathochromic, hypsochromic shifts v. Hyperchromic, hypochromic effects **3. IR spectroscopy:** i. Basic theory, selection rule & nature of IR spectrum ii. Characteristic vibrational frequency of functional groups iii. Fingerprint region **4. ^{1}H-NMR spectroscopy:** i. Basic theory of NMR spectroscopy (NMR active nuclei) ii. ^{1}H-NMR, nature of spectrum & solvents used iii. Chemical shift (δ unit) & factors affecting chemical shift iv. Standard used in ^{1}H-NMR v. Spin-spin coupling & coupling constant vi. Application of deuterium exchange technique **5. Mass spectrometry:** i. Basic theory, nature of mass spectrum ii. General rules of fragmentation iii. Molecular ion peak iv. Base peak v. Isotopic peaks vi. Nitrogen rule vii. Rule of 13 for determination of empirical and molecular formula **6.** Spectral characteristics of the following classes of organic compounds including benzene , mono and disubstituted benzenes with respect to UV, IR, NMR & mass spectra: i. Alkanes ii. Alkenes iii. Alkynes iv. Haloalkanes v. Alcohols vi. Carbonyl compounds vii. Ethers viii. Amines ix. Acid & acid derivatives	**15L**

	Problems based on structure elucidation of simple organic compounds using either individual or combined use of UV-vis, IR, Mass & NMR spectroscopic technique expected (Index of hydrogen deficiency should be the first step in solving the problems)	

References:

1. Finar, I. L. (2012) *Organic Chemistry (Volume 1)* Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
2. Finar, I. L. (2002) *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of NaturalProducts)* Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
3. McMurry, J.E. (2013). *Fundamentals of Organic Chemistry, 7th Ed.* Cengage Learning India Edition
4. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P. (2012)*Organic Chemistry*. Oxford University Press
5. Solomons, T.W.G. (2009).*Organic Chemistry*. John Wiley & Sons, Inc.
6. Barton, D.; Ollis, D. (2009). *Comprehensive Organic Chemistry- The synthesis and reactions of Organic Compounds*. Pergamon Press
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8. Eliel, E. L.; Wilen, S. H. (1994)*Stereochemistry of Organic Compounds*, Wiley & sons
9. Kalsi, P. S. (2005) *Stereochemistry, Conformation and Mechanism*. New Age International
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11. March, J. (2007). *March's, Advanced Organic chemistry,6th edition*,John Wiley & sons
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15. Mukherji; Singh; Kapoor. (2002) *Reaction Mechanisms in Organic Chemistry*.McMillan
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17. Miller B.; Prasad R. (2004). *Advanced Organic Chemistry – Reactions and Mechanisms*, Pearson/Prentice Hall
18. Singh J.; Yadav L. (2011), *Advanced Organic Chemistry*, Pragati Prakashan
19. Nasipuri, D. (2012)*Stereochemistry of Organic compounds – Principles & Applications*, New Age International Ltd.
20. Robinson, M. (2005).*Organic Stereochemistry*.Oxford University Press
21. Gilbert A.; Baggott J. (1991), *Essentials of Molecular Photochemistry*, Blackwell Scientific Publications
22. Lancaster M.; (2016) *Green Chemistry: An Introductory Text*, RSC publishers
23. Anastas P.T.; Warner J.C.; (2000), *Green Chemistry Theory & Practice*, Oxford University Press
24. Ahluvalia V.K.; (2013), *Green Chemistry*, Narosa Publication.

Course code: SCHE604	**Advanced Analytical Chemistry - II (Credits: 4 Lectures/Week: 4)** **Course description:**	
	Objectives: ➢ To understand difference between potentiometry and voltammetry. ➢ To learn different methods of quantification of polarographic techniques. ➢ To do comparative study of Gas solid chromatography and Gas Liquid Chromatography. ➢ To understand factors affecting separation of ions by ion exchange chromatography technique. ➢ To study various methods of analysis of food products such as milk, honey, tea and coffee. ➢ To have knowledge of various thermal methods and its classifications. ➢ To learn principle of various thermal methods and its instrumentations as a block diagram and its working. **Outcomes:** ➢ Students will learn electroanalytical techniques such as Polarography and amperometry. ➢ On completion of course students should know various chromatographic methods of separation such as Gas Chromatography and Ion exchange chromatography along with their applications. ➢ Learning various constituents of Food and food products , will help students to understand methods of determination of food constituents , methods of preservations etc. ➢ Knowing comparative account of various thermal methods and its classification will help students to update his/her knowledge in the field of Analytical Chemistry**.**	
Unit I	**Unit – I: - ELECTRO ANALYTICAL TECHNIQUES** **Polarography** a. **Difference between potentiometry and voltammetry**, Polarizable and non-polarizable electrodes b. **Basic principle of polarography** H-shaped polarographic cell, DME (construction, working, advantages and limitations) c. **DC polarogram**: Terms involved - Residual current, Diffusion current, Limiting current, Half-Wave Potential i. Role and selection of supporting electrolyte ii. Interference of oxygen and its removal iii. Polarographic Maxima and Maxima Suppressors d. **Qualitative aspects of Polarography**: Half wave potential $E_{1/2}$, Factors affecting $E_{1/2}$ e. **Quantitative aspects of polarography**: Ilkovic equations*: various terms involved in it (No derivation) f. Quantification i. Wave height – Concentration plots (working plots/ calibration)* ii. Internal standard (pilot ion) method	**<>L** **15 L**

	iii. Standard addition method* g. Applications advantages and limitations (Numerical expected)* h. Amperometric Titrations a. Principle, Rotating Platinum Electrode (Construction, advantages and limitations) b. Titration curves with examples c. Advantages and limitations	
Unit II	**UNIT II: METHODS OF SEPARATION - II** **Gas Chromatography** (**Numerical Problems Expected**)* a. **Introduction-** Principle and terms involved* b. **Instrumentation of** GSC and GLC: i. Block diagram and components ii. Types of Columns and their packing iii. Detectors: TCD, FID, ECD c. Qualitative and Quantitative analysis* d. **Applications** e. **Comparison** between GSC and GLC **Ion Exchange Chromatography** a. **Introduction-** Principle. b. Types of Ion Exchangers and their structures, Ideal properties of resin c. Ion Exchange equilibria and mechanism i. Selectivity coefficient ii. Separation factor d. Factors affecting separation of ions e. Ion exchange capacity and its determination for cation and anion exchangers. f. **Applications of Ion Exchange Chromatography** i. Preparation of demineralised water ii. Separation of Lanthanide iv. Preparation of standard solution of acid or base **v.** Separation of amino acids	**15 L**

Unit III	**UNIT III: FOOD AND COSMETICS ANALYSIS** **Introduction to food chemistry** a. **Food processing and preservation**: i. Introduction ii. Need iii. Chemical methods- action of chemicals (sulphur dioxide, boric acid, sodium benzoate, acetic acid, sodium chloride and sugar) iv. pH control v. Physical methods (Pasteurization and Irradiation) b. **Determination of Preservatives**: Boric acid by titrimetry and Sodium benzoate by HPLC. c. **Study and analysis of food products** – **i. Milk**: Composition, nutrients, types of milk (fat free, Organic and lactose milk), Analysis of milk for lactose by Lane Eynon's Method **ii. Honey**: Composition, Analysis of reducing sugars in honey by Coles Ferricyanide method **iii. Tea**: Composition , types (green tea and mixed tea), Analysis of tea for Tannin by Lowenthal's method **iv. Coffee**: Constituents and composition of, Role of Chicory, Analysis of coffee for caffeine by Bailey Andrew method **Cosmetics** a. Introduction and sensory properties b. Study of cosmetics product – **i. Face powder**: Composition, Estimation of calcium and magnesium by complexometric titration **ii. Lipstick**: Constituents, Ash analysis for water soluble salts: borates , carbonates and zinc oxide **iii. Deodorants and Antiperspirants**: Constituents, properties, Estimation of zinc by gravimetry.	**15 L**
Unit IV	**UNIT IV:THERMAL METHODS** **Thermal Methods** a. Classification of Thermal methods b. **Thermogravimetric Analysis(TGA)** i. Principle ii. Instrumentation- block diagram, thermobalance (Basic components: balance, furnace, temperature measurement and control, recorder) iii. Thermogram (TG curve)for $CaC_2O_4.H_2O$ and $CuSO_4.5H_2O$ iv. Factors affecting Thermogram -Instrumental factors and Sample characteristics v. Applications • Determination of drying and ignition temperature range. • Determination of percent composition of binary mixtures	**15 L**

(Estimation ofCalcium and Magnesium oxalate)

c. **Differential Thermal Analysis (DTA):**

i. Principle**,** Instrumentation and Reference material used
ii. Differential thermogram (DTA curve) $CaC_2O_4 .H_2O$ and $CuSO_4.5H_2O$
iii. Applications

d. **Comparison** between TGA and DTA.

e. **Thermometric Titrations –**

i.Principle and Instrumentation
ii. 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**.**

f. **Differential Scanning Colorimetry** (**DSC**)
i. Principle and Instrumentation
ii. Factors affecting DSC curve

References :

UNIT I :

1. Introduction to Polarography and Allied Techniques, By Kamala Zutshi, New Age International, 2006.

UNIT II:

1. Instrumental methods Of Analysis, by Willard Merritt Dean, 7thEdition, CBS Publisher and distribution Pvt Ltd
2. Fundamentals of Analytical Chemistry by Skoog and West , 8th Edition
3. Chemical methods of separation, J A Dean, Van Nostrand Reinhold, 1969
4. Analytical Chromatography, Gurdeep R Chatwal, Himalaya publication

UNIT III:

1. An Advance Dairy chemistry, V 3, P. F. Fox, P. L. H. McSweeney Springer

UNIT IV:

1. Thermal analysis Theory and applications by R.T. Sane, Jagdish Ghadge, Quest Publications

Semester VI – Practical

Course: SCHE6PR1	**Practical Course work in Physical and Inorganic Chemistry - II(Credits: 4Practicals/Week: 2)**

Learning Objectives:

- To learn the calculation of order of reaction graphically from given data.
- To encourage students to understand the calculation of number of electrons from redox reaction.
- To estimate amount of acid present in mixture of acid from conductance measurements.
- To apply static method for determination f empirical formula of the complex.
- To understand the shape and geometry of various complexes having different ligands attached to it
- To understand the set upof glassware and apparatus to conduct volumetric experiments in inorganic Chemistry
- To understand the use of various indicators for specific metal ions in titration

PRACTICAL I

PHYSICAL CHEMISTRY PRACTICAL

1. Non-Instrumental Experiments

a. Chemical Kinetics:

i. To determine order of reaction graphically from the given experimental data and calculate the specific rate constant.

b. Viscosity :

i. To determine the moleculer weight of polyvinyl alcohol (PVA) by viscosity measurements.

2. Instrumental Experiments

a. Potentiometery :

i. To determine amount of iodide, bromide and chloride in the mixture by potentiometric titration with silver nitrate.

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

b. Conductometry :

i. To titrate a mixture of weak acid and strong acid against a strong base and estimate amount of each acid in mixture condutometrically.

c. Colorimetry :

i. To determine the empirical formula of the complex betweenFe(III) and salicylic acid by static method.

PRACTICAL II

INORGANIC CHEMISTRY PRACTICAL

Inorganic preparations

1. Mercury tetrathiocyanatoCobaltate (II) Hg[Co(SCN)4]

	2. Magnesium oxinate[$Mg(Ox)_2$] 3. Tris-acetyl acetonato iron(III) [$Fe(AcAc)_3$] 4. Tetramminecopper (II) sulphate. [$Cu(NH3)_4$]SO_4.H2O 5. HexammineNickel chloride. **Volumetric analysis** 1. Estimation of Lead by complexometric titration. 2. Determination of Fe(II) using $KMnO_4$ 3. Determination of Al by complexometric titration 4. Estimation of Co present in the given solution of $CoSO_4.7H_2O$

Course: SCHE6PR2	**Practical Course work in Organic and Analytical Chemistry - II (Credits: 4Practicals/Week: 2)**

Learning Objectives:

- To identify the nature of the components of a binary mixture
- To separate the components of a binary mixture by chemical/physical method
- To purify the components of binary mixture by recrystallization/distillation
- To identify the components of a binary mixture
- To provide a practical knowledge and hands on training of analytical chemistry and instrumentation
- To inculcate aptitude for experimentation and treatment of data in learners
- To provide knowledge on preparation of analytical reagents, solutions and their molar calculations

ORGANIC CHEMISTRY PRACTICAL

1. **Binary Mixture : Solid-Liquid Binary Mixture & Liquid-Liquid Binary Mixture**

a. To identify the type of the binary mixture
b. To separate the components by physical method
c. To identify one component of the binary mixture
d. To purify the other component of the binary mixture

ANALYTICAL CHEMISTRY PRACTICAL

I. Spectrophotometry

1. Estimation of Chromium in water sample spectrophtotometrically by using diphenylamine carbazide.
2. Estimation of iron in apple juice spectrophotometrically.

II. Analysis of commercial sample

1. Estimation of reducing sugar in honey by Wilstatter method.

III. Ion exchange Separation

1. Estimate the amount of zinc and magnesium present in the given solution of magnesium –zinc mixture, using anion exchanger resin column.

IV. Potentiometry

1. Estimation of acetic acid in vinegar sample by using quinhydrone electrode potentiometrically.

V. pH metry

1. Determination of phosphoric acid in cola sample pH metrically.

Course: SCHE6AC	**Pharmaceutical Chemistry and Paints & Pigments -II(Credits: 2.5 Lectures/Week: 4)** **<u>Course description:</u>** **Drug Discovery, Design and Development; Chemotherapeutic agents and Nanoparticles in Medicinal Chemistry; and Nomenclature, Classification and Application of Dyes (non-textile); Dye Industry and its Future Prospects**	
	Objectives: ➢ To understand the different parameters associated with drug discovery, design and development ➢ To acquaint the learner with different classes of chemotherapeutic drugs; their uses and side effects ➢ To reproduce the syntheses of some common drugs and drug intermediates ➢ To reproduce the classification and nomenclature of dyes brighteners ➢ To analyse the future prospects of the dyestuff industry	
	PHARMACEUTICAL CHEMISTRY	
Unit I **1.1** **1.2** **1.3**	**Drug Discovery, Design and Development** **Medicinal compounds from natural sources: Turmeric, Tulsi** **Synthetic development of medicinal drugs:** a. Lead b. Sources of lead: Serendipity, Drug metabolism studies, Clinical trial observations c. Screening: Random and Non-random screening **Development of drugs:** a. Pharmacophore and its identification b. Modification of structure c. Methods to increase potency through structure modification: Homologation, Chain branching, Ring-chain transformation d. Structure-activity relationship with respect to : Sulphonamides, Benzodiazepines e. Schedule H: Spurious drugs, Adulterated drugs, Misbranded drugs f. Pharmacopeia and its significance g. Impact of pharmaceutical industry on environment h. International Regulation for human experimentation: “The Nuremberg Code” and “The Helsinki Declaration”.	**15L**
Unit II **2.1**	**Chemotherapeutic agents and Nanoparticles in Medicinal Chemistry** **Study of the following chemotherapeutic agents with respect to their classification, therapeutic use and side -effects:**	**15L**

Antibiotics

a. Definition
b. Classification on the basis of Gram stain, spectrum of activity, chemical class (one representative example of each category)
c. Synthesis of Levofloxacin from 2,3,4-trifluoro-1-nitrobenzene

Antimalarials

a. Cause & types of malaria
b. Symptoms of malaria
c. Pathological detection through window period (life cycle of parasite not expected)
d. Representative example from each of the following classes with respect to uses and side effects:
    i. 4-Aminoquinolines: Chloroquine
    ii. Benzodioxepins: Artemether

Anthelmintics

a. Classification of helminths
b. Causes and symptoms of helminth infection
c. Representative example from each of the following classes of anthelminitic drugs with respect to uses and side effects:
    i. Piperazines: Diethyl carbamazine
    ii. Benzimidazoles: Albendazole
d. Synthesis of Albendazole from 2-nitroaniline

Antiamoebic drugs

a. Causes and symptoms of amoebiasis
b. Representative examples from the following class of antiamoebic drugs with respect to uses and side effects: Imidazoles e.g. Ornidazole, Tinidazole
c. Combination therapy for treatment: Ciprofoxacin-Tinidazole

Antitubercular and Antileprotic drugs

a. Types and symptoms of tuberculosis
b. Types and symptoms of leprosy
c. Diagnosis of tuberculosis
d. Representative example from the following classes with respect to uses:
   Aminosalicylates: PAS
    i. Hydrazides: Isoniazid
    ii. Pyrazines: Pyrazinamide
    iii. Aliphatic diamines: (+)-Ethambutol
    iv. Sulphonamides: Dapsone
    v. Phenazines: Clofazimine
e. Combination therapy for treatment: Rifampin + Isoniazid + Pyrazinamide

Anti-neoplastic drugs

2.2 **2.3**	a. Concept of malignancy b. Causes of cancer c. Uses of the following anti-neoplastic drugs: i. 5-fluorouracil ii. Cisplatin iii. Vinca alkaloids **Anti-AIDS drugs** a. Idea of HIV pathogenicity b. Symptoms of AIDS c. Examples of Anti-AIDS drugs: Zidovudine, DDI **Drug Intermediates** Synthesis of the following drug intermediates and their uses: a. 4-(p-Chlorophenyl)-4-hydroxypiperidine from 4-chloroacetophenone b. p-Acetylamino benzenesulphonyl chloride from aniline c. Epichlorohydrin from propene **Nanoparticles in Medicinal Chemistry** a. Targeted drug delivery with carbon nanotubes b. Use of gold nanoparticles in the treatment of: Cancer, Parkinson's disease, Alzheimer's disease c. CNT's as drug carriers for targeted drug delivery	
	PAINTS & PIGMENTS	
Unit III **3.1**	**Classification of Dyes based on Chemical Constitution and Synthesis of Selected Dyes (synthesis of the dyes marked with * is expected)** (i) Nitro Dye: Naphthol Yellow S (ii) Nitroso Dye: Gambine Y (iii) Azo dyes: (a) Monoazo dyes: Orange IV(from sulphanilic acid) and Eriochrome Black T* (from β-naphthol) (b) Bisazo dyes: Congo Red (from nitrobenzene) (c) Trisazo Dye: Direct Deep Black EW* (from benzidine) (iv) Diphenylmethane dye: Auramine O"(from NN-dimethyl aniline) (v) Triphenylmethane dyes (a) Diamine series: Malachite Green* (from benzaldehyde) (b) Triamine series: Acid Magenta (c) Phenol series Rosolic acid (v) Triphenylmethane dyes (a) Diamine series: Malachite Green* (from benzaldehyde) (b) Triamine series: Acid Magenta (c) Phenol series Rosolic acid (vi) Heterocyclic Dyes (a) Thiazine dyes: Methylene Blue (b) Azine dyes: Safranin T (from o-toluidine (c) Xanthene Dyes: Fosin (from phthalic anhydride) (d) Oxazine Dyes: Capri Blue (e) Acridine Dyes: Acriflavine	**15L**

	(vii)Quinone Dyes: (a) Naphthaquinone: Naphthazarin (b) Anthraquinone Dyes: Indanthrene Blue (from anthraquinone) (viii) Indigoid Dyes: Indigo* (from aniline monochloroacetic acid) (ix) Phthalocyanine Dyes: Monastral Fast Blue B Health and Environmental Hazards of Synthetic Dyes and their Remediation processes	
3.2	lmpact of the textile and leather dye industry on the environment with special emphasis on water pollution.	
3.3	Health Hazards: Toxicity of dyes with respect to food colours	
3.4	Effluent Treatment Strategies: Brief introduction to effluent treatment plants (ETP).	
3.5	Primary Remediation processes (Physical Processes) Sedimentation, Acration, Sorption (activated charcoal, fly ash etc),Secondary Remediation processes: Biological Remediation, Biosorption, bioremediation andbiodegradation Chemical Remediation: Oxidation Processes (chlorination), Coagulation-Flocculation-Precipitation	
Unit IV	**Non-textile uses of dyes**	**15L**
3.1	(i) Dyes used in formulations (Tablets, capsules, syrups, etc.) (ii) Biological staining agents Methylene blue. Crystal violet (iii) DNA markers Indigo carmine, Sunset yellow, Tartrazine and Safranine T, Bromophenol blue, Orange G Cresol red (iv) Dyes as therapcutics: Mercurochrome, Acriflavine, Crystal Violet, Prontosil	
3.2	**Dyes used in food and cosmetics** i) Properties of dyes used in food and cosmetics. ii) Introduction to FDA and FSSAL iii) Commonly used food colours and their limits	
3.3	**Paper and leather dyes** (i) Structural features of paper and leather.	
3.4	(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	
3.5	**Pigments** Definition of pigments, examples, properties of pigments,	

	differencebetween dyes and pigments Definition of Lakes and Toners Dyestuff Industry -Indian Perspective Growth and development of the Indian Dyestuff Industry	

References:

Unit I and II

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2. Bruice, Paula Y., *Organic Chemistry,* 8th Edition (2013). Pearson Education India.
3. Voet, Donald, &Voet, Judith G., *Biochemistry*, 4th Edition, (2011). International Student version
4. Sriram, D., Yogeeswari, P., *Medicinal Chemistry*, 2nd Edition, Pearson
5. Kar, Ashutosh, *Medicinal Chemistry,* Revised 3rd Edition, (2006).
6. Alagarsamy, V., *Textbook of Medicinal Chemistry*, Vol. 2, 3rd Edition. CBS Publications and Distributors Pvt. Ltd.
7. Ahluwalia , V.K., Chopra, Mahu, *Medicinal Chemistry*, 1st Edition (2007). CRC Press
8. Thomas, Gareth,*Medicinal Chemistry: An Introduction*, 2nd Edition, (2010). Wiley India Pvt. Ltd.
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10. Patrick, Graham, L., *An Introduction to Medicinal Chemistry*, 4th Edition (2011), OUP India

Unit III and IV

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

Course: SCHE6ACPR	**Practical Course Work in Pharmaceutical Chemistry, Paints & Pigments -I** **(Credits: 2.5Practicals/Week: 1)**
	Learning Objectives: ➢ To prepare dye intermediates on a bench scale ➢ To estimate the concentration of drugs in a given sample, quantitatively ➢ To understand the significance of monograph ➢ To develop the skill of dyeing of fibres with Orange II **PHARMACEUTICAL CHEMISTRY PRACTICAL** 1. Estimation of acid neutralising capacity 2. Estimation of free acid in vegetable oil 3. Estimation of aspirin colorimetrically 4. Monograph **PAINTS & PIGMENTS PRACTICAL** 1. Preparation of fluorescein 2. Preparation of m-dinitrobenzene from nitrobenzene 3. Preparation of m-nitroaniline from m-dinitrobenzene 4. Preparation of Orange II and dyeing of fibres

Evaluation Scheme

A. Evaluation scheme for Theory courses

I. Semester End Examination (SEE)- 100 Marks

B. Evaluation scheme for Practical courses

I. Semester End Examination (SEE)- 200 Marks