Shri Vile Parle Kelavani Mandal's

MITHIBAI COLLEGE OF ARTS, CHAUHAN INSTITUTE OF SCIENCE & AMRUTBEN JIVANLAL COLLEGE OF COMMERCE AND ECONOMICS (AUTONOMOUS)

NAAC Reaccredited 'A' grade, CGPA: 3.57 (February 2016),

Granted under RUSA, FIST-DST & -Star College Scheme of DBT, Government of India

Best College (2016-17), University of Mumbai

Affiliated to the

UNIVERSITY OF MUMBAI

Program: Bachelor of Science

Chemistry

Semester V

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

PROGRAMME SPECIFIC OUTCOMES (PSO'S)

On completion of the B.Sc Chemistry the learners should be enriched with knowledge and be able to-

To have sound knowledge about the fundamentals and applications of various chemical and scientific theories.

PSO2: To introduce the different branches of chemistry like analytical, organic, inorganic, physical, environmental, polymer and biochemistry etc.

PSO3: To explain nomenclature, stereochemistry, structures, reactivity, chemical formulae, and mechanism of the chemical reactions.

PSO4: To apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories and in industries.

PSO5: To develop better understanding of good laboratory practices and safety.

PSO6: To develop research oriented skills, analytical skills and problem solving skills requiring application of chemical principles.

PSO7: To recognize causes of environmental pollution, environmental pollution act and the methods for environmental pollution control.

Preamble

The well-organized curriculum including basic as well as advanced concepts in chemistry from first year to third year shall inspire the students for pursuing higher studies in chemistry and for becoming an entrepreneur and also enable students to get employed in the Research Institutes, Industries, Educational Institutes and in the various concerning departments of State and Central Government based on subject chemistry.

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Evaluation Pattern

The performance of the learner will be evaluated in two components. The first component will be a Continuous Assessment with a weightage of 25% of total marks per course. The second component will be a Semester end Examination with a weightage of 75% of the total marks per course. The allocation of marks for the Continuous Assessment and Semester end Examinations is as shown below:

a) Details of Continuous Assessment (CA)

25% of the total marks per course:

Continuous Assessment	Details	Marks
Component 1 (CA-1)	Class Test	15 marks
Component 2 (CA-2)	Class Test	10 marks

b) Details of Semester End Examination

75% of the total marks per course. Duration of examination will be two and half hours.

Question Number	Description	Marks	Total Marks
Q.1	Attempt **any four** of the following	5 marks each	20
Q.2	Attempt **any four** of the following	5 marks each	20
Q.3	Attempt **any four** of the following	5 marks each	20
Q.4	Attempt **any five** of the following	3 marks each	15
		Total Marks	**75**

Signature Signature Signature

HOD Approved by Vice –Principal Approved by Principal

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: B.Sc. Chemistry (2020-21)				**Semester: V**	
Course: Physical Chemistry				**Course Code: USMACH501**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Lectures per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	4		4 + 2	10 + 15	75

Learning Objectives:
To provide the basic knowledge on the concept of Physical chemistry.

Course Outcomes:
After completion of the course, learners would be able to:
After completion of the course, students would be able to:

CO1: familiarize learner with the principles of thermodynamics and kinetics.
CO2: learn the concept of the principle of adsorption and to determine the surface area of an adsorbate.
CO3: learn branches of spectroscopy such as ESR with its instrumentation and applications.
CO4: acquire knowledge on application of EMF measurements.
CO5: understand Lewis concept of activity and activity coefficient of an electrolyte and its expressions for various types of electrolytes.
CO6: understand the theoretical concept of molecular spectroscopy and to differentiate between different types of molecular spectroscopy.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Lectures**
1	1.1 Molecular spectroscopy –II	15
2	2.1 Electrochemistry -III	15
3	3.1.Chemical Thermodynamics 3.2 Phase Rule-II	15
4	4.1 Surface Chemistry 4.2 Colloids	15
	Total	**60**
PRACTICALS		

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

PRACTICAL I

(If applicable)

Unit	Topic	No. of Lectures/Credits
Module 1	**1.1 Molecular Spectroscopy –II** 1.1.1 Dipole moment: Dipole moment, polarization of a bond, bond moment, dipole moment and molecular structure. 1.1.2 Rotational Spectrum: 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 inter nuclear distance and isotopic shift. 1.1.3 Vibration (IR) spectrum: Vibrational motion, degrees of freedom, modes of vibration, vibrational spectrum of a diatomic molecule, simple harmonic oscillator, energy levels, zero point energy, conditions for obtaining vibrational spectrum, selection rule, nature of IR spectrum. 1.1.4 Vibration-Rotation spectrum of diatomic molecule vibrating rotor, energy levels, selection rule, nature of spectrum, R and P branches, anharmonic oscillator: energy levels, selection rule, fundamental band, overtones. Application of vibration rotation spectrum in determining Force constant, determination and significance. Introduction to infrared spectra of simple molecules like H_2O and CO_2 1.1.5 Raman Spectroscopy : Scattering of electromagnetic radiation, Rayleigh scattering, Raman scattering, nature of Raman spectrum , Stoke's lines, antiStoke's lines, Raman shift, quantum theory of Raman spectrum, comparative study of IR and Raman spectra, rule of mutual exclusion.(example of CO_2molecule). (Numericals Expected)	**15L**
Module 2	**2.1 Electrochemistry – Electrochemical cells** 2.1.1 Lewis concept of Activity and Activity coefficient, Mean ionic III activity and mean ionic activity coefficient ($\gamma_{\pm}$)of an electrolyte, expression for activities of electrolytes of different valence type, ionic strength 2.1.2 Classification of cells:	**15L**

	1. Chemical cells with- and without transference 2.Concentration cells with and without transference (derivations of expression for the EMFof concentration cell are expected) 2.1.3 Origin of liquid -liquid junction potential and its elimination using a salt bridge. 2.1.4 Electrode concentration cells 2.1.5 Electrolyte concentration cell with transference and without transference. (Numericals Expected)	
Module 3	**Chemical Thermodynamics-III (8L)** 3.1.1 Phases in equilibrium: Clapeyron equation and Clapeyron-Clausius equation 3.1.2 Relative lowering of vapour pressure. Elevation in boiling point of a solution, thermodynamic derivation relating elevation in the boiling point of a solution and the molar mass of the non-volatile solute. 3.1..3 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. 3.1.4 Osmosis and Osmotic pressure, thermodynamic derivation of van't Hoff's law .Reverse osmosis. **3.2 Phase Rule (7L)** 3.2.1 Gibb's phase rule and terms involved in the equation. 3.2.2 Application of phase rule to ONE component systems (i) Water system, (ii) Sulphur system 3.2.3 Application of phase rule to TWO component systems, condensed systems, condensed phase rule, eutectic systems (Lead-Silver system), desilverisation of lead. (Numericals Expected)	**15L**
Module 4	**4.1 Surface Chemistry (9L)** 4.1.1 Adsorption: Physical and Chemical Adsorption, types of adsorption isotherms. Langmuir's adsorption isotherm (Postulates and derivation expected). 4.1.2 B.E.T. equation for multilayer adsorption, (derivation not expected). Significance of the terms involved in the equation is expected.),Determination of surface area of an adsorbent using B.E.T. equation. Numericals on surface area determination are expected. 4.1.3 Adsorption of solute by solids,	**15L**

	- Applications of adsorption, - Catalysis of gaseous reactions by solid surfaces, - One reactant gas slightly, moderately and strongly adsorbed - Retarded reactions -The order of heterogeneous reactions **4.2 Colloids (6L)** 4.2.1 Introduction to colloidal state of matter. 4.2.2 Origin of charge on colloidal particles. Concept of electrical double layer, zeta potential, Helmholtz and Stern model, Electro-kinetic phenomena: 1.Electrophoresis, 2.Electrophoresis, 3. Streaming potential 4. Sedimentation potential. 4.2.3 Colloidal electrolytes. 4.2.4 Donnan Membrane Equilibrium. 4.2.5 Surfactants, micelle formation, applications of surfactants in detergents, food industry, in pesticide formulations (Numericals Expected)	
	Practicals	**2**
	1. To determine the reduction potential of Cu^{2+}/Cu Electrode at room temperature. 2. To study the effect of ionic strength on the rate constant of reaction between $K_2S_2O_8$& KI using KCl. 3. To determine the amount of dibasic acid (Oxalic acid) by conductometric titration against strong base. 4. To determine the relative strength of monochloroacetic acid and acetic acid conductometrically. 5. To study rate of adsorption of acetic acid on activated charcoal. 6. To determine the amount of Fe (III) present in the given solution by using salicylic acid by colorimetric titration. (Static method).	

Suggested Readings

1. Peter Atkins and Julio de Paula, Atkin's Physical Chemistry, 7th Edn., Oxford University Press, 2002.

2. K.J. Laidler and J.H. Meiser, Physical Chemistry, 2nd Ed., CBS Publishers and Distributors, New Delhi, 1999.

3. Robert J. Silby and Robert A. Alberty, Physical Chemistry, 3rd Edn., John Wiley and Sons (Asia) Pte. Ltd., 2002.

4. Ira R. Levine, Physical Chemistry, 5th Edn., Tata McGraw-Hill New Delhi, 2002.

5. G.W. Castellan, Physical Chemistry, 3rd Edn., Narosa Publishing House, New Delhi, 1983.

6. S. Glasstone, Text Book of Physical Chemistry, 2nd Edn., McMillan and Co. Ltd., London, 1962

7. B.K. Sen, Quantum Chemistry including Spectroscopy, Kalyani Publishers, 2003.

8. A.K. Chandra, Introductory Quantum Chemistry, Tata McGraw – Hill, 1994.

9. R.K. Prasad, Quantum Chemistry, 2nd Edn., New Age International Publishers, 2000.

10. S. Glasstone, Thermodynamics for Chemists, Affiliated East-West Press, New Delhi, 1964.

11. W.G. Davis, Introduction to Chemical Thermodynamics – A Non – Calculus Approach, Saunders, Philadelphia, 19772.

12. Peter A. Rock, Chemical Thermodynamics, University Science Books, Oxford University Press, 1983.

13. Ira N. Levine, Quantum Chemistry, 5th Edn., Pearson Education (Singapore) Pte. Ltd., Indian Branch, New Delhi, 2000.

14. Thomas Engel and Philip Reid, Physical Chemistry, 3rd Edn., Pearson Education Limited 2013. 15. D.N. Bajpai, Advanced Physical Chemistry, S. Chand 1st Edn., 1992.

16. Bockris, John O'M., Reddy, Amulya K.N., Gamboa-Aldeco, Maria E., Modern Electrochemistry, 2A, Plenum Publishers, 1998.

17. Physical Chemistry by Gurtu and Gurtu

18. A Text book of Physical Chemistry by K L kapoor Vol 5 , 2nd Edn

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: B.Sc. Chemistry (2020-21)				**Semester: V**	
Course: Inorganic Chemistry				**Course Code: USMACH502**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Lectures per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	4		4 + 2	10 + 15	75

Learning Objectives:

Obtain the knowledge on design and development of materials with pre-required properties based on understanding the structure of solids in its influence on physical-chemical properties.

Course Outcomes:

At the completion of this course, students will be able to:

1. Identify the different types of chemical bonds
2. Obtain required knowledge for understanding material science problems
3. study the structure of solids and get introduced with the importance of chemical bonds, crystal disorder and defects in materials.

Gain the fundamental knowledge of inner transition state elements and non-aqueous solvents

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Lectures**
1	1.1 Chemical Bonding	15
2	2.1 Solid State Chemistry	15
3	3.1 Chemistry of elements (Inner transition elements)	15
4	4.1 Some selected topics (Chemistry in Non-aqueous Solvents, Chemistry of Interhalogen, Chemistry of Psuedohalogens, Chemistry of Xenon)	15
	Total	**60**
PRACTICALS		

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

PRACTICAL I
(If applicable)

Suggested Readings

1. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, 2013-2014.

Unit	Topic	No. of Lectures/Credits
Module 1	**1. Chemical Bonding** **1.1 Molecular Symmetry (7L)** 1.1.1 Introduction and Importance of symmetry 1.1.2 Symmetry elements and symmetry operations. 1.1.3 Concept of a Point Group with illustrations using the following point groups: (i) $C_{\alpha v}$(HCl), (ii) $D_{\alpha h}$(H_2), (iii) C_{2v} (H_2O),(iv) C_{3v}(NH_3),(v) C_{2h} (trans – trichloroethylene), and (vi) D_{3h} (BCl_3). **1.2Molecular Orbital Theory for Polyatomic Species (5L)** 1.2.1 LCAO-MO applied to simple triatomic species: $H_3^+$and H_3(correlation between bond angle and Molecular orbitals). 1.2.2 Molecularorbital approach for bonding in AB_2 molecules. Application of symmetry concepts for linear and angular species considering σ-bonding only. (Examples like: i) BeH_2, ii) H_2O Term such as Walsh correlation diagram, Symmetry Adapted Linear Combinations (SALCs), Ligand Group orbitals (LGOs), transformation of atomic orbitals into appropriate symmetry types, expected to be discussed in Unit 1.2 **1.3 Metallic Bonding (3L)** Band theory, explanation of electrical properties of conductors, insulators and semiconductors, intrinsic and extrinsic semiconductors.	**15L**
Module 2	**2. Solid State Chemistry** **2.1 Structures of Solids (11L)** 2.1.1 Explanation of terms viz.crystal lattice, lattice points, unit cells and latticeconstants. 2.1.2 Closest packing of rigid spheres	**15L**

	(hcp, ccp), packing density in simple cubic, bcc, fcc and hcp lattices (numerical problems expected). Relationship between density of unit cell, lattice parameters. (numerical problems expected) 2.1.3 Stoichiometry 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, organic superconductors, alkali metal fullerides, high temperature Superconductors. 2.2.4 Brief applications of superconductors	
Module 3	**3. Chemistry of inner transition elements** 3.1 Introduction **(2L)** 3.1.1 Definition, position in periodic table and electronic configuration of lanthanides and actinides 3.2 Chemistry of Lanthanides **(10L)** 3.2.1 Lanthanide contraction and its consequences 3.2.2 Oxidation states 3.2.3Magnetic and spectral properties, 3.2.4Occurrence, extraction and separation of lanthanides by Solvent extraction. 3.2.5Applications of lanthanides. 3.3 Chemistry of Actinides **(3L**)	**15L**

	3.3.1 Comparison between lanthanide and actinides 3.3.2 Chemistry of Uranium with reference to occurrence and isolation (solvent extraction method) 3.3.3 Properties and applications of Uranium	
Module 4	**4. Some selected topics** **4.1 Chemistry in Non-aqueous solvents (5L)** Classification of solvents and importance of non-aqueous solvents. 4.1.1Super critical carbon dioxide and ionic liquids as solvents 4.1.2 Characteristics and study of liquid ammonia, dinitrogen tetraoxide as non-aqueous solvents with respect to (i) acid-base reactions and (ii) redox reactions. **4.2 Chemistry of Interhalogen (3L)** 4.2.1 Introduction 4.2.2 Preparation and uses 4.2.3 Bonding **4.3 Chemistry of Psuedohalogens (3L)** 4.3.1Introduction 4.3.2Preparation 4.3.3 Reactions and structures **4.4 Chemistry of Xenon (4L)** 4.4.1 Introduction 4.4.2. Compounds of Xenon: Oxides, fluorides and oxyfluorides with respect to preparation, properties and bonding.	**15L**
	Practicals	**2**
	Inorganic preparations and characterization (Complexometric titration): 1. Bis(Ethylene diamine) copper (II) sulphate 2. Hexaamine nickel (II) sulphate/chloride 3. Magnesium oxinate **Titrimetric analysis:**	

	1. Estimation of magnesium from supplied commercial sample of milk of magnesia tablet 2. Estimation of nitrite in the given sodium nitrite solution	

2. W. W. Porterfield, Inorganic Chemistry-A Unified Approach, 2nd Ed., Academic Press, 1993.

3. B. W. Pfennig, Principles of Inorganic Chemistry, Wiley, 2015.

4. C. E. Housecroft and A. G. Sharpe, Inorganic Chemistry, Pearson Education Limited, 2nd Edition 2005.

5. J. Huheey, F. A. Keiter and R. I. Keiter, Inorganic Chemistry–Principles of Structure and Reactivity, 4th Ed., Harper Collins, 1993.

6. P. J. Durrant and B. Durrant, Introduction to Advanced Inorganic Chemistry, Oxford University Press, 1967.

7. R. L. Dekock and H.B.Gray, Chemical Structure and Bonding, The Benjamin Cummings Publishing Company, 1989.

8. G. Miessler and D. Tarr, Inorganic Chemistry, 3rd Ed., Pearson Education, 2004.

9. R. Sarkar, General and Inorganic Chemistry, Books & Allied (P) Ltd., 2001.

10. C. M. Day and J. Selbin, Theoretical Inorganic Chemistry, Affiliated East West Press Pvt. Ltd., 1985.

11. J. N. Murrell, S. F. A. Kettle and J. M. Tedder, The Chemical Bond, Wiley, 1978.

12. G. A. Jeffrey, An Introduction to Hydrogen Bonding, Oxford University Press, Inc., 1997.

13. D. Banerjea,Coordination Chemistry

14. Geary Coordination reviews

15. P.W. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong; Shriver & Atkins: Inorganic Chemistry, 4th ed. Oxford University Press, 2006.

16. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann; Advanced Inorganic Chemistry, 6th ed. Wiley, 1999,

17. B. Douglas, D. McDaniel and J. Alexander. Concepts and Models of Inorganic Chemistry(3rd edn.), John Wiley & Sons (1994).

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: B.Sc. Chemistry (2020-21)				**Semester: V**	
Course: Organic Chemistry				**Course Code: USMACH503**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Lectures per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	4		4 + 2	10 + 15	75

Learning Objectives:

Aim of the course is to provide a sound fundamental understanding of organic chemistry covering topics such as reaction mechanism, stereochemistry in organic reactions, photochemistry. It also introduces students to the application of reagents for interconversion of several functional groups and also to design synthesis of new molecules by retrosynthesis.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: explain the mechanism of various organic name reactions with their stereochemistry
CO2: understand the reactivity of heterocyclic molecule and their synthesis
CO3: design the synthesis of small molecules based on retrosynthesis
CO4: use different reagents for organic functional group transformation

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Lectures**
1	1.1 Mechanism of Organic Reactions – I	15
2	2.1 Stereochemistry 2.2 Photochemistry	15
3	3.1 Oxidation –Reduction 3.2 IUPAC 3.3 Heterocyclic Chemistry	15
4	4.1 Synthesis of organic compounds	15
	Total	**60**
PRACTICALS		

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

PRACTICAL I
(If applicable)

Suggested Readings

1. Comprehensive Organic chemistry, Barton and Ollis, Vol 1

Unit	Topic	No. of Lectures/Credits
Module 1	**1.1 Mechanism of Organic Reactions – I (15L)** 1.1.1 Recapitulations: Intermediates, transition states, electrophilicity, nucleophilicity, acidity, basicity. 1.1.2 Elimination reactions: mechanism and stereochemistry E_1, E_2 mechanisms, factors influencing the mechanism: nature of substrate, leaving group, structure of base, solvent, Saytzeff and Hofmann elimination, elimination vs. substitution, E_1cB mechanism. Pyrolytic elimination: Cope, Chugaev, pyrolysis of acetates 1.1.3 Neighbouring group participation in nucleophilic substitution reactions: participation of lone pair of electrons, kinetics and stereochemical outcome 1.1.4 Mechanism of the following rearrangements with examples and stereochemistry wherever applicable: Pinacol Pinacolon, Dienone – phenol, Benzilic acid, Favorski, Bayer – Villiger, Beckmann, Hofmann rearrangement reaction	**15L**
Module 2	**2.1 Stereochemistry (10L)** 2.1.1Strains in cycloalkanes, Conformation of Cyclohexane, mono and di-di-alkyl Cyclohexane and their relative stability 2.1.2 Stereoselectivity and stereospecificity, Topicity 2.1.3 Stereochemistry of substitution reactions: S_N^1, S_N^2, and S_N^i 2.1.4 Elimination reaction: E2 base induced dehydrohalogenation of 1-bromo-1,2-diphenylpropane 2.1.5 Addition reaction to olefins: Catalytic hydrogenation, Bromination, Synhydroxylation and epoxidation **2.2 Photochemistry (5L)** 2.2.1 Introduction: Difference between thermal and photochemical reactions, Jablonski diagram, singlet and triplet states, allowed and forbidden transitions, fate of excited molecules, photosensitizations. 2.2.2 Photochemical reactions of olefins: Photoisomerization, photochemical rearrangement of 1,4 – dienes (di π methane)	**15L**

	2.2.3 Photochemistry of carbonyl compounds: Norrish I, Norrish II cleavages, Photoreduction (benzophenone to benzpinacol)	
Module 3	**3.1 Oxidation –Reduction (6L)** 3.1.1Oxidation Chromium based reagents: Jone's oxidation, PCC, PDC, Chromyl chloride, $KMnO_4$ Other reagents: NBS, HIO_4, $Pb(OAc)_4$, O_3, SeO_2 , H_2O_2 3.1.2 Reduction Hydride based reduction of Aldehydes / Ketones / Esters/ Acids/ Amides Catalytic hydrogenation of olefins, Alkynes,α, β - unsaturated carbonyls, Benzene, Acid chloride, Imine, Nitro Wolff Kishner reduction, Clemmensen reduction Dissolving metal reduction: Birch reduction **3.2 IUPAC (3L)** 3.2.1 IUPAC systematic nomenclature of the following classes of compounds (including compounds with upto 2 substituents / functional groups) 3.2.2 Bicyclic compounds – spiro, fused and bridged (upto 11 carbon atoms) – saturated and unsaturated compounds. 3.2.3 Biphenyls 3.2.4 Cumulenes upto three double bonds **3.3 Heterocyclic Chemistry (6L)** 3.3.1 Introduction: Electronic structure and aromaticity of furan, pyrrole, thiophene and pyridine 3.3.2 Synthesis of furans, pyrroles and thiophenes by Paal – Knorr synthesis, Pyridine by Hantzsch synthesis and 1,5 – diketones. 3.3.3 Reactivity of furan, pyrrole and thiophene towards aromatic electrophilic substitution reactions on the basis of stability of intermediates and of pyridine on the basis of electron distribution. Reactivity of pyridine to aromatic nucleophilic substitution on the basis of electron distribution 3.3.4 Reactions of furan, pyrrole and thiophene: Halogenation, nitration, sulphonation, Vilsmeier Haack reaction, Frieddel – Crafts reaction, Furan: Diels – Alder	**15L**

	reaction, ring opening. Pyrrole: Acidity and basicity of pyrrole. Comparison of basicity of pyrrole and pyrrolidine. 3.3.5 Pyridine: Basicity, comparison of basicity of pyridine, pyrrole and piperidine, Sulphonation of pyridine (with and without catalyst) 3.3.6 Reduction: Action of sodamide (Chichibabin reaction) 3.3.7 Pyridine N – oxide: Preparation, reactivity to electrophilic and nucleophilic substitution based on electron distribution in the molecule.	
Module 4	**4.1 Synthesis of organic compounds (15 L)** 4.1.1 Introduction : Criterion for an ideal synthesis, calculation of yields, concept of selectivity with examples. Linear and convergent synthesis with one example each Multicomponent reactions: Mannich reaction and Hanztch synthesis 4.1.2 Introduction to retrosynthesis: Analysis and synthesis, Technical terms: Target molecule (TM), Retrosynthetic analysis, FGA, FGI, Disconnection, synthon and reagent. Retrosynthetic analysis of limonene, salbutamol and proparacaine 4.1.3 Green chemistry and synthesis: Introduction to Green Chemistry, definition, need for and importance of green synthesis, Twelve principles of Green Chemistry with examples. Atom economy and E – factor, calculations and their significance, Examples of reactions with low and high atom economy 4.1.4 Green synthesis in Industry: Green starting materials: D – Glucose to adipic acid Green reagents: Selective methylation of active methylene using dimethyl carbonate Green solvents: Supercritical CO_2, Deep eutectic solvents (DES), Green catalysts: Heterogeneous catalysis using Tellurium, Biocatalysis Green synthesis of Paracetamol (green context to be emphasized) 4.1.5 Other methods of organic synthesis: Microwave assisted organic synthesis (using organic solvents and in solid state), Ultrasound in organic synthesis, Phase	**15L**

	transfer catalysis, Polymer supported synthesis: Merrifield polypeptide synthesis.	
	Practicals	**2**
	1. Separation of binary (Solid + Solid, Solid + Volatile liquid and Volatile liquid+ Non volatile liquid) mixture (Weight and physical constant (m.p.) of both crude components to be reported) (Minimum 10 compounds) 2. Checking the purity of the separated compounds with TLC (Thin Layer Chromatography) (Minimum 12 compounds)	

2. Organic Chemistry, J. Claydens, N. Greeves, S. Warren and P. Wothers, Oxford University Press.

3. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Part A and B, Plenum Press.

4. Stereochemistry: Conformation and Mechamism, P.S. Kalsi, New Age International, New Delhi.

5. Stereochemistry of carbon compounds, E.L Eliel, S.H Wilen and L.N Manden, Wiley.

6. Stereochemistry of Organic Compounds- Principles and Applications, D. Nasipuri. New International Publishers Ltd.

7. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Michael B. Smith, Jerry March, Wiley.

8. Mechanism in Organic Chemistry, Peter sykes, 6th edition onwards.

9. Modern Methods of Organic Synthesis, W. Carruthers and Iain Coldham, Cambridge University Press.

10. Organic Synthesis, Jagdamba Singh, L.D.S. Yadav, Pragati Prakashan

11. Advanced Organic Chemistry: Reactions and mechanism, B. Miller and R. Prasad, Pearson Education.

12. Advanced Organic Chemistry: Reaction mechanisms, R. Bruckner, Academic Press.

13. Understanding Organic Reaction Mechanisms, Adams Jacobs, Cambridge University Press.

14. Writing Reaction Mechanism in organic chemistry, A. Miller, P.H. Solomons, Academic Press.

15. Principles of Organic Synthesis, R.O.C. Norman and J.M Coxon, Nelson Thornes.

16. Advanced Organic Chemistry: Reactions and mechanism, L.G. Wade, Jr., Maya Shankar Singh, Pearson Education.

17. Organic Synthesis- The Disconnection Approach, Stuart Warren, Wiley Publication

18. Introduction to Spectroscopy, Donald L. Pavia. Gary M. Lampman. George S. Kriz,

19. Spectrometric Identification of Organic Compounds, R. M. Silverstein, F. X. Webster,

D. J. Kiemle, John Wiley and Sons

20. Text book of polymer science by Fred Billmeyer, Wiley Publication

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: B.Sc. Chemistry (2020-21)				**Semester: V**	
Course: Analytical Chemistry				**Course Code: USMACH504**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical** (Lectures per week)	**Tutorial** (Hours per week)	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	4		4 + 2	10 + 15	75

Learning Objectives:

This paper is to familiarize the students of chemistry at undergraduate level with the analytical methods used in industries.

Course Outcomes:

After completion of the course, learners would be able to:

1. Know about sampling for analysis and how it is done, how to minimize errors during analysis.
2. Have knowledge of the various components of the instruments ,the principle behind them and their working.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Lectures**
1	Treatment of analytical data-I and sampling	15
2	Titrimetric analysis-I and UV-Visible spectroscopy.	15
3	Methods of separation-I	15
4	Optical methods	15
	Total	**60**
PRACTICALS		

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

PRACTICAL I
(If applicable)

Suggested Readings

1) Analytical Chemistry Skoog, West, Holler, 7th Edition.
2) A premier sampling solids, liquids and gases, Smith Patricia I, American statistical association and the society for industrial and applied mathematics, (2001).
3) A guide to Quality in Analytical Chemistry: An aid to accreditation, CITAC and EURACHEM, (2002),

4) Quality control and Quality assurance in Analytical Chemical Laboratory, Piotr Konieczka and Jacek Namiesnik, CRC press (2018)

Unit	Topic	No. of Lectures/Credits
Module 1	**1. Treatment of analytical data-I and sampling** **1.1 Treatment of Analytical Data (7L)** Types of errors, determinate and indeterminate errors, minimization of errors, constant and proportionate errors, accuracy and precision, measures of dispersion and central tendency: mean, median, average deviation, relative average deviation, standard deviation, variance, coefficient of variation.[Numerical problems expected] **1.2 Sampling (8L)** Terms involved, importance of sampling, sampling techniques, sampling of gases, ambient and stack sampling, equipment used, sampling of homogeneous and heterogeneous liquids, sampling of static and flowing liquids, methods and equipment's used, sampling of solids, importance of particle size and sample size, samples used, need for the reduction in the sample size, methods of reduction in sample size, collection, preservation and dissolution of the sample.	**15L**
Module 2	**2. Titrimetric analysis-I and UV-Visible spectroscopy.** **2.1 Acid-base Titrations (6 L)** Construction of titration curves and choice of indicators in the titration of [1] strong acid and strong base, [2] strong acid and weak base, [3] weak acid and strong base, [4] weak acid and weak base. **2.2 Precipitation titrations (4L)** Argentimetric titrations, construction of the titration curve, Volhard's method, Mohr's method, adsorption indicators, theory and applications. **2.3 U.V. Visible Spectroscopy (5 L)** Recapitulation, Spectrophotometers, Instrumentation in the case of single and double beam spectrophotometers, Qualitative and quantitative analysis, calibration curve method.	**15L**
Module 3	**3. Methods of separation-I** **3.1 Solvent Extraction (8L)**	**15L**

	Partition coefficient and distribution ratio, extraction efficiency, separation factor, role of complexing agents in solvent extraction, chelation, ion pair formation, solvation, types of solvent extraction: batch, continuous. [Numerical problems expected] **3.2 Chromatography (2L)** Introduction to chromatographic techniques, classification of chromatographic techniques. **3.3 Planar Chromatography (5L)** Principle, techniques and applications of [1] Paper chromatography [2] Thin layer chromatography	
Module 4	**4. Optical methods** **4.1 Atomic Spectroscopy (7L)** Absorption and emission spectra, energy level diagrams, process involved in atomization, flame photometry, flame atomizer, types of burners, monochromators and detectors, atomic absorption spectroscopy; flame and electrothermal atomizer, sources, instrumentation, quantitative applications of atomic absorption and flame photometry, calibration curve method, standard addition and internal standard method. **4.2 Molecular Fluorescence and Phosphorescence Spectroscopy (4L)** Theory, instrumentation and applications **4.3 Turbidimetry and Nephelometry (4L)** Scattering of light, effect of concentration, particle size and wavelength on light scattering, instrumentation and applications.	**15L**
	Practicals	**2**
	1. Estimation of persulphate in the given sample by the method of back titration. 2. Determination of potassium content of a commercial salt sample by flame photometry. 3. To estimate Fe (II) in a tablet using Diphenylamine as an indicator. 4. Determination of the amount of fluoride in the given solution colorimetrically. 5. Determination of Vitamin C content of a given tablet by titration with sodium hydroxide pH metrically 6. To determine the amount of Sulphate present in the given water sample turbidimetrically.	

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: B.Sc. Chemistry(2020-21)				**Semester: V**	
Course: Drugs and Dyes				**Course Code: USMACH505**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical** (Lectures per week)	**Tutorial** (Hours per week)	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	4		4 + 2	10 + 15	75

Learning Objectives:

1. Students will explore to basics of the drug and related medicinal terms.
2. Students will have acquainted with the synthesis of some important class of the drug.
3. To know steps involved in drug discovery, design and development.
4. To study different chemotherapeutic agents with their uses.

Course Outcomes:

After completion of the course, learners would be able to:

1. Understand basics terms and nomenclatures used in pharmaceutical.
2. Explain routes of drug administration and their dosage.
3. Differentiate between various classes of drugs based on their applications like analgesics, antipoyretics, antimalarials, anti-inflammatory drugs, antidiabetic agents, antiparkinsonism drugs, drugs for respiratory system, antiamoebic drugs, anti HIV drugs,
4. Explain mode of action of drugs and drug metabolism.
5. Suggest route of synthesis for drug Intermediates
6. Explain role of Nano particles in medicinal chemistry.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Lectures**
1	1.1 General Introduction to Drugs 1.2. Routes of Drug Administration and Dosage Forms 1.3.Pharmacodynamic agents 1.4 Analgesics and Antipoyretics	15
2	2.1 Anti-inflammatory 2.2 Antihistaminic Drugs 2.3 Cardiovascular drugs 2.4 Antidiabetic Agents 2.5 Antiparkinsonism Drugs 2.6 Drugs for Respiratory System 2.7 Mode of Action of the Following Drugs	15
3	3.1 Drug Discovery, Design and Development 3.2 Drug Metabolism 3.3 Antibiotics Chemotherapeutic	15

	3.4 Antibiotics 3.5 Antimalarials 3.6 Anthelmintics	
4	4.1 Antiamoebic Drugs 4.2 Antitubercular and Antileprotic Drugs 4.3 Anti-Neoplastic Drugs 4.4Anti HIV Drugs 4.5 Drug Intermediates: Synthesis and uses 4.6 Nano particles in Medicinal Chemistry	15
	Total	**60**
PRACTICALS		

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

PRACTICAL I
(If applicable)

Suggested Readings

5) Analytical Chemistry Skoog, West, Holler, 7th Edition.
6) A premier sampling solids, liquids and gases, Smith Patricia I, American statistical association and the society for industrial and applied mathematics, (2001).
7) A guide to Quality in Analytical Chemistry: An aid to accreditation, CITAC and EURACHEM, (2002),
8) Quality control and Quality assurance in Analytical Chemical Laboratory, Piotr Konieczka and Jacek Namiesnik, CRC press (2018)

Unit	Topic	No. of Lectures/Credits
Module 1	**1. 1General Introduction to Drugs (6L)** 1.1.1 Definition of a drug, Requirements of an ideal drug, Classification of drugs (based on therapeutic action) 1.1.2 Nomenclature of drugs: Generic name, Brand name, Systematic name 1.1.3 Definition of the following medicinal terms: Pharmacon, Pharmacophore, Prodrug, Half-life efficiency, LD50, ED50, Therapeutic Index. 1.1.4 Brief idea of the following terms: Receptors, Drug-receptor interaction, Drug Potency, Bioavailability, Drug toxicity, Drug addiction, Spurious Drugs, Misbranded Drugs, Adulterated Drugs, Pharmacopoeia. **1.2. Routes of Drug Administration and Dosage Forms (2L)** 1.2.1 Oral and Parenteral routes with advantages and disadvantages. 1.2.2 Formulations, Different dosage forms (emphasis on sustained release formulations.) **1.3.Pharmacodynamic agents (5L)** 1.3.1 A brief introduction of the following pharmacodynamic agents and the study with respect to their chemical structure, chemical class, therapeutic uses, and side effects. 1.3.2 CNS Drugs Classification based on pharmacological actions, Concept of sedation and hypnosis, anaesthesia. Phenobarbitone (Barbiturates), Phenytoin (Hydantoins), Trimethadione (Oxazolidinediones), Piracetam (Pyranones), Midazolam, Alprazolam (Benzodiazepines), Methylphenidate (Piperidines), Chlorpromazine (Phenothiazines), Fluoxetine (Phenyl propyl amines) Synthesis of Trimethadione, Methylphenidate, Phenytoin. **1.4 Analgesics and Antipoyretics (2L)** Morphine (Phenanthrene alkaloids), Tramadol (Cyclohexanols), Aspirin (Salicylates), Paracetamol (p-Aminophenols), Synthesis of Tramadol, Paracetamol.	**15L**

dgfgf

Module 2	**2.1 Anti-inflammatory Drugs (2L)** Mechanism of inflammation and various inflammatory conditions. Prednisolone, Betamethasone (Steroids), Aceclofenac (N-Aryl anthranilic acids), Mefanic Acid (N-Aryl anthranilic acids). Synthesis of Aceclofenac **2.2 Antihistaminic Drugs (2L)** Mechanism of histamine release & its action Diphenhydramine (ethanolamines), Cetrizene (piperazine), Chloropheniramine maleate (ethyl amines),Omeprazol, pantoprazol(Benzimidazoles) Synthesis of cetrizine **2.3 Cardiovascular drugs (3L)** Classification based on pharmacological action Enalapril (-amino acids), Isosorbide dinitrate (Nitrates), Atenoldol (Aryloxy propanol amines), Nifedipine (Pyridines), Chlorthiazide (Thiazides), Frusemide /Furosemide (Sulfamyl benzoic acid), Spironolactone (Steroidal- 17- -lactones), Synthesis of Furosemide, Atenolol from 3-Hydroxy phenyl acetamide **2.4 Antidiabetic Agents (2L)** General idea and types of diabetes; Insulin therapy Glibenclamide (sulphonyl ureas), Metformin (Biguanides) **2.5 Antiparkinsonism Drugs (2L)** Idea of Parkinson's disease. Procyclidine hydrochloride (Pyrrolidines), Ethopropazine hydrochloride (Phenothiazines) Laevodopa (-amino acids), Synthesis of Levodopa from Vanillin. **2.6 Drugs for Respiratory System (2L)** General idea of Expectorants; Mucolytes; Bronchodilators Decongestants and Antitussives, Bromhexine (Phenyl methyl amines), Salbutamol, Pseudoephedrine (Phenyl ethyl amines) Oxymetazoline (Imidazolines) Codeine Phosphate (Opiates) Synthesis of Salbutamol **2.7 Mode of Action of the Following Drugs (2L)** Barbiturates (As sedatives and hypnotics), Atenolol (As β-1 blocker), Diphenhydramine (As Anthistaminic agent), Glibenclamide (As oral hypoglycemic agent)	**15L**
Module 3	**3.1 Drug Discovery, Design and Development (5L)** 3.1.1 Discovery of a Lead compound: Screening, drug metabolism studies and clinical observation. 3.1.2 Drug development from	**15L**

	Natural Sources: Anti infective agents Anti cancer agents CNS agent 3.1.3 Development of drug: The Pharmacophore identification, modification of structure or functional group, Structure activity relationship (Benzodiazepines, Sulphonamides). 3.1.4 Structure modification to increase potency: Homologation, Chain branching, Ring-chain transformation, Extension of the structure. 3.1.5 Computer assisted drug design. **3.2 Drug Metabolism (3L)** Introduction, Absorption, Distribution, Bio-transformation, Excretion Different types of chemical transformation of drugs with specific examples. **3.3 Antibiotics Chemotherapeutic Agents (1L)** Study of the following chemotherapeutic agents with respect to their chemical structure, chemical class, therapeutic uses, and side effects. **3.4 Antibiotics** (2L) Definition, Characteristics and properties of : Amoxicillin; Cloxicillin (-lactum antibiotics) Cephalexin (Cephalosporins) Doxycycline (Tetracyclines) Gentamycin (Aminoglycosides) Ciprofloxacin (Quinolones) Synthesis of Ciprofloxacin **3.5 Antimalarials** (2L) Types of malaria: Symptoms; pathological detection during window period (Life cycle of the parasites not o be discussed) Chloroquine (3-Amino quinolines) Paludrine (Biguanides) Pyrimethamine (Diamino pyrimidines) Artemether (Benzodioxepins) Following combination to be discussed (i) Sulfadosine-Pyrimethamine (ii) Atremether-Lumefantrine (no structure) Synthesis of Paludrine. **3.6 Anthelmintics (**2L) Drugs effective in the treatment of Nematodes and Cestodes intestations. Diethyl carbamazine (Piperazines) Mebandazole; Albendazole (Benzimidazoles) Niclosamide (Amides) Synthesis of Albendazole	

Module 4	**4.1 Antiamoebic Drugs** (1L) Types of Amoebiasis Metronidazole; Diloxamide furoate (Furans) Following combination therapy to be discussed: Ciprofloxacin-Tinidazo Synthesis of Metronidazole **4.2 Antitubercular and Antileprotic Drugs** (3L) Types of Tuberculosis; Symptoms and diagnosis of Tubeculosis. Types of Leprosy. General idea of Antibiotics used in their treatment. PAS (Aminosalicylates) Isoniazide (Hydrazides) Pyrazinamide (Pyrazines) (+) Ethambutol (Aliphatic diamines) Ethionamide (Thioamides) Dapsone (Sulfonamides) Clofazimine (Phenazines) Following combination therapy to be discussed: (i) Rifampin + Ethambutol + Pyrazinamide (ii) Rifampin + Isoniazide + Pyrazinamide (iii) Rifampin + Clofazimine + Ethionamide. Synthesis: (+) Ethambutol, Dapsone. **4.3 Anti-Neoplastic Drugs** (2L) Idea of malignancy; Causes of cancer, brief idea of Immuno Stimulants, Immuno depressants. (1) Lomoustine (Nitrosoureas) (2) Fluorouracil (Pyrimidines) (3) Estrogen (Steroidal hormones) (3) Mitomycin C (Antibiotics) (5) Vincristine; vinblastine; vindesine (Vica alkaloids-no structures) Synthesis of 5-Fluorouracil from urea. **4.4Anti HIV Drugs** (1L) Idea of HIV pathogenecity, Symptoms of AIDS, AZT, Lamivudine, Stavudine (Pyrimidines), DDI (Purines) **4.5 Drug Intermediates: Synthesis and uses** (3L) (i) 2-Amino-5- chlorobenzophenone from pchloronitrobenzene (ii) 2,3,6-Triamino-6- hydroxypyrimidine from Guanidine. (iii) 3-Chloro-5-sulphonyl amino anthranilic acid from 3-Chloro-2- toludine (iv) p-[2'-(5-Chloro-2-methoxybenzamido) ethyl] benzenesulphonamide from Methyl-5-chloro-2-methoxybenzene (v) 3-(p-Chlorophenyl)-3- hydroxypiperidine from 3-Chloroacetophenone. (vi) p-Acetyl amino benzenesulphonyl chloride from Aniline (vii) Epichlorohydrine from propene. **4.6 Nano particles in Medicinal Chemistry** (3L) Introduction, Carbon nano particles (structures), Carbon nano	**15L**

	tubes: Functionalisation for Pharmaceutical applications Targeted drug delivery In vaccine (Foot and mouth disease) Use in Bio-physical treatment. Gold nano particles in treatment of cancer, Parkinsonism, Alzheimer. Silver nano particles: Antimicrobial activity.	
	Practicals	**2**
	I) Drug Estimation: 1. Estimation of Ibuprofen 2. Estimation of Acid neutralizing capacity of a drug **II)** Preparation of monogram of any one drug from syllabus by I.P. method **III) Drug Preparations:** 1) Preparation of p-Nitroacetanilide from Acetanilide 2) Preparation of p-Nitroaniline from p- Nitroacetanilide 3) Preparation of Methyl Salicylate from Salicylic Acid **IV) Drug Preparation:** 1) Preparation of Aspirin from Salicylic Acid **V) Drug Estimation:** 1. Estimation of Tincture of Iodine 2. Estimation of Free Acid in Vegetable oil	

Shri Vile Parle Kelavani Mandal's

MITHIBAI COLLEGE OF ARTS, CHAUHAN INSTITUTE OF SCIENCE & AMRUTBEN JIVANLAL COLLEGE OF COMMERCE AND ECONOMICS (AUTONOMOUS)

NAAC Reaccredited 'A' grade, CGPA: 3.57 (February 2016),

Granted under RUSA, FIST-DST & -Star College Scheme of DBT, Government of India

Best College (2016-17), University of Mumbai

Affiliated to the

UNIVERSITY OF MUMBAI

Program: B.Sc.

Course: CHEMISTRY

Semester: VI

Choice Based Credit System (CBCS) with effect from the Academic year: 2018-2019

PROGRAMME SPECIFIC OUTCOMES (PSO'S)

On completion of the B.Sc Chemistry the learners should be enriched with knowledge and be able to-

PSO1: To have sound knowledge about the fundamentals and applications of various chemical and scientific theories.

PSO2: To introduce the different branches of chemistry like analytical, organic, inorganic, physical, environmental, polymer and biochemistry etc.

PSO3: To explain nomenclature, stereochemistry, structures, reactivity, chemical formulae, and mechanism of the chemical reactions.

PSO4: To apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories and in industries.

PSO5: To develop better understanding of good laboratory practices and safety.

PSO6: To develop research oriented skills, analytical skills and problem solving skills requiring application of chemical principles.

PSO7: To recognize causes of environmental pollution, environmental pollution act and the methods for environmental pollution control.

Preamble

The well-organized curriculum including basic as well as advanced concepts in chemistry from first year to third year shall inspire the students for pursuing higher studies in chemistry and for becoming an entrepreneur and also enable students to get employed in the Research Institutes, Industries, Educational Institutes and in the various concerning departments of State and Central Government based on subject chemistry.

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Evaluation Pattern

The performance of the learner will be evaluated in two components. The first component will be a Continuous Assessment with a weightage of 25% of total marks per course. The second component will be a Semester end Examination with a weightage of 75% of the total marks per course. The allocation of marks for the Continuous Assessment and Semester end Examinations is as shown below:

c) Details of Continuous Assessment (CA)

25% of the total marks per course:

Continuous Assessment	Details	Marks
Component 1 (CA-1)	Class Test	15 marks
Component 2 (CA-2)	Class Test	10 marks

d) Details of Semester End Examination

75% of the total marks per course. Duration of examination will be two and half hours.

Question Number	Description	Marks	Total Marks
Q.1	Attempt **any four out of six**	5 marks each	20
Q.2	Attempt **any four** out of six	5 marks each	20
Q.3	Attempt **any four** out of six	5 marks each	20
Q.4	Attempt **any five** out of six	3 marks each	15
		Total Marks	**75**

Signature Signature Signature

HOD Approved by Vice –Principal Approved by Principal

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: B.Sc. Chemistry				**Semester: VI**	
Course: Physical Chemistry				**Course Code: USMACH601**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (lectures per week)	**Practical** (Lecture per week)	**Tutorial** (Hours per week)	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	4	NIL	4 + 2	10 + 15	75

Learning Objectives:

To provide fundamental understanding of nuclear chemistry, quantum chemistry, electrochemistry, nuclear magnetic resonance and physical chemistry aspects of polymers.

Course Outcomes:

After completion of the course, learners would be able to:

CO7: Understand the classification, applications of polymers and to understand various method used for determination of its molecular weight.

CO8: Learn various branches of spectroscopy such as NMR with its instrumentation and applications.

CO9: Provide knowledge on concept of overvoltage and understand method of its determination using Tafel's theory.

CO10: Understand the basics of quantum mechanics and the concept of operators.

CO11: Provide an in-depth knowledge of fuels for future with its advantages and limitations.

CO12: Introduce and explain the theory and applications of nuclear chemistry.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Lectures**
1	1.1 Chemical Kinetics 1.2 Polymers-II 1.3 Nuclear Magnetic Resonance Spectroscopy	15
2	2.1 Applied Electrochemistry 2.2 Renewable Energy Sources	15
3	3.1 Nuclear Chemistry	15
4	4.1 Basic Quantum Chemistry	15
	Total	**60**
PRACTICALS		

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

PRACTICAL I

(If applicable)

Unit	Topic	No. of Lectures/Credits
Module 1	Chemical kinetics-III (5L) 1.1.1Collision theory of reaction rates: application of collision theory to 1. Uni-molecular reaction and 2. Bimolecular reaction (Lindemann theory, derivation expected). Merits and drawbacks of collision theory. 1.1.2Concept of activated complex 1.1.3Classification of reaction: slow, fast and ultra -fast. study of kinetics of fast reactions by Stop flow method 1.2 Polymers (5L) 1.2.1 Classification of polymers based on (i) source, (ii) structure, (iii) thermal response, (iv) physical properties. 1.2.2. Molar masses of polymers: 1. Number average molar mass, 2.Weight average molar mass, 3. Viscosity average molar mass, monodispersity, polydispersity. 1.2.3. Methods of determining molar masses of polymers: 1. Ultracentrifuge method (Limiting velocity method IV only). Viscosity method (Mark - 1 Houwink equation). (Numericals Expected) 1.3 Nuclear Magnetic Resonance Spectroscopy (5L) 1.3.1. Nuclear spin, magnetic moment, nuclear 'g' factor, energy levels, Larmor precession, Relaxation processes in n.m.r. (spin -spin relaxation and spin - lattice relaxation). 1.3.2 NMR Spectrometer, chemical shift, shielding and deshielding of protons, low resolution n.m.r. spectrum of methanol and ethanol. (Numericals Expected)	**15L**
Module 2	2.1 Applied Electrochemistry 2.1.1 Applications of EMF .measurements in the determination of 1. pH of a solution using quinhydrone and glass electrode. 2 solubility and solubility product of sparingly soluble salts using chemical cell and concentration cell method 3 . determination of liquid -liquid junction potential. 2.1.2Decomposition potential, experimental determination of decomposition potential, factors affecting decomposition potential (nature of electrolyte, nature of electrodes and temperature) Tafel's equation for hydrogen overvoltage, Overvoltage, experimental determination of over -voltage, Electroplating - objectives and theory. (Numericals Expected) 2.2 Renewable Energy Sources 2.2.1 Lithium ion cell.	**15L**

	2.2.2 Fuel cells; Choice of fuel and oxidant, Bacon's H2 and O2 fuel cell. 2.2.3 Solar cells, solar energy, photovoltaic effect, semiconductors as solar energy converters, silicon solar cell 2.2.4 Hydrogen: Fuel of the future, production of hydrogen by direct electrolysis of water, advantages of hydrogen as a universal energy medium.	
Module 3	3.1 Nuclear Chemistry 3.1.1 Types of nuclear radiations and their characteristics, behaviour of ion pairs in electric field, 3.1.2 Detection and measurement of nuclear radiations using G. M. Counter and Scintillation Counter. 3.1.3 Radioactive equilibrium (secular and transient); difference between chemical and radioactive equilibrium. 3.1.4 Kinetics of radioactive decay, units of radioactivity (Curie, Becquerel, Rutherford) 3.1.5 Use of radioisotopes as tracers in 1. Chemical investigations - reaction mechanism, 2. Medical applications. 3.1.6 Nuclear reaction: nuclear transmutation, artificial radioactivity –mechanism; different type of projectile-alpha particle and neutrons. Mode of artificially radioactive elements-(1) emission of positrons (2) emission of electrons (3) K- electron capture. 3.1.7 Nuclear energy 3.1.8 Q - value of nuclear reaction, threshold energy. 3.1.9 Nuclear fission: fission process, fission fragment, factor controlling Nuclear fission-1. Multiplication factor 2.Critical size or Mass of fissionable material. 3.1.10 Nuclear power reactor and breeder reactor: basic component, breeder reactor-Fissile and Fertile material. Nuclear power reactor in India. 3.1.11 Nuclear fusion: characteristics; thermonuclear reactions occurring onstellar bodies and Earth. (Numericals Expected)	**15L**
Module 4	4.1 Basics of Quantum Chemistry 4.1.1 Classical mechanics, limitations of classical mechanics, Black body radiation, photoelectric effect, Compton effect. 4.1.2Introduction to quantum mechanics, Planck's theory of quantization, wave particle duality, de -Broglie equation, Heisenberg's uncertainty principle. 4.1.3Progressive and standing waves, boundary conditions, Time dependent and time independent (Steady State) Schrodinger equation(derivation expected)., interpretation and properties of wave function, Stationary State,	**15L**

	Superposition principle.Probability current density, Equation of continuity and its physical significance. 4.1.4 Postulates of quantum mechanics (following are to be considered), 4.1.5 State function and it's significance 4.1.6Concept of operators: Definition, addition, subtraction and multiplication of operators, commutative and non - commutative operators, linear operator, Hamiltonian operator, 4.1.7 Eigen function and Eigen value, Eigen value equation. (Numericals Expected)	
	Practicals	**2**
	1. To determine the solubility product and solubility of AgCl potentiometrically using chemical cell. 2. To determine the strength of the given strong acid (HCl) by potentiometric titration using quinhydrone electrode (Calculation of pH from Ecell and the plot of (a) against V (b) pH against V graphs are expected). 3. To determine the energy of activation for the acid catalysed hydrolysis of methyl acetate. 4. To determine pKa value of the given weak monobasic acid (CH3COOH) by e.m.f. measurements. 5. To determine the molecular weight of high polymer polyvinyl alcohol (PVA) by viscosity measurement. 6. To determine the acidic and basic dissociation constant of amino acid and hence calculate isoelectric point.	

Suggested Readings

1. Peter Atkins and Julio de Paula, Atkin's Physical Chemistry, 7th Edn., Oxford University Press, 2002.

2. K.J. Laidler and J.H. Meiser, Physical Chemistry, 2nd Ed., CBS Publishers and Distributors, New Delhi, 1999.

3. Robert J. Silby and Robert A. Alberty, Physical Chemistry, 3rd Edn., John Wiley and Sons (Asia) Pte. Ltd., 2002.

4. Ira R. Levine, Physical Chemistry, 5th Edn., Tata McGraw-Hill New Delhi, 2002.

5. G.W. Castellan, Physical Chemistry, 3rd Edn., Narosa Publishing House, New Delhi, 1983.

6. S. Glasstone, Text Book of Physical Chemistry, 2nd Edn., McMillan and Co. Ltd., London, 1962

7. B.K. Sen, Quantum Chemistry including Spectroscopy, Kalyani Publishers, 2003.

8. A.K. Chandra, Introductory Quantum Chemistry, Tata McGraw – Hill, 1994.

9. R.K. Prasad, Quantum Chemistry, 2nd Edn., New Age International Publishers, 2000.

10. S. Glasstone, Thermodynamics for Chemists, Affiliated East-West Press, New Delhi, 1964.

11. W.G. Davis, Introduction to Chemical Thermodynamics – A Non – Calculus Approach, Saunders, Philadelphia, 19772.

12. Peter A. Rock, Chemical Thermodynamics, University Science Books, Oxford University Press, 1983.

13. Ira N. Levine, Quantum Chemistry, 5th Edn., Pearson Education (Singapore) Pte. Ltd., Indian Branch, New Delhi, 2000.

14. Thomas Engel and Philip Reid, Physical Chemistry, 3rd Edn., Pearson Education Limited 2013. 15. D.N. Bajpai, Advanced Physical Chemistry, S. Chand 1st Edn., 1992.

16. Bockris, John O'M., Reddy, Amulya K.N., Gamboa-Aldeco, Maria E., Modern Electrochemistry, 2A, Plenum Publishers, 1998.

17. Physical Chemistry by Gurtu and Gurtu

18. A Text book of Physical Chemistry by K L kapoor Vol 5 , 2nd Edn

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: B.Sc. Chemistry				**Semester: VI**	
Course: Inorganic Chemistry				**Course Code: USMACH602**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Lectures per week)	**Practical** (Lectures per week)	**Tutorial** (Lectures per week)	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	4	NIL	4 + 2	10 + 15	75

Learning Objectives:

Obtain the knowledge on design and development of co-ordinate compounds with reference to properties based on understanding reaction mechanism. use of organometallic compounds in catalysis. Basics of Nano materials, complexes in medicine and role of radio pharmaceutical diagnosis, sterilization and treatment.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Understand the bonding and reactivity of co-ordination complexes.
CO2: Explain the Molecular Orbital Theory (MOT),VBT,CFT for Coordination Complexes
CO3: Understand different usage of organometallic compounds in catalyst
CO4: Basics of nano-material, its properties and application various field of life
CO5: Role of transtionmetaloenzymes in biology, uses of complexes in as medicine.
CO6: Use of inorganic radio pharmaceutical in diagnosis, sterilization and treatment.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Lectures**
1	**1.1 Coordination Chemistry**	15
2	**2.1 Properties of Coordination compounds**	15
3	**3.1 Organometallic Chemistry**	15
4	**4.1 Some Selected Topics (Nanomaterials, Bioinorganic and Medicinal Chemistry** inorganic radio pharmaceutical**,)**	15
	Total	**60**
	Practicals	

Unit	Topic	No. of Hours/Credits
Module 1	Coordination Chemistry 1.1 Theories of the Metal-Ligand Bond (10L) 1.1.1 Limitations of VBT 1.1.2 Crystal field theory and effect of crystal field on central metal valence orbitals in various geometries 1.1.3 Splitting of d-orbitals in octahedral, tetrahedral and square planar crystal fields. 1.1.4 Distortion from the octahedral geometry: i) effect of ligand field and ii) Jahn – Teller distortions 1.1.5 Crystal field splitting parameter, its calculation and factors affecting it in octahedral complexes, Spectrochemical series 1.1.6 Crystal field stabilization energy (CFSE), calculation of CFSE, for octahedral and tetrahedral complexes with d0 to d10 metal ion configurations. 1.1.7 Consequences of crystal field splitting on Ionic radius, hydration energy, lattice energy, enthalpies of formation, color and magnetic properties 1.1.8 Limitations of the CFT: Evidences for covalence in metal complexes: i) ESR spectrum of [IrCl6]2- (ii) Intensities of d-d transitions, and (iii) Nephelauxetic effect. 1.2 Molecular Orbital Theory (MOT) for Coordination Complexes (05L) 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 1.2.3 Construction of σ-molecular orbitals for an ML6 complex.	**15L**
Module 2	**2. Properties of Coordination compounds** 2.1 Electronic Spectra **(7L)** 2.1.1 Origin of electronic spectra 2.1.2 Types of electronic transitions like intra –ligand transitions, charge transfer transitions and intra-metal transitions 2.1.3Electronic configuration and electronic micro states: Terms and term symbols, coupling of spin momenta (M_s), orbital momenta (M_l) and spin-orbit coupling or Russell-Saunders coupling. 2.1.4 Determination of terms for p^2 and d^2 electronic configurations 2.1.5 Terms and micro states for transition metal atoms/ions	**15L**

	2.1.6 Orgel Diagrams for D and F Terms (i.e,d^1 to d^9 electronic configurations in octahedral crystal fields) 2.1.7 Selection rules for electronic transitions: Spin and Orbital forbidden transitions (Laporte selection rules) **2.2 Stability of Complexes (4L)** 2.2.1 Thermodynamic stability and kinetic stability of complexes with examples. 2.2.2 Stability constants: Stepwise and overall constants and their interrelationship. 2.2.3 Factors affecting thermodynamic stability (factors related to nature of central metal atom, nature of ligand, chelate effect to be discussed.) **2.3 Reactivity of Metal complexes (4L)** 2.3.1 Comparison between Inorganic and Organic reactions 2.3.2 Types of reactions in metal complexes. 2.3.3 Inert and labile complexes: Correlation between electronic configurations and lability of complexes. 2.3.4 Ligand substitution reactions: Associative and dissociative mechanisms 2.3.5Acid hydrolysis, base hydrolysis and anation reactions	
Module 3	**Organometallic Chemistry** **3.1 Organometallic Compounds of main group metals (6L)** 3.1.1General characteristics of various types of organometallic compounds viz. ionic, σ-bonded and electron deficient compounds 3.1.2 General synthetic methods:(i)Oxidative addition,(ii)Metal- Metal exchange (Transmetallation), (iii) Carbanion-Halide exchange, (iv) Metal Hydrogen exchange and (v) Methylene insertion reactions. 3.1.3Chemical reactions: (i) Reactions with oxygen and halogens, (ii) Alkylation and arylation reactions (iii) Reactions with protic reagents (iv) Redistribution reactions and (iv) Complex formation reactions. **3.2 Metallocenes (5L)** 3.2.1 Introduction, Ferrocene: Synthesis, properties, structure and bonding on the basis of VBT **3.3 Catalysis (4L)** 3.3.1 Overview of Homogeneous catalysis 3.3.2 Selection of catalytic cycles (Should be read as reactions in catalytic cycles) 3.3.3 Coupling Reactions: Heck and Suzuki reactions	**15L**

Module 4	**Some Selected Topics** **4.1 Nanomaterials (8L)** 4.1.1 Introduction and importance of nanomaterials. 4.1.2 Chemical Methods of synthesis of nanomaterials 4.1.3 Characterization of nanomaterials (UV and XRD techniques) 4.1.4 Dimensions and Forms of nanomaterials: nanofilms, nanolayers, nanotubes, nanowires, nanoparticles. 4.1.5 Properties (Comparison between bulk and nanomaterials): (i) Optical properties, (ii) Electrical conductivity, and (iii) Mechanical properties. 4.1.6 Applications **4.2 Bioinorganic and Medicinal Chemistry (7L)** 4.2.1 Metal coordination in biological systems: Enzymes, apoenzymes and coenzymes 4.2.2 Biological role of carboxypeptidases, catalases and peroxidases 4.2.3 Metal complexes in medicine: cis-platins and gold complexes 4.2.4 Inorganic radiopharmaceuticals	**15L**
	Practicals	**2**
	Inorganic preparations and characterization (Instrumental techniques): 1. Tris(acetylacetonato) iron (III) (colorimetry) 2. Tris(Thiourea) copper (I) sulphate (colorimetry) 3. Potassium trioxalato ferrate (Flame photometry) **Titrimetric analysis:** 1. Estimation of copper iodometrically using sodium thiosulphate 2. Determination of COD of given water sample	

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

PRACTICAL I
(If applicable)

Suggested Readings

1. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, 2013-2014.

2. W. W. Porterfield, Inorganic Chemistry-A Unified Approach, 2nd Ed., Academic Press, 1993.

3. B. W. Pfennig, Principles of Inorganic Chemistry, Wiley, 2015.

4. C. E. Housecroft and A. G. Sharpe, Inorganic Chemistry, Pearson Education Limited, 2nd Edition 2005.

5. J. Huheey, F. A. Keiter and R. I. Keiter, Inorganic Chemistry–Principles of Structure and Reactivity, 4th Ed., Harper Collins, 1993.

6. P. J. Durrant and B. Durrant, Introduction to Advanced Inorganic Chemistry, Oxford University Press, 1967.

7. R. L. Dekock and H.B.Gray, Chemical Structure and Bonding, The Benjamin Cummings Publishing Company, 1989.

8. G. Miessler and D. Tarr, Inorganic Chemistry, 3rd Ed., Pearson Education, 2004.

9. R. Sarkar, General and Inorganic Chemistry, Books & Allied (P) Ltd., 2001.

10. C. M. Day and J. Selbin, Theoretical Inorganic Chemistry, Affiliated East West Press Pvt. Ltd., 1985.

11. J. N. Murrell, S. F. A. Kettle and J. M. Tedder, The Chemical Bond, Wiley, 1978.

12. G. A. Jeffrey, An Introduction to Hydrogen Bonding, Oxford University Press, Inc., 1997.

13. D. Banerjea,Coordination Chemistry

14. Geary Coordination reviews

15. P.W. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong; Shriver & Atkins: Inorganic Chemistry, 4th ed. Oxford University Press, 2006.

16. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann; Advanced Inorganic Chemistry, 6th ed. Wiley, 1999,

17. B. Douglas, D. McDaniel and J. Alexander. Concepts and Models of Inorganic Chemistry(3rd edn.), John Wiley & Sons (1994).

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: B.Sc. Chemistry				**Semester: VI**	
Course: Organic Chemistry				**Course Code: USMACH603**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Lectures per week)	**Practical** (lectures per week)	**Tutorial** (Lectures per week)	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	4	NIL	4 + 2	10 + 15	75

Learning Objectives:

The objective of the course is to introduce students to some important topics in organic chemistry like organic reactive intermediates, biomolecules, spectroscopy, polymers, natural products and organometallic chemistry. Practical course will train them to plan and execute simple organic transformations along with spectral interpretation of product isolated.

Course Outcomes:

After completion of the course, learners would be able to:

CO5: gain an understanding of chemistry of reactive intermediates, natural products, biomolecules, organometallic compounds and polymer science.

CO6: be able to elucidate the structure of simple organic compounds on the basis of spectral data.

CO7: acquire the skill to plan and execute simple organic reactions along with spectral interpretation of product formed.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Lectures**
1	1.1 Mechanism of Organic Reactions - II 1.2 Natural Products	15
2	2.1 Biomolecules	15
3	3.1 Spectroscopy	15
4	4.1 Organometallics 4.2 Pericyclic reactions 4.3 Polymers	15
	Total	**60**
PRACTICALS		

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

Unit	Topic	No. of Hours/Credits
Module 1	**1.1 Mechanism of Organic Reactions – II (6L)** 1.1.1 Carbene Chemistry: Synthesis Mechanism of the following reactions with examples and stereochemistry wherever applicable : Wolff rearrangement reaction, Simmon Smith reaction, Arndt Eistert reaction, Reimer Tiemann reaction 1.1.2 Nitrene Chemistry: Synthesis Mechanism of the following reactions with examples and stereochemistry wherever applicable : Curtius, Hoffmann and Lossen 1.1.3 Free radical Chemistry: Synthesis Mechanism of the following reactions with examples and stereochemistry wherever applicable : Pinacol reaction, McMurry reaction **1.2 Natural Products (9L)** 1.2.1 Introduction to the following natural products (Structures of compounds specified are expected) Terpenoids: Isoprene rule, Special isoprene rule, α – terpeniol, citral, camphor and α – pinene Alkaloids: Nicotine, Atropine Vitamins: Vitamin A, Vitamic C Hormones: Adrenaline, Thyroxine Steroids: Cholesterol, progesterone 1.2.2 Structure determination of natural products: Ozonolysis in terpenoids, Examples of open chain and monocyclic monoterpenoids Hofmann exhaustive methylation and degradation in alkaloids: simple open chain and monocyclic amines 1.2.3 Commercial synthesis: Camphor from α – pinene, α – and β – ionone from citral 1.2.4 Introduction to primary and secondary metabolites and broad classification of natural products based on biosynthesis	**15L**
Module 2	**2.1 Chemistry of Biomolecules** 2.1.1 Carbohydrates 2.1.1.1 Introduction: Classification, reducing and non reducing sugars, DL notation	**15L**

	2.1.1.2 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 Stereoisomers of D–Glucose: enantiomer, diastereomers, anomers, epimers 2.1.1.3 Mutarotation in D - Glucose with mechanism 2.1.1.4 Chain lengthening and shortening reactions: Modified Kiliani– Fischer synthesis (D–arabinose to D–glucose and D–mannose), Wohl method (D – glucose to D – arabinose) 2.1.1.5 Reactions of D – glucose and D – Fructose: osazone formation, reduction: H_2 / Ni, $NaBH_4$, Oxidation: bromine water, HNO_3, HIO_4, acetylation, methylation 2.1.2 Amino acids and Proteins 2.1.2.1 α–Amino acids: General structure, configuration, essential, neutral, acidic and basic amino acids (systematic names with abbreviations), pH dependency of ionic structure and isoelectric point 2.1.2.2 Polypeptides and proteins: Nature of peptide bond, nomenclature and representation of peptides di and tri peptides) 2.1.2.3 Proteins: General idea of primary, secondary, tertiary and quaternary structure. 2.1.3 Nucleic acids Controlled hydrolysis of nucleic acids, sugars and bases in nucleic acids, Structures of nucleosides and nucleotides in DNA and RNA. Structures of nucleic acis (DNA and RNA including base pairing) 2.1.4 Lipids Introduction and classification	
Module 3	**3.1Spectroscopy** 3.1.1 Introduction: Electromagnetic spectrum, units of wavelength and frequency 3.1.2 UV – Visible spectroscopy: Basic theory, solvents, nature of uv – visible spectrum, concept of chromophore, auxochrome, bathochromic and hypsochromic shifts,	**15L**

PRACTICAL I

	hyperchromic and hypochromic effects, chromophore – chromophore and chromophore – auxochrome interactions 3.1.3 IR spectroscopy: Basic theory, selection rule, nature of IR spectrum, characteristic vibrational frequencies of functional groups, finger print region. 3.1.4 PMR spectroscopy: Basic theory of PMR, nature of PMR spectrum, chemical shift, standard for PMR, solvents used. Factors affecting chemical shift: inductive effect and anisotropic effect, spin - spin coupling and coupling constant, application of deuterium exchange technique. 3.1.5 Spectral characteristic of the following classes of organic compounds including benzene and monosubstituted benzenes with respect to UV – Vis., IR and PMR: alkanes, alkenes, polynes, alkynes, haloalkanes, alcohols, carbonyl compounds, ethers, carboxylic acids, esters, amides, amines, amides (broad regions characteristic of different groups are expected) 3.1.6 Mass Spectrometry: Basic theory, nature of mass spectrum, general rules of fragmentation, importance of molecular ion peak, isotopic peaks, base peak, nitrogen rule. Fragmentation of alkanes an aliphatic carbonyl compounds including Mclafferty rearrangement 3.1.7 Problems on structure elucidation of simple organic compounds using individual combined use of the above spectroscopic techniques (Index of hydrogen deficiency expected).	
Module 4	**4.1 Organometallic Chemistry (7L)** 4.1.1 Introduction: Carbon metal bond: Nature, types and reactivity 4.1.2 Organomagnesium compounds: Grignard reagent: Preparation, structure and stability. Reactions with compounds containing acidic hydrogen, carbonyl compounds, CO_2, cyanides and epoxides. 4.1.3 Organolithium compounds: Preparation using alkyl / aryl halides. Reactions with compounds containing acidic hydrogen, alkyl halides, carbonyl compounds, CO_2, cyanides and epoxides. Lithium dialkyl cuprates: Preparation and reactions with aliphatic / aromatic / vinyl halides 4.1.4 Organozinc compounds: Reformatsky reaction and Simmon – Smith reaction with mechanism and applications **4.2 Pericyclic reactions (3L)**	**15L**

	4.2.1 Introduction 4.2.2 Electrocyclic , Sigmatropic and Cycloaddition reactions 4.2.3 Diels – Alder reaction **4.3 Polymer Chemistry (5L)** 4.3.1 Introduction: Review of terms– monomer, polymer, homopolymer, copolymer, thermoplastics and thermosets 4.3.2 Addition polymers: polyethylene, polypropylene, Teflon, polystyrene, PVC, uses recycling 4.3.3 Condensation polymers: polyesters, polyamides, polyurethanes, polycarbonates, phenol – formaldehyde resins, uses. 4.3.4 Mechanism of free radical addition polymerization 4.3.5 Stereochemistry of polymers: Tacticity, Mechanism of stereochemical control of polymerization using Ziegler Natta catalysts 4.3.6 Natural and synthetic rubbers: Polymerization of isoprene: 1,1 and 1,4 addition (cis and trans), Styrene – butadiene copolymer 4.3.7 Additives to polymers: Plasticizers, Stabilizers and fillers 4.3.8 Biodegradable polymers: Classification and uses. Polylactic acid – structure, properties and use for packaging and medical purposes. (Identification of monomer in a given polymer and structure of polymer from given monomer(s) is expected. Conditions for isomerisation not expected.	
	Practicals	**2**
	Preparation of an organic compounds, purification, measurement of mass and recording the m.p./b.p.(10 No.) a) Acetylation of Aniline/p-toluidine b) Nitration of nitrobenzene/Salicylic acid c) Methylation of β-Naphthol/α-Naphthol d) Bromination of Acetanilide e) Preparation of Schiff base with benzaldehyde with aniline and p-toluidine f) Acetylation of hydroquinone g) Hydrolysis of ethylbenzoate h) Hydrolysis of p-nitroacetanilide i) Oxidation of benzaldehyde/p-nitrobenzaldehyde 1. Checking the purity of the organic compounds with TLC (Thin Layer Chromatography)	

	2. Spectral Interpretation of organic compounds using FT-IR spectra 3. Separation of compounds by using Column Chromatography (β-Naphthol + m-dinitrobenzene)	

(If applicable)

Suggested Readings

1. Comprehensive Organic chemistry, Barton and Ollis, Vol 1

2. Organic Chemistry, J. Claydens, N. Greeves, S. Warren and P. Wothers, Oxford University Press.

3. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Part A and B, Plenum Press.

4. Stereochemistry: Conformation and Mechamism, P.S. Kalsi, New Age International, New Delhi.

5. Stereochemistry of carbon compounds, E.L Eliel, S.H Wilen and L.N Manden, Wiley.

6. Stereochemistry of Organic Compounds- Principles and Applications, D. Nasipuri. New International Publishers Ltd.

7. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Michael B. Smith, Jerry March, Wiley.

8. Mechanism in Organic Chemistry, Peter sykes, 6th edition onwards.

9. Modern Methods of Organic Synthesis, W. Carruthers and Iain Coldham, Cambridge University Press.

10. Organic Synthesis, Jagdamba Singh, L.D.S. Yadav, Pragati Prakashan

11. Advanced Organic Chemistry: Reactions and mechanism, B. Miller and R. Prasad, Pearson Education.

12. Advanced Organic Chemistry: Reaction mechanisms, R. Bruckner, Academic Press.

13. Understanding Organic Reaction Mechanisms, Adams Jacobs, Cambridge University Press.

14. Writing Reaction Mechanism in organic chemistry, A. Miller, P.H. Solomons, Academic Press.

15. Principles of Organic Synthesis, R.O.C. Norman and J.M Coxon, Nelson Thornes.

16. Advanced Organic Chemistry: Reactions and mechanism, L.G. Wade, Jr., Maya Shankar Singh, Pearson Education.

17. Organic Synthesis- The Disconnection Approach, Stuart Warren, Wiley Publication

18. Introduction to Spectroscopy, Donald L. Pavia. Gary M. Lampman. George S. Kriz,

19. Spectrometric Identification of Organic Compounds, R. M. Silverstein, F. X. Webster,

D. J. Kiemle, John Wiley and Sons

20. Text book of polymer science by Fred Billmeyer, Wiley Publication

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: B.Sc. Chemistry				**Semester: VI**	
Course: Analytical Chemistry				**Course Code: USMACH604**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Lectures per week)	**Practical** (Lectures per week)	**Tutorial** (Lectures per week)	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	2	NIL	4 + 2	10 + 15	75

Learning Objectives:

To familiarize the student Electroanalytical methods, the various methods of separation. Use of titrimetric analysis for qualitative and quantitative analysis in Various fields.methods used in industries.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: To introduce aspects of analytical chemistry with the newer, more instrumental aspects of the subject in order to present various analytical methods that are currently utilised.

CO2:To produce quality that takes a relatively small fraction of the time allocated to undergraduate training.

CO3:To introduce integrates analysis in other branches of science and exemplifies their application

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Lectures**
1	1.1 Electroanalytical methods.	15
2	2.1 Methods of separation-II	15
3	3.1 Treatment of analytical data-II 3.2 Titrimetric analysis-II	15
4	4.1 Concepts in Quality and miscellaneous methods	15
	Total	**60**
PRACTICALS		

Unit		No. of Hours/Credits
Module 1	**1.Electroanalytical methods** **1.1 Ion selective electrode (3L)** Classifications of ion selective electrodes, glass electrode, fluoride electrode **1.2 D.C. Polaroghraphy (9L)** Polarizable and nonpolarizable electrodes, basic principles, residual current, diffusion current, limiting current, dropping mercury electrode, supporting electrolyte half wave potential, derivation of the polarographic wave equation for a reversible reaction. Ilkovic equation, oxygen interference and its removal, maxima and maxima suppressors, polarographic cell, qualitative and quantitativeanalysis, calibration curve and standard addition method, applications. [Numerical problems expected] **1.3 Amperometric Titrations (3L)** Basic principles, rotating platinum electrode and nature of the titration curves, applications, advantages and limitations.	**15L**
Module 2	**2. Methods of separation-II** **2.1 GasChromatography (6L)** Gas liquid chromatography, basic principles retention time, retention volume, resolution, peak width theoretical plates. HETP, instrumentation, columns, detectors, applications. **2.2 High Performance Liquid Chromatography (4L)** Instrumentation, types of elution, U.V. and I.R. detector and applications **2.3 Ion Exchange Chromatography (5L)** Types of ion exchangers, mechanism of ion exchange, selectivity coefficients and separation factors, capacity and its determination, factors affecting the separation of ions, applications.	**15L**
Module 3	**Treatment of analytical data-II and Titrimetric analysis-II**	**15L**

	3.1 Treatment of Analytical Data (6L) Distribution of random errors, Gaussian curve, students' t, confidence limits and confidence interval, criteria for rejection of result: 2.5d rule,4.0d rule and Q test, F-test, testing for significance, null hypothesis, method of averages, least squares method. Numerical problems expected] **3.2 Complexometric Titrations (4L)** General introduction, EDTA titrations, advantages and limitations of EDTA as the titrant, absolute and conditional formation constants of metal EDTA complexes, construction of titration curves, types of EDTA titrations,methods of increasing the selectivity of EDTA as a titrant, metallochromic indicators, theory and applications. **3.3 Redox Titrations (3L)** General introduction, theory of redox indicators, criterion for choosing an indicator for a redox titration, construction of the titration curves in the case of (1) Fe (II) Vs. Ce(IV) (2) Fe (II) Vs. dichromate, use of diphenyl amine and ferroin as redox indicators. **3.4 Non-aqueous titrations (2L)** Need for non-aqueous titration, types of solvents, factors deciding choice of solvent, solvents used, and applications.	
Module 4	**4. Concepts in Quality and miscellaneous methods (15L)** **4.1 Total quality management (5L)** concept of quality, quality control, quality assurance total quality management, ISO series, Good laboratory practices **4.2 Mass Spectrometry (2L)** Basic principles, introduction of components only **4.3 Thermal Methods (5L)** Classification of thermal methods, thermo-gravimetricanalysis,basic principles, instrumentation factors affecting the TG curve, applications **4.4 Introduction to Radio Analytical Techniques (3L)** Classification of the techniques, introduction to neutron activation analysis and its applications.	**15L**
	Practicals	**2**

	1. Determination of glucose content of a honey sample by Wilstater's method . 2. Determination of percentage purity of a sample of common salt using a cation exchanger. 3.Estimation of Magnesium content in talcum powder.. 4. Determination of acetic acid content of a vinegar sample by potentiometric titration with sodium hydroxide using quinhydrone. 5. Determination of Cr (VI) in the water sample spectrophotometrically by using Diphenylcarbazide. 6. Determination of phosphoric acid in cola sample pH metrically.	

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

PRACTICAL I
(If applicable)

Suggested Readings

9) Analytical Chemistry Skoog, West, Holler, 7th Edition.
10) A premier sampling solids, liquids and gases, Smith Patricia I, American statistical association and the society for industrial and applied mathematics, (2001).
11) A guide to Quality in Analytical Chemistry: An aid to accreditation, CITAC and EURACHEM, (2002),
12) Quality control and Quality assurance in Analytical Chemical Laboratory, Piotr Konieczka and Jacek Namiesnik, CRC press (2018)

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: B.Sc. Chemistry				**Semester: VI**	
Course: Dyes				**Course Code: USMACH605**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Lectures per week)	**Practical (Lectures per week)**	**Tutorial (Lectures per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	2		4 + 2	10 + 15	75

Learning Objectives:

Students will explore to Fundamental chemistry involved in dyes. Different types of fibres and dyes used for dyeing of fibres. Classification of dyes, their hazards and remedies. Synthesis of dye intermediates.

Course Outcomes:

CO1: Understand basics terms, classifications and nomenclatures used in dyestuff chemistry.
CO2: Understand the difference between dyes used for various applications.
CO3:Differentiate between dyes and pigments, lakes and tonners.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Lectures**
1	1.1 Introduction to Dyestuff Chemistry 1.2 Classification of dyes based on constitution 1.3 Classification Based on Application	15
2	2.1 Colour and chemical constitution of dyes 2.2 Non-textile Uses of Dyes 2.3 Optical Brighteners 2.4 Organic Pigments	15
3	**3.1** Chemistry of Dye Intermediates 3.2Preparation of the following Intermediates 3.3 Dyeing Method of Cotton Fibres	15
4	4.1Synthesis of Specific Dyes and their Uses 4.2Types of Fibres and Classes of Dyes Applicable to them	15
	Total	**60**
PRACTICALS		

Unit	Topic	No. of Hours/Credits
Module 1	**1.1 Introduction to Dyestuff Chemistry (5L)** 1.1.1 Important landmark in the history of dyes 1.1.1.1 Natural colouring matter and their limitations:e.g,; Heena, Turmeric, kesar, Chlorolphyll, Indigo, Alizarine from roots of madder plants, Logwood. Tyrian Purple. 1.1.1.2 Synthetic Dyes: Important milestones, i.e. Mauve, Diazotization, aniline Yellow, Congo Red, Synthesis and structure of Indigo, disperse Dye, fluorescent Brighteners, procion reactive Dyes, Remazole Dyes. (Emphasis on Name of the Scientist and dyes and the year of the discovery is required and structure is not expected 1.1.2 Defination of dyes, Properties i.e. colour, Chromophore and Auxochrome, Solubility, Linearity, Coplanarity, fastness properties, substantivity, Economic viability 1.1.3 Explanation of nomenclature of commercial dyes with atleast one example .suffixes-G, O, R, B, 6B, GK, 3GK, 6GK, L, S Explanation: naming of dyes by colour index(two examples) **1.2.Classification of dyes based on constitution (**3L) (Examples are mention below with structures) (i) Nitro Dyes-Napyhol yellow S (ii) Nitroso Dye-Gambine Y (iii) Azo Dyes- (a) Monoazo Dyes- Metanil yellow (b) DiazoDyes- Napthol Blue Black (c) Triazodyes - Chloroamine Green B (iv) Diphenymethane Dyes-Auramine G (v) Triphenyl methane Dyes (a) Malachite Green Series- Naphthalene green V (b) Magenta Series- Acid Magenta (c) Rosolic acid Series-Chrome Violet (vi) Heterocyclic Dyes (a) Xanthene-Rhodamine 6G (b) Acridines-Acriflavine (c) Azines- SafranineB (d) Oxazines- Capri blue (e) Thiazines-Methylene Green (f) Quiolines- Quinoline Yellow (g) Thiazoles-Primuline (vii) Benzoquinones and naphthaquinones- Napthazarin (viii) Anthraquinone Dyes- Indanthrene, Turquoise Blue 3GK (ix) Indigoids-Indigo Caramine	**15L**

	(x) Pthacyanines-Sirius Light green FFGL **1.3 Classification Based on Application (6L)** Definition, fastness properties & applicability on substrates examples with structures (a) Acid Dyes- Orange II, (b) Basic Dyes-methyl violet, Victoria Blue B (c) Direct cotton Dyes- Benzofast Yellow 5GL (d) Azoic Dyes-Diazo components; Fast yellow G,Fast orange R. Coupling components. Naphtol AS, Naphthol ASG (e) Mordant Dyes-Erichrome Black A, Alizarin (f) Vat Dyes- Indanthrene brown RRD, Indanthrene Red 5GK (g) Sulphur Dyes- Sulphur Black T (no structure) (h) Disperse Dyes-Celliton Fast brown 3R, perlon fast blue FFR (i) Reactive Dyes cibacron Brilliant Red B, procion brilliant Blue HB.	
Module 2	**2. 1 Colour and chemical constitution of dyes (5L)** 2.1.1 Absorption of visible light, colour of wavelength absorbed, complementary colour. 2.1.2 relation between colour and chemical constitution. (i) Armstrong theory (quinonoid theory) and its limitations (ii) Valence Bond theory; Comparative study and relation of colour in the following classes of compounds/dyes: Benzene, Nitrobenze, Nitroanilines, Nitrophenols, Benzoquinones, Azo, Triphenyl methane, Anthraquinones. (iii) Molecular Orbital Theory. **2 (6L)** Structural features of the substrate, fastness and other property requirements and main classes of dyes used to be mentioned as applicable. (Two examples with structures for each of the following.) 1) Leather 2) Paper 3) Foodstuff 4) Cosmetics 5) Medicinal 6) Biological Stains 7) Indicator & Analytical Reagents 8) Coloured Smokes & Camouflage colours 9) Laser Dyes **2.3 Optical BrightenerS (2L)** General idea and important characteristics of optical brighteners, one example each with structure of the following classes: Stilbene, Coumarin, Heterocyclic vinylene derivatives, Diaryl pyrazolines, Naphthalimide derivatives. **2.4 Organic Pigments (2L)**	**15L**

	General idea, distinguish between dyes and pigments, important characteristics of organic pigments, Toners, Lakes, Classification of organic pigments with suitable examples, i.e. Ionic pigments-Lake of acid and basic dyes. Nonionic pigments-Azo, Indigoid, Anthraquinone, Quinacridone, Phthalocyanine (Copper phthalocyanine).	
Module 3	**3.1 Chemistry of Dye Intermediates (11L)** 3.1 A brief idea of Unit processes 3.1.1 Introduction of primary intermediates, unit processes 3.1.2 (a) Nitration (b) Sulphonation (c) Halogenation (d) Diazotization : 3 different methods, importance (e) Ammonolysis (f) Oxidation N.B.: Definition, Reagents Examples with reaction conditions (mechanism is not expected) **3.2 Preparation of the following Intermediates. (9L)** 3.2.1 Benzene derivatives: Benzenesulphonic acid; 1,3-Benzenedisulphonic acid; phenol; resorcinol; sulphanilic acid; o-,m- ,p-chloronitrobenzenes; o-,m-,pnitroanilines; o-,m-p- phenylene diamines; Naphthol ASG. 3.2.2 Naphthalene derivatives: α,β- Naphthols; α,β-Naphthylamines; Schaeffer acid, Tobias acid; Naphthionic acid; N.W. acid; Clev-6-acid; H acid; Naphthol As. 3.2.3 Anthracene derivatives: 1-Nitroanthraquinone; 1-Aminoanthraquinone; 2-Aminoanthraquinone; 2-Methylanthraquinone; anthraquinone-1-sulphonic acid; Anthraquinnone-2-sulphonic acid; 1-Chloroanthraquinone; Chloroanthraquinone; Benzanthrone **3.3 Dyeing Method of Cotton Fibres (3L)** 3.3.1 (i) Direct dyeing (ii) Vat dyeing (iii) Mordant dyeing (iv) Disperse dyeing 3.3.2 Forces binding of dyes to the fibres: Ionic forces, Hydrogen bonds, Van-der-Wall's forces, Covalent linkages.	**15L**
Module 4	**4.1 Synthesis of Specific Dyes and their Uses (12L)** (i) Orange IV from sulphanilic acid (ii) Eriochrome Black T from β- naphthol	**15L**

	(iii) Eriochrome Red B by using ethyl aceto acetate and 1-amino-2- naphthol-4-sulphonic Acid. (iv) Direct Deep Black EW by using benzidine, H acid, aniline, and m-phenylen diamine. (v) Congo Red from nitrobenzene vi) Diamond Black F by using 5- amino salicylic acid, N.W. acid and α-naphthylamine. (vii) Malachite Green by using benzaldehyde and N,Ndimethylaniline. (viii) Auramine O from dimethylaniline (ix) Methylene Blue by using 4- amino-N,N-dimethylaniline and N,N-dimethylaniline (x) Safranine T by using otoluidine and aniline (xi) Pararosaniline by using ptoluidine and aniline (xii) Alizarine Cyanine Green G by using phthalic anhydride and pcholorophenol (xiii) Indanthrene from anthraquinone (xiv) Disperse Yellow 6G from benzanthrone (xv) Indigo from aniline (xvi) Eosine by using phthalic anhydride and resorcinol (xvii) Bismark Brown from mphenylenediamine. **4.2 Types of Fibres and Classes of Dyes Applicable to them (1L)** Introduction to the following types of fibres with structures and classes of dyes applicable to it. Cotton, Wool, Silk, Polyester. **4.3 Ecology and Toxicity of Dyes (2L)** With reference to the textile dyes, food colours, benzidine etc.	
	Practicals	**2**
	I) Dye Preparation: 1) Preparation of Orange-II **II) Dyes Estimation:** 1. Estimation of Primary amino group by diazotisation **III) Drug Estimation:** 1. Estimation of Ibuprofen 2. Estimation of Acid neutralizing capacity of a drug **IV)** Preparation of monogram of any one drug from syllabus by I.P. method. **V)Dyes Preparations:** 1) Preparation of m-dinitrobenzene 2) Preparation of m-nitroaniline **VI) Dye Estimation:** 1. Estimation of Methyl Orange/ Eriochrome	

	Black T/Eosin/Congo Red by colorimetry	

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

PRACTICAL I
(If applicable)

Suggested Readings

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