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: M.Sc.

Course: General Chemistry

Semester I

Credit Based Choice System (CBCS) with effect from the Academic year 2021-22

PROGRAMME SPECIFIC OUTCOMES (PSO'S)

On completion of the **M.Sc.-General Chemistry**, the learners should be enriched with knowledge and be able to-

PSO1: gain complete knowledge about all fundamental aspects of all the elements of different branches of chemistry.

PSO2: develop analytical thinking and apply the same for the understanding of underlining principles, proposing mechanism, problem solving, identification of chemical species, derivation process, conductometric and potentiometric analysis and arriving to logical conclusion.

PSO3: understand the background of organic reaction mechanisms, complex chemical structure, and molecular rearrangements.

PSO4: gain knowledge in classical laboratory techniques and be able to use modern sophisticated instrumentation, so that they can perform new experiments, obtain experimental data and its spectral interpretation through theoretical principals.

PSO5: integrate knowledge learned in chemistry to various industry and pharmaceutical needs.

PSO6: learn about the potential uses of medicinal chemistry and green chemistry.

PSO7: create an awareness of the impact of chemistry on the environment, society and development outside the scientific community.

PSO8: develop research oriented skills and to inculcate the scientific temperament in the students.

Preamble

The purpose of post-graduate education in science is to create highly skilled manpower in specific areas, which will lead to generation of new knowledge and creation of wealth for the country. Chemistry is a fundamental science and has contributed immensely to the improvement of the life of human beings by providing many of human requirements and essentialities. The credit system has been adopted for all these courses, which would allow students to develop a strong foundation in the fundamentals and specialize in the disciplines of his/her liking and abilities. The courses are designed so that the students pursuing these courses will obtain fundamental knowledge about the subject in the respective specialization. The students are also expected to get corresponding experimental training during the practical courses.

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:

a) Details of Continuous Assessment (CA)

25% of the total marks per course:

Continuous Assessment	Details	Marks
Component 1 (CA-1)	Test	15 marks
Component 2 (CA-2)	Assignment	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
1	Attempt any Three out of Five	15 Marks	15 Marks
2	Attempt any Three out of Five	15 Marks	15 Marks
4	Attempt any Three out of Five	15 Marks	15 Marks
4	Attempt any Three out of Five	15 Marks	15 Marks
5	Attempt any Three out of Four	15 Marks	15 Marks
		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: M.Sc. General Chemistry				**Semester : I**	
Course : Physical Chemistry				**Course Code: PSMACHG101 A**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	4	N/A	4 + 2	15 +10	75

Learning Objectives:

The objective of the course is to introduce students to orient learner about the importance, theory and principles of physical chemistry and to teach about the various applications of physical chemistry to understand the physical phenamenon.

Course Outcomes:

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

CO1: Interpret the state functions and exact differentials, the student will be able to solve the problems.

CO2: Derive the Maxwell equation

CO3: Describe the Maxwell thermodynamic Relations and its significance and applications to ideal gases.

CO4: Understand classical mechanics, failure of classical mechanics, Need for Quantum Mechanics

CO5: Describe Debye-Huckel equation, limiting and extended forms.

CO6: Explain operators and their algebra, linear and Hermitian operators, operators for the dynamic variables of a system

CO7: Discuss membrane potentials, theory of membrane potentials, interfacial electron transfer in biological systems

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Thermodynamics-I**	**15 L**
2	**Quantum Chemistry**	**15 L**
3	**Quantum Chemistry-II**	**15 L**
4	**Electrochemistry**	**15 L**
	Total	**60 L**
PRACTICALS		

DETAILED SYLLABUS		
Modules	**Topics**	**Duration (Lecture)**
Module-I	**Thermodynamics-I**	**15L**
	1.1. State function and exact differentials. Maxwell equations, Maxwell thermodynamic Relations; it's significance and applications to ideal gases, Joule Thomson experiment, Joule Thomson coefficient, inversion temperature, Joule Thomson coefficient in terms of van der Waals constants. 1.2. Third law of Thermodynamics, Entropy change for a phase transition, absolute entropies, determination of absolute entropies in terms of heat capacity, standard molar entropies and their dependence on molecular mass and molecular structure, residual entropy.	
Module-II	**Quantum Chemistry**	**15L**
	2.1. Classical Mechanics, failure of classical mechanics: Need for Quantum Mechanics. 2.2. Particle waves and Schrödinger wave equation, wave functions, properties of wave functions, Normalization of wave functions, orthogonality of wave functions. 2.3. Operators and their algebra, linear and Hermitian operators, operators for the dynamic variables of a system such as, position, linear momentum, angular momentum, total energy, eigen functions, eigen values and eigen value equation, Schrödinger wave equation as the eigen value equation of the Hamiltonian operator, average value and the expectation value of a dynamic variable of the system, Postulates of Quantum Mechanics, Schrodinger's Time independent wave equation from Schrodinger's time dependent wave equation. 2.4. Application of quantum mechanics to the following systems: a) Free particle, wave function and energy of a free particle. b) Particle in a one, two and three dimensional box, separation of variables, Expression for the wave function of the system, expression for	

	the energy of the system, concept of quantization, introduction of quantum number, degeneracy of the energy levels. c) Harmonic oscillator, approximate solution of the equation, Hermite polynomials, expression for wave function, expression for energy, use of the recursion formula.	
Module-III	**Quantum Chemistry-II**	**15L**
	3.1 Rigid rotor, spherical coordinates Schrödinger wave equation in spherical coordinates, separation of the variables, the phi equation, wave function, quantum number, the theta equation, wave function, quantization of rotational energy, spherical harmonics. 3.2 Hydrogen atom, the two particle problem, separation of the energy as translational and potential, separation of variables, the R the θ * and the ϕ equations, solution of the equation, introduction of the four quantum numbers and their interdependence on the basis of the solutions of the three equations, total wave function, expression for the energy, probability density function, distances and energies in atomic units, radial and angular plots., points of maximum probability, expressions for the total wave function for 1s,2s, 2p and 3d orbitals of hydrogen 3.3 Application of the Schrödinger equation to two electron system, limitations of the equation, need for the approximate solutions, methods of obtaining the approximate solution of the Schrödinger wave equation.	
Module-IV	**Electrochemistry**	**15L**
	Recapitulation – basics of electrochemistry. 4.1. Debye-Hückel theory of activity coefficient, Debye-Hückel limiting law and it's extension to higher concentration (derivations are expected). 4.2. Electrolytic conductance and ionic interaction, relaxation effect,. Debye-Hückel- Onsager equation (derivation expected). Validity of this equation for aqueous and non- aqueous solution, deviations from Onsager equation, Debye -Falkenhagen effect (dispersion of conductance at high frequencies), Wien effect.	

	4.3. Batteries: Alkaline fuel cells, Phosphoric acid fuel cells, High temperature fuel cells [Solid –Oxide Fuel Cells (SOFC) and Molten Carbonate Fuel Cells] 4.4. Bio-electrochemistry: Introduction, cells and membranes, membrane potentials, theory of membrane potentials, interfacial electron transfer in biological systems, adsorption of proteins onto metals from solution, electron transfer from modified metals to dissolved protein in solution, enzymes as electrodes, electrochemical enzyme-catalysed oxidation of styrene. Goldmann equation. (Derivations are expected)	

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

PRACTICAL I

Course code: PSMACHG1P1

Non – Instrumental:

1. To determine the heat of solution (ΔH) of a sparingly soluble acid (benzoic /salicylic acid) from solubility measurement at three different temperature.
2. To study the variation of calcium sulphate with ionic strength and hence determine the thermodynamic solubility product of $CaSO_4$ at room temperature.
3. To investigate the reaction between acetone and iodine.
4. To study the variation in the solubility of $Ca(OH)_2$ in presence of NaOH and hence to determine the solubility product of $Ca(OH)_2$ at room temperature.
5. Graph Plotting of mathematical functions –linear, exponential and trigonometry and identify whether functions are acceptable or non-acceptable?

Instrumental:

1. To determine the mean ionic activity coefficient of an electrolyte by e.m.f. measurement.
2. To study the effect of substituent on the dissociation constant of acetic acid conductometrically.
3. To determine pKa values of phosphoric acid by potentiometric titration with sodium hydroxide using glass electrode.
4. To verify Ostwald's dilution law and to determine the dissociation constant of a weak mono-basic acid conductometrically.

Textbooks				
Priority Sr. No	**Author**	**Title**	**Edition/ Year of Publication**	**Publisher**
1	Puri, Sharma, Pathania	Principles of Physical Chemistry	2012	Jatandhar (Vishal Pub)
2	Donald A McQuarrie	Quantum Chemistry	2nd Edition	University Science Books California
3	John O'. M, Bockris, Amulya, K. N. Reddy and Maria Gamboa-Aldeco	Modern Electrochemistry 2B	2nd Edition	Kluwer Academic publisher

Suggested reading

Priority Sr. No	**Author**	**Title**	**Edition/ Year of Publication**	**Publisher**
1	John O'. M, Bockris, Amulya, K. N. Reddy and Maria Gamboa-Aldeco	Modern Electrochemistry 2A	2nd Edition	Kluwer Academic publisher
2	Horia Meithu	Physical Chemistry-Quantum Mechanics	1st Edition 2006	Garland Science
3	Anantharaman R	Fundamentals of quantum chemistry	2001	McMillan India Ltd
4	Glasstone Samuel	Thermodynamics for chemists	1992	East west press
5	Arun Bahl and Bahl	Essentials of Physical Chemistry	2020	S. Chand
6	Peter Atkin	Elements of Physical Chemistry	4th Edition	Oxford University Press

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

Program: M.Sc. General Chemistry				**Semester : I**	
Course : Inorganic Chemistry				**Course Code: PSMACHG102 A**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	4	N/A	4 + 2	15 +10	75

Learning Objectives:

The objective of the course is to provide in-depth knowledge of Molecular Orbital Theory for polyatomic species considering σ bonding etc., concepts of group theory. Spectral calculations in metal complexes, new concepts of Solid state chemistry, types of nanomaterials, properties and its morphology.

Course Outcomes:

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

CO1: Understand the molecular orbital theory for polyatomic species considering σ bonding in some molecules

CO2: apply Great Orthogonality Theorem in construction of character tables for point groups

CO3: interpret spectra of metal complexes using Orgel and Tanabe-Sugano diagram

CO4: develop sound foundation in application of electronic structure of solids and band theory.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Chemical Bonding**	**15 L**
2	**Molecular Symmetry and Group Theory**	**15 L**
3	**Materials Chemistry and Nanomaterials**	**15 L**
4	**Characterization of Coordination compounds**	**15 L**
	Total	**60 L**
PRACTICALS		

DETAILED SYLLABUS		
Modules	**Topics**	**Duration (Lecture)**
Module-I	**Chemical Bonding**	**15L**
	1.1 Recapitulation of hybridization Derivation of wave functions for sp, sp^2,sp^3 orbital hybridization types considering only sigma bonding. **1.2** Discussion of involvement of d orbitals in various types of hybridizations. Concept of resonance, resonance energy derivation expected. Formal charge with examples. **1.3** Molecular Orbital Theory for diatomic species of First transition Series. **1.4** Molecular Orbital Theory for Polyatomic species considering σ bonding for SF_6, CO_2, B_2H_6, I_3^- molecular species. **1.5** Weak forces of attraction: Hydrogen bonding – concept, types, properties, methods of detection and importance. Van der Waal's forces, ion-dipole, dipole-dipole, London forces.	
Module-II	**Molecular Symmetry and Group Theory**	**15L**
	2.1. Symmetry criterion of optical activity, symmetry restrictions on dipole moment. A systematic procedure for symmetry classification of molecules. **2.2.** Concepts of Groups, Sub-groups, Classes of Symmetry operations, Group Multiplication Tables. Abelian and non-Abelian point groups. **2.3.** Representation of Groups: Matrix representation of symmetry operations, reducible and irreducible representations. The Great Orthogonality Theorem and its application in construction of character tables for point groups C_{2v}, C_{3v} and D_{2h}, structure of character tables	

	2.4. Applications of Group Theory (a) Symmetry adapted linear combinations (SALC), symmetry aspects of MO theory, sigma bonding in AB_n (Ammonia, CH_4) molecule. (b) Determination of symmetry species for translations and rotations. (c) Mulliken's notations for irreducible representations. (d) Reduction of reducible representations using reduction formula. (e) Group-subgroup relationships. (f) Descent and ascent in symmetry correlation diagrams showing relationship between different groups.	
Module-III	**Materials Chemistry and Nanomaterials**	**15L**
	3.1 Solid State Chemistry **3.1.1** Electronic structure of solids and band theory, Fermi level, K Space and Brillouin Zones. **3.1.2** Structures of Compounds of the type: AB [nickel arsenide (NiAs)], AB_2 [fluorite(CaF_2) and anti-fluorite structures, rutile (TiO_2) structure and layer structure[cadmium chloride and iodide ($CdCl_2$, CdI_2)]. **3.1.3** Methods of preparation for inorganic solids: Ceramic method, precursor method, sol-gel method (applications in Biosensors), microwave synthesis (discussion on principles, examples, merits and demerits are expected) **3.2** Nanomaterials, type of nano-materials, classification **3.2.1** Preparative methods: chemical methods, solvothermal, combustion synthesis, microwave, co-precipitation, Langmuir Blodgett (L-B) method. Biological methods: synthesis using microorganisms. **3.2.2** Morphology of nanomaterials, some important properties of nanomaterials, optical, magnetic, electronic, structural and chemical	

	properties, Applications in the field of electronics, energy, space, toys, sports, defense, automobiles, cosmetics and medicine.	
Module-IV	**Characterization of Coordination compounds**	**15 L**
	4.1 Formation, thermal studies, Conductivity measurements, electronic spectral and magnetic measurements, IR, NMR and ESR spectroscopic methods. **4.2** Spectral calculations using Orgel and Tanabe-Sugano diagram, calculation of electronic parameters such as Δ, B, C, Nephelauxetic ratio. **4.3** Determination of formation constants of metal complexes (Overall and Stepwise): Comparative studies of Potentiometric and spectral methods.	

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

PRACTICAL II

Course code: PSMACHG1P2

Inorganic Preparations (Synthesis and Characterization)-

1) Bis (tetraethylammonium) tetrachloro Cuprate (II) $(Et_4N)_2[CuCl_4]$

2) Bis (tetraethylammonium) tetrachloro Cobaltate(II) $(Et_4N)_2[CoCl_4]$ (Any two from above preparations)

3) Bis (ethylenediammine) Copper (II) Sulphate $[Cu(en)_2]SO_4$

4) Hydronium dichlorobis(dimethylglyoximato) Cobaltate(III) $H[Co(dmgH)_2Cl_2]$

Instrumentation-

1) Determination of equilibrium constant by Slope intercept method for Fe^{+3}/ SCN^- system

2) Determination of Electrolytic nature of inorganic compounds by Conductance measurement.

Textbooks				
Priority Sr. No	**Author**	**Title**	**Edition/ Year of Publication**	**Publisher**
1	CATHERINE E HOUSECROFT and ALAN G SHARPE	Inorganic Chemistry	4th edition	Pearson
2	R. Gopalan	Concise Coordination Chemistry	2008	Vikas Publishing House
3	F.A. Cotton	Chemical applications of group theory	1992	Wiley

Suggested Readings

Priority Sr. No	**Author**	**Title**	**Edition/ Year of Publication**	**Publisher**
1	J D Lee	Concise Inorganic chemistry	1996	Chapman and Hall Publication
2	James E. Huheey, Ellen A Keiter, Richard L Keiter	Inorganic chemistry Principles of structure and reactivity	4th Edition	Harper Collins College Publication New York
3	Shriver D F	Inorganic chemistry	3rd Edition	Oxford University Press
4	B. D. Gupta, A. J. Elias	Organometallic and Bioinorganic chemistry	2nd Edition	CRC Publication
5	Gurudip Chatwal	Coordination Chemistry	1992	Himalaya Publishing House
6	B. Viswanathan	Nano materials	2010	Narosa Publication House
7	Narkhade	Chemistry of Material	2004	Nirali Publication
8	Winter Mark	Chemical bonding	2005	Oxford Science Pub

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

Program: M.Sc. General Chemistry				**Semester : I**	
Course : Organic Chemistry				**Course Code: PSMACHG103A**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	4	N/A	4 + 2	15 +10	75

Learning Objectives:

The objective of the course is to introduce students to physical organic chemistry , MOT, Nucleophilic substitution reactions, Aromaticity, Spectroscopy, Oxidation and Reduction.

Course Outcomes:

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

CO1: Understand the theory of ESR (Electron spin resonance) spectroscopy and calculation of number of signals appeared in the ESR spectra of organic radicals (paramagnetic substances) helps the students to identify the structure of the paramagnetic substances.

CO2: Learn the principles of molecular spectroscopy, Raman, Electronic and Mossbauer spectroscopy and their applications.

CO3: Explain the term symbols for linear molecules, selection rules characteristics of electronic transitions and different types of electronic transitions.

CO4: Introduces the basic principle and working of Proton and C^{13}NMR spectroscopy and Solve structural problems based on UV-Vis, IR, 1HNMR, 13CNMR and mass spectral data.

CO5: Explain other Advanced NMR techniques such as DEPT, NOE and 2D-NMR techniques like COSY, TOCSY, NOESY, ROESY, HMBC, HSQC and HMQC.

CO6: Interpret the 2D NMR spectra of the organic compounds.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Physical Organic Chemistry and MOT**	**15 L**
2	**Nucleophilic substitution reactions and Aromaticity**	**15 L**
3	**Spectroscopy**	**15 L**
4	**Oxidation and Reduction:**	**15 L**
	Total	**60 L**
PRACTICALS		

DETAILED SYLLABUS		
Modules	**Topics**	**Duration (Lecture)**
Module-I	**Physical Organic Chemistry and MOT**	**15L**
	1.1 Thermodynamic and kinetic requirements of a reaction: rate and equilibrium constants, reaction coordinate diagram, transition state (activated complex), nature of activated complex, Hammond postulate, Reactivity *vs* selectivity, Curtin-Hammett Principle, Microscopic reversibility, Kinetic *vs* thermodynamic control of organic reactions. **1.2 Determining mechanism of a reaction:** Product analysis, kinetic studies, use of isotopes (Kinetic isotope effect – primary and secondary kinetic isotope effect). Detection and trapping of intermediates, crossover experiments and stereochemical evidence. **1.3. Acids and Bases:** Factors affecting acidity and basicity: Electronegativity and inductive effect, resonance, bond strength, electrostatic effects, hybridization, aromaticity and solvation. Comparative study of acidity and basicity of organic compounds on the basis of pKa values, Leveling effect and non-aqueous solvents. Acid and base catalysis – general and specific catalysis with examples. **1.4 Molecular orbitals:** Formation of σ- and π-MOs by using LCAO method. Formation of π MOs of ethylene, butadiene, 1, 3, 5-hexatriene, allylcation, anion and radical. Concept of nodal planes and energies of π-MOs **1.5 Introduction to FMOs:** HOMO and LUMO and significance of HOMO-LUMO gap in absorption spectra as well as chemical reactions. MOs of formaldehyde: The effect of electronegativity perturbation and orbital polarization in formaldehyde. HOMO and LUMO (π and π* orbitals) of formaldehyde. A brief description of MOs of nucleophiles and electrophiles. Concept of 'donor-acceptor' interactions in nucleophilic addition reactions on formaldehyde.	

	Connection of this HOMO-LUMO interaction with 'curved arrows' used in reaction mechanisms. The concept of hardness and softness and its application to electrophiles and nucleophiles. Examples of hard and soft nucleophiles/ electrophiles. Identification of hard and soft reactive sites on the basis of MOs. **1.6** Application of FMO concepts in (a) S_N2 reaction, (b) Lewis acid base adducts (BF_3NH_3 complex), (c) ethylene dimerization to butadiene, (d) Diels-Alder cycloaddition, (e) regioselective reaction of allylcation with allyl anion (f) addition of hydride to formaldehyde.	
Module-II	**Nucleophilic substitution reactions and Aromaticity**	**15L**
	2.1. Nucleophilic substitution reactions: **2.1.1. Aliphatic nucleophilic substitution:** S_N1, S_N2, S_N^i reactions, mixed S_N1 and S_N2 and SET mechanisms. S_N reactions involving NGP - participation by aryl rings, α and pi-bonds. Factors affecting these reactions: substrate, nucleophilicity, solvent, steric effect, hard-soft interaction, leaving group. Ambident nucleophiles. S_NCA, S_N1' and S_N2' reactions. S_N at sp^2 (vinylic) carbon. **2.1.2. Aromatic nucleophilic substitution:** S_NAr, S_N1, benzyne mechanisms. Ipso, cine, tele and vicarious substitution. **2.1.3. Ester hydrolysis:** Classification, nomenclature and study of all eight mechanisms of acid and base catalyzed hydrolysis with suitable examples. **2.2. Aromaticity:** **2.2.1.** Structural, thermochemical, and magnetic criteria for aromaticity, including NMR characteristics of aromatic systems. Delocalization and aromaticity. **2.2.2.** Application of HMO theory to monocyclic conjugated systems. Frost-Musulin diagrams. Huckel's (4n+2) and 4n rules. **2.2.3.** Aromatic and antiaromatic compounds up-to 18 carbon atoms. Homoaromatic compounds. Aromaticity of all benzenoid systems,	

	heterocycles, metallocenes, azulenes, annulenes, aromatic ions and Fullerene (C_{60})	
Module-III	**Spectroscopy**	**15L**
	3.1 Ultraviolet spectroscopy: Recapitulation, UV spectra of dienes, conjugated polyenes (cyclic and acyclic), carbonyl and unsaturated carbonyl compounds, substituted aromatic compounds. Factors affecting the position and intensity of UV bands – effect of conjugation, steric factor, pH, and solvent polarity. Calculation of absorption maxima for above classes of compounds by Woodward-Fieser rules (using Woodward-Fieser tables for values for substituents). **3.2 Infrared spectroscopy:** Fundamental, overtone and combination bands, vibrational coupling, factors affecting vibrational frequency (atomic weight, conjugation, ring size, solvent and hydrogen bonding). Characteristic vibrational frequencies for alkanes, alkenes, alkynes, aromatics, alcohols, ethers, phenols, amines, nitriles and nitro compounds. Detailed study of vibrational frequencies of carbonyl compounds, aldehydes, ketones, esters, amides, acids, acid halides, anhydrides, lactones, lactams and conjugated carbonyl compounds. **3.3 Proton magnetic resonance spectroscopy:** Principle, Chemical shift, Factors affecting chemical shift (Electronegativity, H-bonding, Anisotropy effects). Chemical and magnetic equivalence, Chemical shift values and correlation for protons bonded to carbon and other nuclei as in alcohols, phenols, enols, carboxylic acids, amines, amides. Spin-spin coupling, Coupling constant (J), Factors affecting J, geminal, vicinal and long range coupling (allylic and aromatic). First order spectra, Karplus equation. **3.4 ^{13}C NMR spectroscopy:** Theory and comparison with proton NMR, proton coupled and decoupled spectra, off-resonance decoupling. Factors influencing carbon shifts, correlation of	

	chemical shifts of aliphatic, olefin, alkyne, aromatic and carbonyl carbons. **3.5 Mass spectrometry:** Molecular ion peak, base peak, isotopic abundance, metastable ions. Nitrogen rule, Determination of molecular formula of organic compounds based on isotopic abundance and HRMS. Fragmentation pattern in various classes of organic compounds (including compounds containing hetero atoms), McLafferty rearrangement, Retro-Diels-Alder reaction, ortho effect. **3.6** Structure determination involving individual or combined use of the above spectral techniques.	
Module-IV	**Oxidation and Reduction:**	**15L**
	4.1. Oxidation: General mechanism, selectivity, and important applications of the following: **4.1.1. Dehydrogenation:** Dehydrogenation of C-C bonds including aromatization of six membered rings using metal (Pt, Pd, Ni) and organic reagents (chloranil, DDQ). **4.1.2. Oxidation of alcohols to aldehydes and ketones:** Chromium reagents such as $K_2Cr_2O_7/H_2SO_4$ (Jones reagent), CrO_3-pyridine (Collin's reagent), PCC (Corey's reagent) and PDC (Cornforth reagent), hypervalent iodine reagents (IBX, Dess-Martin periodinane). DMSO based reagents (Swern oxidation), Corey-Kim oxidation - advantages over Swern and limitations; and Pfitzner-Moffatt oxidation-DCC and DMSO and Oppenauer oxidation. **4.1.3. Oxidation involving C-C bonds cleavage:** Glycols using HIO_4; cycloalkanones using CrO_3; carbon-carbon double bond using ozone, $KMnO_4$, CrO_3, $NaIO_4$ and OsO_4; aromatic rings using RuO_4 and $NaIO_4$. **4.1.4. Oxidation involving replacement of hydrogen by oxygen:** oxidation of CH_2 to CO by SeO_2, oxidation of arylmethanes by CrO_2Cl_2 (Etard oxidation).	

	4.1.5. Oxidation of aldehydes and ketones: with H_2O_2 (Dakin reaction), with peroxy acid (Baeyer-Villiger oxidation) **4.2. Reduction:** General mechanism, selectivity, and important applications of the following reducing reagents: **4.2.1. Reduction of CO to CH_2 in aldehydes and ketones-** Clemmensen reduction, Wolff Kishner reduction and Huang-Minlon modification. **4.2.2. Metal hydride reduction:** Boron reagents ($NaBH_4$, $NaCNBH_3$, diborane, 9-BBN, $Na(OAc)_3BH$, aluminium reagents ($LiAlH_4$, DIBAL-H, Red Al, L and K- selectrides). **4.2.3.** NH_2NH_2 (diimide reduction) and other non-metal based agents including organic reducing agents (Hantzsch dihydropyridine). **4.2.4. Dissolving metal reductions:** using Zn, Li, Na, and Mg under neutral and acidic conditions, Li/Na-liquid NH_3 mediated reduction (Birch reduction) of aromatic compounds and acetylenes.	

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

PRACTICAL III

Course code: PSMACHG1P3

Session I: Basic Laboratory techniques

1. Crystallization
2. Solvent Extraction
3. Simple distillation
4. Fractional Distillation
5. TLC

Session-II: Combined spectral identification

Interpretation of spectral data of organic compounds (UV, IR, PMR, CMR and Mass spectra)

A student will be given UV, IR, PMR, CMR, and Mass spectra of a compound from which preliminary information should be reported within first half an hour of the examination without referring to any book/reference material. The complete structure of the compound may then be elucidated by referring to any standard text-book/reference material etc (Minimum 8 spectral analysis).

Suggested Readings

Textbooks				
Priority Sr. No	**Author**	**Title**	**Edition/ Year of Publication**	**Publisher**
1	W. Carruthers and Iain Coldham,	Modern methods of Organic Synthesis,	2004 4th Edition	Cambridge University Press.
2	Clayden Greeves Warren and Wothers,	Organic Chemistry	2001	Oxford Press
3	Pavia, D. L.; Lampmann, G. M.; Kriz, G. S.; Vyvyan, J. R.	Introduction to Spectroscopy	2014	Cengage Learning

Further readings

Priority Sr. No	**Author**	**Title**	**Edition/ Year of Publication**	**Publisher**
1	P. Volhardt and N. Schore,	Organic Chemistry: Structure and Function	2012. 5th Edition,	W H Freeman
2	W. G. Solomons, C. B. Fryhle,	Organic Chemistry	9th Edition 2009	Wiley India Pvt. Ltd
3	John McMurry	Organic chemistry	8th edition	Cengage learning
4	W. Carruthers and Iain Coldham,	Modern methods of Organic Synthesis,	2004 4th Edition	Cambridge University Press.
5	P. S. Kalsi	Stereochemistry	4th edition,	New Age International Ltd.
6	Francis A. Carey, Richard J. Sundberg	Advanced Organic Chemistry, Part A and Part B: Reaction and Synthesis	5th Edition	Springer Verlag
7	G.S. Zweifel and M.H. Nantz	Modern Organic Synthesis: An Introduction	2007	W.H. Freeman and Company
8	R. Bruckner,	Advanced Organic Chemistry: Reaction Mechanism	2002	Academic Press
9	R. T .Morrison, R. N. Boyd, & S. K. Bhattacharjee	Organic Chemistry	7th Edition	Pearson
10	B. Miller & R. Prasad	Advanced Organic Chemistry: Reactions & Mechanisms,	2nd Edition	Pearson
11	P.S. Kalsi,	Organic reactions and their mechanisms,	3rd revised edition,	New Age International Publishers

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

Program: M.Sc. General Chemistry				**Semester : I**	
Course : Analytical Techniques				**Course Code:PSMACHG104A**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	4	N/A	4 + 2	15 +10	75

Learning Objectives:

The objective of the course is to introduce students to importance of the principles and fundamentals of analytical techniques in research and commercial applications.

Course Outcomes:

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

CO1:

CO2:

CO3:

CO4:

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Spectroscopic techniques**	**15 L**
2	**Chromatographic techniques**	**15 L**
3	**Radioactivity and imaging techniques**	**15 L**
4	**Nanotechnology techniques**	**15 L**
	Total	**60 L**
PRACTICALS		

DETAILED SYLLABUS

Modules	**Topics**	**Duration (Lecture)**
Module-I	**SPECTROSCOPIC TECHNIQUES**	**15L**

	Design of spectrophotometers- Single beam, Double beam and split beam. Errors in spectrophotometric analysis. Applications- Basic concepts or principles, overview of components, calibration and applications of- UV-visible spectroscopy; Flame Photometry; Fluorimetry and Phosphorimetry (Spectro fluorimeters and phosphorimeters); IR-Single beam, double beam and FTIR, Raman spectroscopy; NMR; MS; AAS	
Module-II	**CHROMATOGRAPHIC TECHNIQUES**	**15L**
	Introduction to Chromatography- separation procedure b) development procedure classification terminology **basic concepts in chromatography**: requirements of an ideal detector, types of detectors in LC and GC, comparative account of detectors with reference to their applications (LC and GC respectively), qualitative and quantitative analysis**.**	**2L**
	Concept of plate and rate theories in chromatography: efficiency, resolution, selectivity and separation capability. Van Demeter equation and broadening of chromatographic peaks. Optimization of chromatographic conditions**.**	**2L**
	High Performance Liquid Chromatography: Principles, Instrumentation, operation, calibration, accuracy and applications. Normal phase and reversed phase with special reference to types of commercially available columns (Use of C8 and C18 columns). Diode array type and fluorescence detector, Applications of HPLC.	**5L**
	Supercritical Liquid Chromatography: Properties of SFE/SFC, Instrumentation, operation, advantages and applications.	**1L**
	Gas Chromatography: Principles, Instrumentation of GC with special reference to sample injection systems – split/split less, column types, solid/ liquid stationary phases, column switching techniques, temperature programming, Thermionic and mass spectrometric detector, operation, calibration, accuracy and Applications. Processing Chromatography data: Chromatogram, Chromatography software. (2)	**5L**
Module-III	**RADIOACTIVITY AND IMAGING TECHNIQUES**	**15L**
	Interaction of Radiation with Matter Radioactive decay, Photoelectric effect, Compton Effect, Pair production, Ionisation of matter, Energy absorbed from X- rays, X – rays Scattering, X - rays transmission through the medium, Interaction of charged particle and neutrons with matter. Acute exposure and chronic exposure L D 50/60. Production of Isotopes, Synthesis of labelled compounds **Detection and measurement of radiation & measuring instruments**	

	Ionisation of gases, Fluorescence and Phosphorescence, G.M. Counters, Scintillation Detectors, Liquid scintillator, Pocket Dosimeters, TL Dosimeters and their use in personnel monitoring badges, Advantages and disadvantages of various detectors, appropriateness of different types of detectors for different types of radiation measurement. Physical and chemical characteristics of radionuclides used in nuclear medicine, Criteria for selection of the radionuclides for diagnosis and therapy. Chemistry of 99mTc, labelling, Use of Radioisotopes in Biological Science Safety aspects **IMAGING TECHNIQUES:** Basic Principles, Instrumentation, working and applications of: Flow Cytometry, Inspissator, Medical Imaging: Introduction, principle and applications of: X-Rays, CT Scan, MRI, SPECT, PET, ultrasound systems, colour flow imaging applications (Doppler), Autoradiography, Neutron Activation Analysis, RIA, Radiolabelled antibodies/ receptors LASERS	
Module-IV	**NANOTECHNOLOGY TECHNIQUES**	**15L**
	Nanotechnology: Definition, Different classes of nanomaterials, synthesis of nanomaterials, nano structures and applications**,** Nanophotonics, Imaging & diagnostic techniques from nano to Micro scale Characterization using optical and chromatography techniques Microscopy: Scanning Probe Microscopes - scanning tunnelling microscope (STM), atomic force microscope (AFM), magnetic force microscope (MFM), scanning near field microscope (SNOM), Electron Microscopy: SEM, TEM, CCD camera and application Diffraction Techniques: X-ray diffraction (XRD) Photoluminescence Spectroscopy: X-ray and UV photoelectron spectroscopies (XPS)/Auger electron spectroscopy	

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

PRACTICAL IV

Course code: PSMACHG1P4

Non-Instrumental:

1. To carry out assay of the sodium chloride injection by Volhard's method using Statistical method.

2. To determine amount of Cr(III) and Fe(II) individually in a mixture of the two by titration with EDTA.

3. To determine amount of Cu(II) present in the given solution containing a mixture of Cu(II) and Fe(II).

4. To determine number of nitro groups in the given compound using $TiCl_3$.

Instrumental:

1. To determine percentage purity of sodium carbonate in washing soda pH metrically.

2. To determine the amount of Fe(II) and Fe(III) in a mixture using 1,10-phenanthroline spectrophotometrically.

3. Simultaneous determination of Cr(VI) and Mn(VII) in a mixture spectrophotometrically.

4. To determine amount of potassium in the given sample of fertilizers using flame photometer by standard addition method.

Textbooks				
Priority Sr. No	**Author**	**Title**	**Edition/ Year of Publication**	**Publisher**
1	Robert E. Henkin, Mark A. Boles, Gary Dillehay, J. R. Hlama, Stephen M. Karesh, Robert Wargner, and Michael Zimmer	Nuclear Medicine Vol-I	2nd Edition	Mosby

Suggested Reading-

Priority Sr. No	**Author**	**Title**	**Edition/ Year of Publication**	**Publisher**
1	E. B. Podgorsak	Radiation oncology physics : A Handbook for teachers and students	2005	IAEA publications

2	Faiz M Khan	The Physics of Radiation Therapy	2003	Lippincott Williams & Wilkins
3	Upadhyay, upadhyay & Nath	Biophysical chemistry	4th Edition	Himalaya Publishing House
4	Robert E Henkin, Mark A Boles, Gary Dillehay, James R Halama, Stephen M Karesh , Robert Wargner and Michael Zimmer	Nuclear Medicine -Vol I-	2nd Edition	Mosby
5	Keith Wilson and John Walker	Principles and Techniques of Biochemistry and Molecular Biology	7th Edition	Cambridge University Press
6	Editors- Ian D. Wilson, Michael Cooke Colin F. Pool	Encyclopaedia of Separation Sciences	2000	Academic Press

Signature Signature Signature

HOD Approved by Vice –Principal Approved by Principal

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: M.Sc.

Course: General Chemistry

Semester II

Credit Based Choice System (CBCS) with effect from the Academic year 2021-22

PROGRAMME SPECIFIC OUTCOMES (PSO'S)

On completion of the **M.Sc.-General Chemistry**, the learners should be enriched with knowledge and be able to-

PSO1: gain complete knowledge about all fundamental aspects of all the elements of different branches of chemistry.

PSO2: develop analytical thinking and apply the same for the understanding of underlining principles, proposing mechanism, problem solving, identification of chemical species, derivation process, conductometric and potentiometric analysis and arriving to logical conclusion.

PSO3: understands the background of organic reaction mechanisms, complex chemical structure, and molecular rearrangements.

PSO4: gain knowledge in classical laboratory techniques and be able to use modern sophisticated instrumentation, so that they can perform new experiments, obtain experimental data and its spectral interpretation through theoretical principals.

PSO5: integrate knowledge learned in chemistry to various industry and pharmaceutical needs.

PSO6: learn about the potential uses of medicinal chemistry and green chemistry.

PSO7: create an awareness of the impact of chemistry on the environment, society and development outside the scientific community.

PSO8: develop research-oriented skills and to inculcate the scientific temperament in the students.

Preamble

The purpose of post-graduate education in science is to create highly skilled manpower in specific areas, which will lead to generation of new knowledge and creation of wealth for the country. Chemistry is a fundamental science and has contributed immensely to the improvement of the life of human beings by providing many of human requirements and essentialities. The credit system has been adopted for all these courses, which would allow students to develop a strong foundation in the fundamentals and specialize in the disciplines of his/her liking and abilities. The courses are designed so that the students pursuing these courses will obtain fundamental knowledge about the subject in the respective specialization. The students are also expected to get corresponding experimental training during the practical courses.

Evaluation Pattern

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

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)	Test	15 marks
Component 2 (CA-2)	Assignment	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
1	Attempt any Three out of Five	15 Marks	15 Marks
2	Attempt any Three out of Five	15 Marks	15 Marks
4	Attempt any Three out of Five	15 Marks	15 Marks
4	Attempt any Three out of Five	15 Marks	15 Marks
5	Attempt any Three out of Four	15 Marks	15 Marks
		Total Marks	**75**

Signature Signature Signature

HOD Approved by Vice –Principal Approved by Principal

Program: M.Sc. General Chemistry	**Semester : II**
Course : Physical Chemistry-II	**Course Code: PSMACHG201**

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

Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	4	N/A	4 + 2	15 +10	75

Learning Objectives:

The objective of the course is to orient learner about the chemical thermodynamics, quantum chemistry, chemical kinetics, molecular reaction dynamics, solid state chemistry and phase equilibria.

Course Outcomes:

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

CO1: uunderstand the ffugacity of real gases, Gibb's energy of mixing.
CO2: learn the Schrödinger wave equation in spherical coordinates, H atom and total wave functions.
CO3: explain the application of the Schrödinger equation.
CO4: introduce the cconcept of eelementary rexactions in ssolution and kinetics of solid-state reactions.
CO5: explain the solid-state chemistry particularly two component systems.

Outline of Syllabus: (per session plan)

Module	Description	No of Hours
1	**Chemical Thermodynamics II**	**15 L**
2	**Quantum Chemistry II**	**15 L**
3	**Chemical Kinetics and Molecular Reaction Dynamics**	**15 L**
4	**Solid State Chemistry and Phase Equilibria**	**15 L**
	Total	**60 L**
PRACTICALS		

DETAILED SYLLABUS

Modules	Topics	Duration (Lecture)
Module-I	**Chemical Thermodynamics II**	**15L**
	1.1. Fugacity of real gases, Determination of fugacity of real gases using graphical method and from equation of state. Equilibrium constant for real gases in terms of fugacity. Gibbs energy of mixing, entropy and enthalpy of mixing. **1.2.** Real solutions: Chemical potential in non-ideal solutions excess functions of non-ideal solutions calculation of partial molar volume and partial molar enthalpy, Gibbs DuhemMargules equation. **1.3.** Thermodynamics of surfaces, Pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, BET isotherm (derivations expected). **1.4.** Bioenergetics: standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, synthesis of ATP from ADP.	
Module-II	**Quantum Chemistry II**	**15L**
	2.1 Rigid rotor, spherical coordinates Schrödinger wave equation in spherical coordinates, separation of the variables, the phi equation, wavefunction, quantum number, the theta equation, wave function, quantization of rotational energy, spherical harmonics. **2.2** Hydrogen atom, the two particle problem, separation of the energy as translational and potential, separation of variables, the R the θ * and the φ equations, iintroduction of the four quantum numbers and their interdependence on the basis of the solutions of the three equations, total wave function, expression for the energy, probability density function, distances and energies in atomic units, radial and angular plots., points of maximum probability, expressions for the total wave function for 1s, 2s, 2p and 3d orbitals of hydrogen. **2.3** Application of the Schrödinger equation to two electron system, limitations of the equation, need for the approximate solutions, methods of obtaining the approximate solution of the Schrödinger wave equation. **2.4** Hückel Molecular Orbitals theory for ethylene, 1,3-butadiene, cyclobutadiene, allyl radical and benzene. (Derivation expected)	
Module-III	**Chemical Kinetics and Molecular Reaction Dynamics**	**15L**
	3.1 Elementary Reactions in Solution: - Solvent Effects on reaction rates, Reactions between ions- influence of solvent Dielectric constant, influence of ionic strength, Linear free energy relationships Enzyme action. **3.2** Kinetics of reactions catalyzed by enzymes -Michaelis-Menten analysis, Lineweaver-Burk and Eadie Analyses. **3.3** Inhibition of Enzyme action: Competitive, Noncompetitive and Uncompetitive Inhibition. Effect of pH, temperature, Enzyme activation by metal ions, Regulatory enzymes. **3.4** Kinetics of reactions in the Solid State: - Factors affecting reactions in solids Rate laws for reactions in solid: The parabolic rate law, the first order rate Law,	

	the contracting sphere rate law, Contracting area rate law, some examples of kinetic studies.	
Module-IV	**Solid State Chemistry and Phase Equilibria**	**15L**
	4.1 Phase equilibria **4.2**. Recapitulation: Introduction and definition of terms involved in phase rule. Thermodynamic derivation of Gibbs Phase rule. **4.3.** Two component system: a) Solid –Gas System: Hydrate formation, Amino compound formation b) Solid – Liquid System: Formation of a compound with congruent melting point, Formation of a compound with incongruent melting point. (with suitable examples) **4.4.** Three component system- Type-I: Formation of one pair of partially miscible liquids. Type-II: Formation of two pairs of partially miscible liquids. Type-III: Formation of three pairs of partially miscible liquids.	

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

PRACTICAL

Course code: PSMACHG2P1

Non – instrumental:

1. Polar plots of atomic orbitals such as 1s, 2Pz and 3dz2 orbitals by using angular part of hydrogen atom wave functions.

2. To study the influence of ionic strength on the base catalysed hydrolysis of ethyl acetate.

3. To study phase diagram of three component system water – chloroform /toluene - acetic acid.

4. To determine the rate constant of decomposition reaction of diacetone alcohol by dialtometric method.

Instrumental:

1. To determine the formula of silver ammonia complex by potentiometric method.

2. To determine CMC of sodium Lauryl Sulphate from measurement of conductivities at different concentrations.

3. To determine Hammette constant of m- and p- amino benzoic acid/nitro benzoic acid by pH measurement.

4. To determine the Michaelis – Menten's constant value (Km) of the enzyme Beta Amylase spectrophotometrically.

Reference Books:

Priority Sr. No	**Author**	**Title**	**Edition/ Year of Publication**	**Publisher**
1	D.N. Bajpai	Advanced Physical Chemistry	1st Edn	S. Chand Publishing
2	James E. House	Principles of Chemical Kinetics	2nd Ed	ELSEVIER
3	R.K. Prasad	Quantum Chemistry	2nd Edn	New Age International Publishers
4	H.V. Keer	Principles of the Solid State	2011	New Age International Publishers

Suggested Reading:

Priority Sr. No	**Author**	**Title**	**Edition/ Year of Publication**	**Publisher**
1	Peter Atkins and Julio de Paula	Atkin's Physical Chemistry	7th Edn	Oxford University Press
2	Robert J. Silby and Robert A. Alberty	Physical Chemistry	3rd Edn	John Wiley and Sons (Asia) Pte. Ltd
3	Ira R. Levine	Physical Chemistry	5th Edn	Tata McGraw-Hill
4	G.W. Castellan	Physical Chemistry	3rd Edn	Narosa Publishing House
5	S. Glasstone	Text Book of Physical Chemistry	2nd Edn	McMillan and Co. Ltd
6	B.K. Sen	Quantum Chemistry including Spectroscopy	2003	Kalyani Publishers
7	A.K. Chandra	Introductory Quantum Chemistry	1994	Tata McGraw – Hill
8	S. Glasstone	Thermodynamics for Chemists	1964	East-West Press
9	W.G. Davis,	Introduction to Chemical Thermodynamics – A Non – Calculus Approach	1972	Saunders
10	Peter A. Rock	Chemical Thermodynamics	1983	Oxford University Press
11	Ira N. Levine	Quantum Chemistry	5th Edn	Pearson Education (Singapore) Pte. Ltd
12	Thomas Engel and Philip Reid	Physical Chemistry	3rd Edn	Pearson Education Limited

13	Lesley E. Smart & Elaine A. Moore	Solid State Chemistry [An Introduction]	3rd Ed	Taylor & Francis
14	Stephen Elliott	The Physics and Chemistry of Solids	2010	Wiley-Blackwell
15	D.K. Chakrabarty	Solid State Chemistry	1996	New Age International Publishers
16	Marron, Samuel and Prutton	Principles of physical Chemistry	5th	The Macmillan Company
17	Arun Bahl, B. S Bahl, G. D.Tulli	Essentials of Physical Chemistry	2012 Edition	S Chand and Co. Ltd
18	L.V Azaroff	Introduction of Solids	1993	Tata McGraw Hill
19	K L Kapoor	A Text book of physical Chemistry ; Applications of thermodynamics	2011	Mac Millan Publishers India Ltd
20	C.N.R. Rao and J Gopalkrishnan	New directions in solid state Chemistry	2nd Edn	Cambridge University Press
21	B. Viswanathan and P.S. Raghavan	Practical Physical Chemistry	2005	Viva Books Private Limited
22	A. M. James and F. E. Prichard	Practical Physical Chemistry	3rd Edn	Longman Group Ltd
23	V.D. Athawale and P. Mathur	Experimental Physical Chemistry	2001	New Age International Publishers

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

Program: M.Sc. General Chemistry				**Semester : II**	
Course : Inorganic Chemistry-II				**Course Code: PSMACHG202**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical** (Hours per week)	**Tutorial** (Hours per week)	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	4	N/A	4 + 2	15 +10	75

Learning Objectives:

The objective of the course is to acquaint the principles and fundamentals of inorganic reaction Mechanism, Organometallic chemistry, Environmental chemistry and Bioinorganic chemistry.

Course Outcomes:

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

CO1: understand the reaction mechanism of octahedral and square planer complexes.
CO2: learn the mechanisms ligand substitution reaction, redox reactions.
CO3: explain the term in organometallic chemistry of transition metals and environmental chemistry.
CO4: introduces the concept of oxygen carries, hemoglobin, its mechanism of oxygen binding.
CO5: explain the separation of elements of alloys and estimation of Cu and Fe potentiometrically.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Inorganic Reaction Mechanism:**	**15 L**
2	**Organometallic Chemistry of Transition metals:**	**15 L**
3	**Environmental Chemistry:**	**15 L**
4	**Bioinorganic Chemistry:**	**15 L**
	Total	**60 L**
PRACTICALS		

DETAILED SYLLABUS		
Modules	**Topics**	**Duration (Lecture)**
Module-I	**Inorganic Reaction Mechanism:**	**15L**
	1.1 Rate of reactions, factors affecting the rate of reactions, techniques for determination of rate of reaction (Direct chemical analysis, spectrophotometric method, electrochemical and flow methods). **1.2** Ligand substitution reactions of: a) Octahedral complexes without breaking of metal ligand bond (Use of isotopic labelling method) b) Square planar complexes, trans-effect, its theories and applications. Mechanism and factors affecting these substitution reactions. **1.3** Redox reactions: inner and outer sphere mechanisms, complimentary and non-complimentary reactions. **1.4** Stereochemistry of substitution reactions of octahedral complexes. (Isomerization and racemization reactions and applications.)	
Module-II	**Organometallic Chemistry of Transition metals:**	**15L**
	2.1 Eighteen and sixteen electron rule and electron counting with examples. **2.2** Preparation, properties and applications of the following compounds (of transition metals in general): (a) Alkyl and aryl derivatives (b) Carbenes and carbynes (c) Alkene derivatives (d) Alkyne derivatives (e) Allyl derivatives (f) Sandwich compounds and Half Sandwich compounds **2.3** Structure and bonding on the basis of VBT and MOT in the following organometallic compounds: Zeise's salt, bis(triphenylphosphine)diphenylacetylene platinum (0) $[Pt(PPh_3)_2(HC{\equiv}CPh)_2]$, diallylnickel(II), ferrocene and bis(arene)chromium(0), tricarbonyl (η4-butadiene) iron(0).	
Module-III	**Environmental Chemistry:**	**15L**
	3.1 Conception of Heavy Metals: Critical discussion on heavy metals. **3.2** Toxicity of metallic species: Mercury, lead, cadmium, arsenic, copper and chromium, with respect to their sources, distribution, speciation, biochemical effects and toxicology, control and treatment. **3.3** Case Studies: (a) Itai-itai disease for Cadmium toxicity,	

	(b) Arsenic Poisoning in the Indo-Bangladesh region. **3.4** Interaction of radiation in context with the environment: Sources and biological implication of radioactive materials. Effect of low level radiation on cells- Its applications in diagnosis and treatment, Effect of radiation on cell proliferation and cancer.	
Module-IV	**Bioinorganic Chemistry:**	**15L**
	4.1 Biological oxygen carriers; hemoglobin, hemerythrene and hemocyanine- structure of metal active center and differences in mechanism of oxygen binding, Differences between hemoglobin and myoglobin: Cooperativity of oxygen binding in hemoglobin and Hill equation, pH dependence of oxygen affinity in hemoglobin and myoglobin and its implications. **4.2** Activation of oxygen in biological system with examples of mono-oxygenases, and oxidases- structure of the metal center and mechanism of oxygen activation by these enzymes. **4.3** Copper containing enzymes- superoxide dismutase, tyrosinase and laccase: catalytic reactions and the structures of the metal binding site. **4.4** Nitrogen fixation-nitrogenase, hydrogenases. **4.5** Metal ion transport and storage: ionophores, transferrin, ferritin and metallothionins **4.6** Medicinal applications of cis-platin and related compounds.	

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

PRACTICAL

Course code: PSMACHG2P2

Ores and Alloys:

1) Analysis of Devarda's alloy
2) Analysis of Cu – Ni alloy
3) Analysis of Tin Solder alloy
4) Analysis of Limestone.

Instrumentation:

1) Estimation of Copper using Iodometric method Potentiometrically.
2) Estimation of Fe^{+3} solution using Ce(IV) ions Potentiometrically
3) Estimation of Cl^- ion using silver nitrate conductometrically

Reference Books:

Priority Sr. No	Author	Title	Edition/ Year of Publication	Publisher
1	P. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong	Inorganic Chemistry	5^{th} edition	Oxford University Press
2	R.H Crabtree	The Organometallic Chemistry of the Transition Metals	5^{th} edition	Wiley International Pvt, Ltd
3	A. K. De	Environmental Chemistry	8^{th} edition	New Age International Publisher

Suggested Reading:

Priority Sr. No	Author	Title	Edition/ Year of Publication	Publisher
1	D. Banerjee	Coordination Chemistry	1993	Tata McGraw Hill

2	W. H. Malik, G. D. Tuli and R. D. Madan	Selected Topics in Inorganic Chemistry	8th Ed	S. Chand & Company ltd.
3	M. L. Tobe and J. Burgess	Inorganic Reaction Mechanism	1999	Longman
4	S. Asperger	Chemical kinetics and Inorganic Reaction Mechanism	2nd Ed	Kluwer Academic/ Plenum Publishers
5	Gurdeep Raj	Advanced Inorganic Chemistry	12th Edition	Goel publishing house
6	B. R. Puri, L. R. Sharma and K. C. Kalia	Principles of Inorganic Chemistry	2013-2014	Milestone Publishers
7	F. Basalo and R. G. Pearson	Mechanism of Inorganic Reactions	2nd Ed	Wiley
8	R. Gopalan and V. Ramlingam	Concise Coordination chemistry	2001	Vikas Publishing house Pvt Ltd
9	Robert B. Jordan	Reaction Mechanisms of Inorganic and Organometallic Systems	3rd Ed	Oxford University Press
10	D. Banerjea	Coordination chemistry	1993	Tata McGrew Hill
11	R.C Mehrotra and A. Singh	Organometallic Chemistry- A unified Approach	2nd ed	New Age International Pvt Ltd
12	B. Doughlas, D.H McDaniel and J.J Alexander	Concepts and Models of Inorganic Chemistry	2nd edition	John Wiley and Sons
13	G.S Sodhi.	Organometallic Chemistry	2009	Ane Books Pvt Ltd

14	Colin Baird Michael Cann	Environmental Chemistry	5th edition	W. H. Freeman and Company, New York
15	Stanley E. Manahan	Environmental Chemistry	7th edition	CRC Press Publishers
16	Daniel A. Vallero	Environmental Contaminants	2004	Elsevier Inc
17	G. Tyler Miller Jr. and Scott E. Spoolman	Environmental Science	13th edition	Brooks/Cole Cengage Learning
18	Stanley E. Manahan	Fundamentals of Environmental and Toxicological Chemistry	4th edition	CRC Press Taylor & Francis Group
19	G. Tyler Miller Jr. and Scott E. Spoolman	Living in the Environment	17th edition	Brooks/Cole Cengage Learning
20	Jerrold B. Leikin, Frank P. Paloucek,	Poisoning and Toxicology Handbook	4th edn	CRC Press
21	Casarett and Doulls	Toxicology- The Basic Science of Poisons	6th edition	McGraw-Hill
22	R. W. Hay	*Bioinorganic Chemistry*	1984	Ellis Harwood, England
23	I. Bertini, H.B.Gray, S. J. Lippard and J.S. Valentine	Bioinorganic Chemistry	First South Indian Edition	Viva Books
24	J. A. Cowan	*Inorganic Biochemistry- An introduction*	1993	VCH Publication
25	S. J. Lippard and J. M. Berg	*Principles of Bioinorganic Chemistry*	1994	University Science Publications

26	G.N. Mukherjee and A. Das	Elements of Bioinorganic Chemistry	1988	Dhuri & Sons
27	Robert R.Crechton	Biological Inorganic Chemistry	3rd edition	Elsevier
28	J. R. Frausto da Silva and R. J. P. Williams,	*The Biological Chemistry of the Elements*	1991	Clarendon Press, Oxford
29	JM. D. Yudkin and R. E. Offord	*A Guidebook to Biochemistry*	1980	Cambridge University Press
30	G. N. Mukherjee	Advanced experiments in Inorganic Chemistry	1st Edn	U.N.Dhur & Sons Pvt Ltd
31	Dr Deepak Pant	Inorganic Chemistry Practical Under UGC Syllabus for M.Sc. in all India Universities	2010	Science

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

Program: M.Sc. General Chemistry				**Semester : II**	
Course : Organic Chemistry-II				**Course Code: PSMACHG203**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical** (Hours per week)	**Tutorial** (Hours per week)	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	4	N/A	4 + 2	15 +10	75

Learning Objectives:

The objective of the course is to introduce students to importance of, the principles and fundamentals of Enolate Chemistry, Reactions and Rearrangements, Drug design, development and synthesis and Stereochemistry-I

Course Outcomes:

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

CO1: understand the regioselectivity in enolate formation, nitrogen analogs of enols and enolates, reaction of carbon nucleophiles with carbonyl groups.

CO2: learn the mechanisms, stereochemistry of reactions and rearrangements and applications.

CO3: explain the term procedures in drug design, Introduction to quantitative structure activity relationship studies. QSAR parameters, Introduction to modern methods of drug design and synthesis, concept of prodrugs and soft drugs and Synthesis and application of the following drugs.

CO4: introduces the concept of chirality, molecules with tri- and tetra-coordinate centers, molecules with two or more chiral centers, axial and planar chirality and prochirality.

CO5: explain the separation of binary mixture using micro-scale technique.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Enolate Chemistry**	**15 L**
2	**Reactions and Rearrangements**	**15 L**
3	**Drug design, development and synthesis**	**15 L**
4	**Stereochemistry-I**	**15 L**
	Total	**60 L**
PRACTICALS		

DETAILED SYLLABUS

Modules	Topics	Duration (Lecture)
Module-I	**Enolate Chemistry**	**15L**
	1.1. Generation of carbanion, kinetic and thermodynamic enolate formation, Regioselectivity in enolate formation, alkylation of enolates. **1.2.** Generation and alkylation of dianion, medium effects in the alkylation of enolates, oxygen versus carbon as the site of alkylation. **1.3.** Alkylation of aldehydes, ketones, esters, amides and nitriles. **1.4.** Nitrogen analogs of enols and enolates- Enamines and Imines anions, alkylation of enamines and imines. **1.5.** Alkylation of carbon nucleophiles by conjugate addition (Michael reaction). **1.6.** Reaction of carbon nucleophiles with carbonyl groups: Mechanism of Acid and base catalyzed Aldol condensation, Mixed Aldol condensation with aromatic aldehydes, regiochemistry in mixed reactions of aliphatic aldehydes and ketones, intramolecular Aldol reaction and Robinson annulation, chiral enolate **1.7.** Addition reactions with amines and iminium ions; Mannich reaction. **1.8.** Amine catalyzed condensation reaction: Knoevenagel reaction. **1.9.** Acylation of carbanions.	
Module-II	**Reactions and Rearrangements**	**15L**
	Mechanisms, stereochemistry (if applicable) and applications of the following: **2.1. Reactions:** Baylis-Hilman reaction, McMurry Coupling, Corey-Fuchs reaction, Nef reaction and Passerini reaction. **2.2. Concerted rearrangements:** Hofmann, Curtius, Lossen, Schmidt, Wolff, and Boulton Katritzky. **2.3. Cationic rearrangements:** Tiffeneau-Demjanov, Pummerer, Dienone-phenol, Rupe and Wagner-Meerwein. **2.4. Anionic rearrangements:** Brook, Neber, Von Richter, Wittig, Gabriel–Colman and Payne.	
Module-III	**Drug design, development and synthesis**	**15L**
	3.1 Procedures in drug design: Drug discovery without a lead: Penicillin, Librium. Lead discovery: random screening, non-random (or targeted) screening. Lead modification: Identification of the pharmacophore, Functional group modification. Structure-activity relationship, Structure modification to increase potency and therapeutic index: Homologation, chain branching, ring-chain transformation, bioisosterism, combinatiorial synthesis (basic idea) and Drug development. **3.2 Introduction to quantitative structure activity relationship studies. QSAR parameters:** - steric effects: The Taft and other equations; Methods used to	

	correlate regression parameters with biological activity: Hansch analysis- A linear multiple regression analysis. **3.3 Introduction to modern methods of drug design and synthesis-** drug design via enzyme inhibition (reversible and irreversible), bioinformatics and drug design. **3.4 Concept of prodrugs and soft drugs.** (a) Prodrugs: Prodrug design, types of prodrugs, functional groups in prodrugs, advantages of prodrug use. (b) Soft drugs: concept and properties. **3.5 Synthesis and application of the following drugs:** Fluoxetine, cetrizine, fluconazole, zidovudine and diclofenac.	
Module-IV	**Stereochemistry-I**	**15L**
	4.1. Concept of Chirality: Recognition of symmetry elements. **4.2. Molecules with tri- and tetra-coordinate centers:** Compounds with carbon, silicon, nitrogen, phosphorous and sulphur chiral centers, relative configurational stabilities. **4.3. Molecules with two or more chiral centers:** Constitutionally unsymmetrical molecules: erythro-threo and syn-anti systems of nomenclature. Interconversion of Fischer, Sawhorse, Newman and Flying wedge projections. Constitutionally symmetrical molecules with odd and even number of chiral centers: enantiomeric and meso forms, concept of stereogenic, chirotopic, and pseudoasymmetric centres. R-S nomenclature for chiral centres in acyclic and cyclic compounds. **4.4. Axial and planar chirality:** Principles of axial and planar chirality. Stereochemical features and configurational descriptors (R,S) for the following classes of compounds: allenes, alkylidene cycloalkanes, spirans, biaryls (buttressing effect) (including BINOLs and BINAPs), ansa compounds, cyclophanes, trans-cyclooctenes. **4.5. Prochirality:** Chiral and prochiral centres; prochiral axis and prochiral plane. Homotopic, heterotopic (enantiotopic and diastereotopic) ligands and faces. Identification using substitution and symmetry criteria. Nomenclature of stereoheterotopic ligands and faces. Symbols for stereoheterotopic ligands in molecules with i) one or more prochiral centres ii) a chiral as well as a prochiral centre, iii) a prochiral axis iv) a prochiral plane v) pro-pseudoasymmetric centre. Symbols for enantiotopic and diastereotopic faces. **4.6**. Basic concept of asymmetric induction	

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

PRACTICAL I

Course code: PSMACHG2P3

Separation of Binary mixture using micro-scale technique

1. Separation of binary mixture using chemical methods.
2. Characterization of one of the components with the help of chemical analysis and confirmation of the structure with the help of derivative preparation and its physical constant. The Component which has to be characterized has to be bi-functional.
3. Determination of mass of the second component.

The following types are expected:

(i) Water soluble/water insoluble solid and water insoluble solid,

(ii) Non-volatile liquid-Non-volatile liquid (chemical separation)

(iii) Water-insoluble solid-Non-volatile liquid.

Minimum three mixtures from each type and a total of ten mixtures are expected.

Reference Books:

Textbooks				
Priority Sr. No	**Author**	**Title**	**Edition/ Year of Publication**	**Publisher**
1	W. Carruthers and Iain Coldham,	Modern methods of Organic Synthesis,	2004 4th Edition	Cambridge University Press.
2	Clayden Greeves Warren and Wothers,	Organic Chemistry	2001	Oxford Press
3	D, Nasipuri,	Stereochemistry of Carbon Compounds: Principles and Applications	3rd edition	New Age International Ltd.
4	Richard B. Silverman & Mark W, Holladay	The organic chemistry of Drug Design and Drug Action	2nd or 3rd Edition	Academic Press, New Delhi

Suggested Readings:

Priority Sr. No	**Author**	**Title**	**Edition/ Year of Publication**	**Publisher**
1	John McMurry	Organic chemistry	8th edition	Cengage learning
2	Ernest L. Eliel and Samuel H. Wilen	Stereochemistry of Organic Compounds	1994	Wiley-India
3	P. S. Kalsi	Stereochemistry	4th edition,	New Age International Ltd.
4	L. Kurti& B. Czako	Strategic Applications of Name Reactions in Organic Synthesis	2005	Elsevier Academic Press
5	M. J. T. Robinson,	Organic Stereochemistry,	(India edition) 2005.	Oxford University Press, New Delhi,
6	Francis A. Carey, Richard J. Sundberg	Advanced Organic Chemistry, Part A and Part B: Reaction and Synthesis	5th Edition	Springer Verlag
7	G.S. Zweifel and M.H. Nantz	Modern Organic Synthesis: An Introduction	2007	W.H. Freeman and Company
8	R. Bruckner,	Advanced Organic Chemistry: Reaction Mechanism	2002	Academic Press
9	R.O.C. Norman & J. M. Coxon	Principles of Organic Synthesis	3rd Edition	Nelson Thornes
10	Bradford P. Mundy, Michael G. Ellard, and Frank Favoloro, Jr	Name Reactions and Reagents in Organic Synthesis	2nd Edition	Wiley-Interscience
11	B. Miller & R. Prasad	Advanced Organic Chemistry: Reactions & Mechanisms,	2nd Edition	Pearson
12	P.S. Kalsi,	Organic reactions and their mechanisms,	3rd revised edition,	New Age International Publishers

13	R. T .Morrison, R. N. Boyd, & S. K. Bhattacharjee	Organic Chemistry	7th Edition	Pearson

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

Program: M.Sc. General Chemistry				**Semester : II**	
Course : Research Methodology				**Course Code: PSMACHGC204**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks - 25)**	**Semester End Examinations (SEE) (Marks- 75 in Question Paper)**
4	4	N/A	4 + 2	15 +10	75

Learning Objectives:
The objective of the course is to introduce students to importance of the principles and process of research.

Course Outcomes:
After completion of the course, learners would be able to:
CO1:understand some basic concepts of research and its methodologies
CO2: identify appropriate research topics
CO3: select and define appropriate research problem and parameters
CO4: prepare a project proposal (to undertake a project)
CO5: organize and conduct research (advanced project) in a more appropriate manner
CO6:write a research report and thesis
CO7:write a research proposal (grants)

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Research Methodology**	**15 L**
2	**Biostatistics- Introduction**	**15 L**
3	**Theory of probability**	**15 L**
4	**Research hypothesis**	**15 L**
	Total	**60 L**
PRACTICALS		

DETAILED SYLLABUS		
Modules	**Topics**	**Duration (Lecture)**
Module-I	**Research Methodology**	**15L**
	1.1 Strategies, planning and analysis 1.1.1. Scientific problem 1.1.2. Objectives of research 1.1.3. Short term and long term goals 1.1.4. Research conditions 1.1.5. Research design- characteristics of a good research design, types of research design 1.1.6. Repeatability, reproducibility and reliability 1.1.7. Experimental protocols **1.2** Literature search 1.1.8. Information literacy 1.1.9. Systematic literature search 1.1.10. How to formulate a query: PICO 1.1.11. Search techniques 1.1.12. Methodology filters 1.1.13. Critical appraisal 1.1.14. Impact factor 1.1.15. Medical and scientific internet 1.1.16. Principal bibliographic databases 1.1.17. Citation style 1.1.18. Reference management software e.g. Mendeley, Zoreto **1.3** Ethics in science 1.1.19. Introduction to ethics 1.1.20. Scientific conduct and misconduct 1.1.21. Authorship issues 1.1.22. Plagiarism **1.4** Basic principles of human research ethics- international regulation Ethics of animal research- CPCSEA, Institutional ethics committee, OECD guidelines.	
Module-II	**BIOSTATISTICS**	**15L**
	2.1. Introduction- definition, scope and limitations **2.2.** Measurement scales, variables & their measurements **2.3.** Collection of data, classification & tabulation-diagrammatic & graphical representation **2.4.** Measures of central tendency -mean, median, mode, geometric mean **2.5.** Measures of dispersion- Range, Q.D., M.D., variance, standard deviation **2.6.** Correlation and Regression analysis: Correlations and regressions-: Relation between two variables, scatter diagram, definition of correlations & their equations, interpretation of regression coefficients, principles of least squares, Two regression lines, curve fitting Karl Pearson's coefficient of correlation, Spearman's coefficient of correlation	

	2.7. Sampling-sampling frame, importance of probability sampling, simple random sampling, systemic sampling, stratified random sampling, cluster sampling.	
Module-III	**THEORY OF PROBABILITY**	**15L**
	3.1 Random experiments, sample space of an experiment, event, mutually exclusive events, exhaustive events, independent events, additional theory(statement only), conditional probability, multiplication theorem(statement only), Bayes' theorem. **3.2** Discrete distribution- Binomial distribution, Poisson distribution. **3.3** Continuous distribution- Normal distribution and its properties and Sampling distribution.	
Module-IV	**Research Hypothesis**	**15L**
	4.1 HYPOTHESIS TESTING 4.1.1 Null and alternate hypothesis 4.1.2 Type-I & Type-II errors 4.1.3 Level of significance, 4.1.4 Power of test 4.1.5 p value **4.2 PARAMETRIC TESTS** 4.2.1 Large sample Tests 4.2.1.1 Testing significance of single population mean 4.2.1.2 Testing significance of single population proportion 4.2.1.3 Testing significance of two population mean 4.2.1.4 Testing significance of two population proportion 4.2.2 Small sample Tests 4.2.2.1 Testing significance of single population mean 4.2.2.2 Testing difference between two independent normal population mean 4.2.2.3 Testing difference between two correlated normal population mean 4.2.2.4 Testing significance of correlation coefficient 4.2.3 χ^2 test 4.2.3.1 Testing single population variance 4.2.3.2 Testing Goodness of fit 4.2.3.3 Testing association between two attributes 4.2.4 F-test- Testing equality of variance 4.2.5 ANOVA- one-way classification, two-way classification **4.3 INTRODUCTION TO NON-PARAMETRIC TESTS** 4.3.1 Rank test-sign test 4.3.2 The Wilcoxon Signed-Rank test for location 4.3.2.1 Testing single population mean 4.3.2.2 Testing difference between correlated(match pair) population means 4.3.2.3 Testing difference between two independent population means 4.3.3 The Mann-Whitney Test(Mann-Whitney-Wilcoxon test -for equality of medians) 4.3.4 The Kolmogorov-Smirnov Goodness- of -Fit Test 4.3.5 The Kruskal-Wallis One-Way Analysis of Variance by Ranks The Friedman Two-Way Analysis of Variance by Ranks	

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

PRACTICAL IV

Course code: PSMACHGC2P4

1. Numerical problem on
    a. Z-Test
    b. T-Test
    c. Chi-Squares Test
    d. Simple Regression
    e. Correlation
2. Use of excel for hypothesis testing
3. Use of excel for graph preparation
4. Construction of questionnaire for survey

Reference Books:

Priority Sr. No	**Author**	**Title**	**Edition/ Year of Publication**	**Publisher**
1	R. D. Broun	Introduction to instrumental analysis	1987	Mc Graw Hill
2	H. willard, L.Merrit, J.A. Dean and F.A. settle	Instrumental methods of chemical analysis	6^{th} edition	CBS
3	D. A. Skoog, D. M. West and H. J. Holler	Fundamentals of analytical chemistry	6^{th} edition (1992)	
4	Vogel Text Book of quantitative analysis	A. I. Vogel	6^{th} Ed	Longman

Suggested reading:

Priority Sr. No	**Author**	**Title**	**Edition/ Year of Publication**	**Publisher**
1	C.R. Kothari,	Research Methodology: Methods and Techniques	2nd edition	New Age International publishers
2	Bernard, H. Russell	Research Methods in Anthropology: Qualitative and Quantitative Approaches	1995	Altamira Press, Walnut Creek
3	Goode W J and Hatt P K	Methods in Social Research	1952	McGraw Hills, New York
4	Mukherji, P.N.	Methodologies in Social Science	1999	Sage Publications, New Delhi.
5	Royce A. Singleton and Bruce C. Straits	Approaches to Social 22/46 Research	1999	Oxford University Press.
6	Young P V.	Scientific Social Surveys and Research	4th Edition	Prentice-Hall, New York
7	Pullum W.	Assessment of Age and Data Reporting in the DHS Surveys	2006	Marco International Inc.
8	Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye	Probability and Statistics for Engineers and Scientists	8th Edition	Pearson Education Asia
9	Douglas C. Montgomery and George C. Runger	Applied Statistics and Probability for Engineers	2005	John Wiley and Sons Inc.
10	Ravichandran, J.	Probability and Statistics for engineers	First Reprint Edition	Wiley India
11	Amir D. Aczel and Jayavel Sounderpandian	Complete Business Statistics	6th Edn	Tata McGraw-Hill Publishing Company

12	Hogg R.V and Craig A.T	Introduction to Mathematical Statistics	4th Edn	Collier Macmillan Publisher
13	Mood A.M. Graybill F.A. and Boes D.C.	Introduction to the Theory of Statistics	3rd Edn	McGraw Hill
14	Goon A.M. Gupta M.K. and Dasgupta B.	An Outline of Statistical Theory	Vol 2	World Press Publishers Pvt. Ltd.
15	Roa C.R.	Linear Statistical Inference and Applications	Revised edition	Wiley Eastern
16	Gibbons JK	Practical Non Parametric Statistics	3rd Edn	Wiley publications
17	James J. Higgins	Introduction to Non parametric statistics	Duxbury advanced series	Brooks/Cole
18	Sidney Siegel & Castellan Jhon	Non parametric statistics for behavioural sciences	2nd Edn	McGraw-Hill international editions