Program Outcomes (PO) for Science Post Graduate Program

1. **Disciplinary knowledge**- Attain profound knowledge in Discipline with advanced concepts in science & technology to design the methodology suitable to the problem encountered and ability to apply the knowledge to solve real-life problems.
2. **Research Skills**- Attain Research Skills to analyze problems, formulate a hypothesis, evaluate, and validate results with the help of advanced tools and technology, and draw a logical conclusion.
3. **Communication:** Able to present scientific and technical information with clarity, conciseness, and correct manner in both oral and written presentation.
4. **Leadership Skills:** Ability to demonstrate leadership and work collaboratively as a part of a team in multidisciplinary settings.
5. **Ethics**: Attain the relevant knowledge and skills to identify unethical behavior and truthful actions in all aspects and demonstrate standard professional ethics in the discipline concerned.
6. **Lifelong Learning:** Ability to seek new knowledge and skills and inculcate the habit of self-learning throughout life and adapting to contemporary demands of workplace.

Program Specific Outcomes (PSO)

PSO_1 Gain knowledge about the fundamental aspects of inorganic chemistry to synthesize, predict and analyse properties and acquire skill to handle various categories of chemicals with precautions.

PSO_2 Understands the underlying principles, proposing mechanisms of various organic reactions, identifying chemical structure, and developing skills for characterization of compounds through experimental and instrumental methods

PSO_3 Acquire the knowledge learnt in various courses of physical and analytical chemistry to develop an understanding regarding their application for problem solving.

PSO_4 Integrate the knowledge and potential use of environmental, green, industrial, computational and allied areas of chemistry for the interpretation and explanation of various aspects of chemical compounds and their utilization.

Programme :	**M.Sc.**	**Semester :**	**1st**
Name of the Course:	**Inorganic Chemistry I**	**Course Code:**	**MCH 1101**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: I	**Inorganic Chemistry I [MCH 1101]**
Students will be able to	
CO1	Recognize the different non valence forces and their influence on the physical & chemical properties
CO2	Illustrate an understanding of the principles of theories of metal-ligand bond
CO3	Interpret the stability of complexes
CO4	Understand the substitution reactions in transition metal complexes

Syllabus:

Unit I: Stereochemistry and Bonding in main group compounds

VSEPR theory & drawbacks, Pπ–Pπ, Pπ–dπ and dπ–dπ bonds, Bent rule, Hybridization involving f-orbital energies of hybridization, some simple reactions of covalently bonded molecules.

Unit II: Metal-Ligand Equilibria in Solution

Stepwise and overall formation constant and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by spectrophotometry and potentiometric (pH) methods.

Unit III: Reaction Mechanisms of Transition Metal Complexes

Introduction, potential energy diagram and reactivity of metal complexes, ligand substitution reactions, substitution reactions mechanisms, labile and inert metal complexes, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis,

conjugate base mechanism, anation reaction, substitution reactions in square planar complexes, trans effect, mechanism of the substitution reaction reactions without metal ligand bond cleavage, electron transfer processes outer and inner sphere, Berry pseudorotation.

Unit IV: Metal Ligand Bonding-I

Crystal field theory (CFT), salient features, spectrochemical series, splitting of d-orbitals in tetragonal, square planar, trigonalbipyramidal and square-pyramidal geometry, applications of CFT- colours of transition metal complexes, magnetic properties of octahedral complex, Factors affecting CFSE, limitations of CFT, Experimental evidence for metal-ligand covalent bonding in complexes, Nephelauxetic effect,

Unit V: Metal Ligand Bonding-II

Ligand field theory and molecular orbital theory; nephelauxetic series, structural distortion and lowering of symmetry, electronic, Jahn-Tellar distortion, steric and Jahn-Teller effects on energy levels, conformation of chelate ring, structural equilibrium, magnetic properties of transition metal ions and free ions presentive, effects of L-S coupling on magnetic properties, temperature independent paramagnetism(TIP) in terms of crystal field theory CFT and molecular orbital theory (MOT), quenching of orbital angular momentum by crystal fields in complexes in terms of term splitting. effect of spin-orbit coupling and A, E & T states mixing.

Books Suggested

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.

2. Inorganic Chemistry, J.E. Huhey, Harpes & Row;

3. Chemisiryol the Elements, N.N. Greenwood and A. Earnshow, Pergamon.

4. Inorganic Electron ioSpeciroscopy, A. B. P. Leve r, Elsevier.

5. Magnetochemistry, R.L. Cariin, Springer Vertag,

6. Comprehensive Coordination Chemistry eds., Q. Wilkinson, R.D. Gillars and J.A. McCleverty, Pergamon.

CO-PO & PSO Correlation

Course Name: Inorganic Chemistry I [MCH 1101]										
COs	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	2						3			
CO 2		1								1
CO 3	1						2			
CO 4						1	2			

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**1st**
Name of the Course:	**Organic Chemistry I**	**Course Code:**	**MCH 1102**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: I	**Organic Chemistry-I [MCH 1102]**
Students will be able to	
CO1	Acquire the skills for correct stereochemical assignment and interpretation in rather simple organic molecules.
CO2	Formulate his/her own reasoned opinions in the mechanistic side of organic reactions
CO3	Predict the product due to rearrangement reaction and determine its mechanism.
CO4	Understand stereo chemical implications of pericyclic reaction in organic synthesis.
CO5	Know the mechanistic pathways of cycloaddition, sigma tropic and electrocyclic reaction

Syllabus:

Unit I: Nature of Bonding in Organic Molecules

Delocalized chemical bonding conjugation, cross conjugation, resonance, hyperconjugation, bonding in fullerenes, tautomerism.

Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's rule, energy level of nm molecular orbitals, annulenes, homo-aromaticity, PMO approach.

UNIT- II: Stereochemistry

Conformational analysis of cycloalkanes, decalins effect of conformation on reactitity, conformation of sugars, steric strain due to unavoidable crowding.

Elements of symmetry, chirality, molecules with more than one chiral centre, threo and erythro isomers, methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecfic and stereo selective synthesis. Asymmetric synthesis.Optical activity in the absence of chiral carbon (biphenyls. allenes and spiranes).chirality due to helical shape.

Stereo chemistry of the compounds containing nitrogen sulphur and phosphorus.

UNIT III: Reaction Mechanism- Structure and Reactivity

Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle.

Potential energy diagrams, transition states and intermediates, methods of determining mechanism, isotope effects.Hammett equation and linear free energy relationship, substituent and reaction constants.

Reaction Intermediates: Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes, nitrenes, and benzynes.

UNIT IV: Pericyclic Reactions

Molecular orbital symmetry, frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward-Hoffmann correlation diagrams, FMO and PMO approach. Electrocyclic reactions-conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems. Cycloadditions - antrafacial and suprafacial additions. 4n, 4n+2 systems, 2+2 addition of ketenes, 1,3dipolar cycloadditions and cheleotropic reactions.

Sigmatropic rearrangements - suprafacial and antrafacial shifts of H, Sigmatropic shifts involving carbon moieties, 3,3- and 5,5- sigmatropic rearrangements, Claisen, Cope and Aza-Cope rearrangements. Fluxional tautomerism, Ene reaction.

UNIT V: Molecular rearrangement

General mechanistic approach to molecular rearrangement reactions, carbocation rearrangement- migratory aptitude and memory effects.

Brief study of following rearrangement reactions.Favoroskii, Baeyer-Villigers oxidation, Stork enamine reaction, Shapiro reaction, Sommelet rearrangement, wittig's rearrangement, Grovenstein-Zimmerman rearrangement.

Book Suggested:

1. Advanced Organic Chemistry, Reaction Mechanism and Structure, Jerry March. John Wiley.
2. Advanced Organic Chemistry, F.A. Carey and R.K. Sundberg, Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Syke, Longman,
4. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.
5. Organic Chemistry, R.T. Morrison and R.N. Boyed, Prentice-Hall.
6. Modern Organic Reactions, H.O. House. Benjamin.
7. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic and Professional.
8. Pericyclic Reaction, S.M. Mukherji, Macmilan, India.
9. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh,Macmilan.

10. Stereochemistry of Organic compounds, D. Nasipuri, New age International.
11. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International.

CO-PO & PSO Correlation

Course Name: Organic Chemistry-I [MCH 1102]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1		1						2		
CO 2		1						1		
CO 3	2							1		1
CO 4	1							3		
CO 5	1							2		

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**1st**
Name of the Course:	**Physical Chemistry I**	**Course Code:**	**MCH 1103**
Credits :	**4**	**No of Hours :**	
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: I	**Physical Chemistry-I [MCH 1103]**
Students will be able to	
CO1	Identify thermodynamics property of any system to apply it for various systems
CO2	Acquire the knowledge of phase equilibria for various systems
CO3	Get knowledge about various aspects of statistical thermodynamics

Syllabus:

Unit 1: Thermodynamics

Concepts involved in first, second and third law of thermodynamic, Helmholtz and Gibbs Energies, Maxwell relations, equilibrium constant, temperature-dependence of equilibrium constant, Van't Hoff equation.

Unit 2: **Partial Molar Properties and Fugacity**

Partial molar properties. Chemical potential of a perfect gas, dependence of chemical potential on temperature and pressure, Gibbs- Duhem equation, real gases, fugacity, its importance and determination, standard state for gases.

Solid-Liquid Solutions: Solutions of nonelectrolytes and electrolytes. Colligative properties of solutions, such as osmotic pressure, depression of the freezing point and elevation of the boiling point.

Unit 3: **Thermodynamics of Simple Mixtures**

Thermodynamic functions for mixing of perfect gases. chemical potential of liquids. raoult's law, thermodynamic functions for mixing of liquids (ideal solutions only). Real solutions and activities.Clausius-clapeyron equation and its application to solid-liquid, liquid-vapour and solid-vapour equilibria.

Unit 4: **Statistical Thermodynamics**

Thermodynamic probability and entropy, maxwell-boltzmann, bose-einstein and fermi-dirac statistics.partition function, molar partition function, thermodynamic properties in term of molecular partition function for diatomic molecules, monoatomic gases, rotational, translational, vibrational and electronic partition functions for diatomic molecules, calculation of equilibrium constants in term of partition function. monoatomic solids, theories of specific heat for solids.

Book Suggested:

1. Barrow, G. M. Physical Chemistry, 5th Edition, 2007, Tata McGraw-Hill.
2. Kapoor, K. L. Text Book of Physical Chemistry, Volume 2-3,5, 5th/3rd Edition, 2011, Macmillan.
3. Atkins, P. and De Paula, J. Atkins' Physical Chemistry. 9th Edition, 2009, Oxford University Press.
4. McQuarrie, D. A. and Simon, J. D. Physical Chemistry: A Molecular Approach, 1st edition, 1998, Viva Books.
5. Moore, J. W. and Pearson, R. G. Kinetics and Mechanism, 3rd edition, 1981, John Wiley and Sons.
6. Silbey, R. J. Alberty, R. A. and Bawendi, M. G. Physical Chemistry, 4th Edition, 2004, Wiley-Interscience Publication.
7. Engel, T., Reid, P. and Hehre, W. Physical Chemistry, 3rd Edition, 2012, Pearson Education.
8. Puri, B.R., Sharma L.R. and Pathania, M.S. Principles of Physical Chemistry, 46th Edition, 2013, Vishal Publishing Company.
9. Rastogi, R. P. and Mishra, R. R. An Introduction to Chemical Thermodynamics 6th edition, 2013, Vikas Publishing
10. Rajaram, J. and Kuriacose, J. C. Chemical Thermodynamics, Classical, Statistical and Irreversible Thermodynamics, 2013, Pearson Education.
11. Laurendeau N. M. Statistical Thermodynamics: Fundamentals and Applications, 2005, Cambridge University Press.
12. Nash, L. K. Elements of Statistical Thermodynamics, 2nd Edition, 2012, Dover Publication Inc.
13. Hill, T. L. An Introduction to Statistical Thermodynamics, 1986, Dover Publications Inc.

CO-PO & PSO Correlation

Course Name: Physical Chemistry-I [MCH 1103]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	1								3	
CO 2	2								2	
CO 3	1					1			2	1

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**1st**
Name of the Course:	**Mathematics for Chemists**	**Course Code:**	**MCH 1104**
Credits :	**2**	**No of Hours :**	**30**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: I	**Mathematics for Chemists**
Students will be able to	
CO1	Understand Vector and Matrix Algebra
CO2	Apply the knowledge of calculus in chemistry
CO3	Learn fundamental concepts of Elementary Differential Equations
CO4	Learn and apply the basic knowledge of Permutation and Probability in chemistry

Syllabus:

UNIT I: Vector and Matrix Algebra

(a) Vectors: Vector dot, cross and triple products etc. The gradient divergence and curl. Vector calculus, Gauss' theorem, divergence theorem, etc.

(b) Matrix Algebra: Addition and multiplication, inverse, adjoint and transpose of matrices, special matrices. (Symmetric, Skew symmetric, diagonal, unitary, etc) and their properties, matrix equation, Homogeneous, non-Homogeneous linear equations. Introduction to vector spaces, matrix eigenvalues and eigenvectors, diagonilization, determinants.

Unit II: Calculus

(a) Differential calculus: Functions, continuity and differentiability, rules for differentiation, applications of differential calculus including maxima and minima. Exact & Inexact differentials with their application to thermodynamics properties.

(b) Integral calculus, basic Rules for Integration, integration by parts, partial fraction and substitution. Reduction formulae, applications of integral calculus. Functions of several variables, partial differentiation.

UNIT III: Elementary Differential Equations

Variables- separable and exact, first-order differential equation, homogeneous, exact and linear equation. Applications to chemical kinetics, secular equilibrium, quantum chemistry, etc.

UNIT IV: Permutation and Probability

Permutations and combinations, probability and probability theorem, probability curves, average, root mean square and most probable errors, examples from kinetic theory of gases.

Book Suggested:

1. The Chemistry Mathematics Book, E. Steiner, Oxford University Press.
2. Mathematics for Chemistry, Doggett and Sectcliffe, Longman.
3. Mathematical preparation for physical chemistry, F. Daniels Mcgrow Hill.
4. Chemical Mathematics, D.M. Hirst, Longman.
5. Applied Mathematics for Physical Chemistry, J.R. Barrante, Prentice Hall.
6. Basic Mathematics for Chemists Tebbutt, Wiley.

CO-PO & PSO Correlation

Course Name: Mathematics for Chemists										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1		1					1			
CO 2	3									
CO 3	2									
CO 4	1									2

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**1st**
Name of the Course:	**Biology for Chemists**	**Course Code:**	**MCH 1104**
Credits :	**2**	**No of Hours :**	**30**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: I	**Biology for Chemists**
Students will be able to	
CO1	Understand structure of a cell and its functions
CO2	Learn about the role of carbohydrates in living organism
CO3	Understand the role of fatty acids and lipids in biological system
CO4	Learn and understand the synthesis and structure of amino acids and proteins
CO5	Identify and understand the components and importance of Nucleic acids

Syllabus:

UNIT I: Cell Structure and Functions

Structure of prokaryotic and eukaryotic cells, intercellular organelles and their functions, comparison of plant and animal cells.Overview of metabolic processes-catabolism and anabolism.ATP- The biological Energy currency.Origin of life- unique properties of carbon, chemical evolution and rise of living systems.Introduction to biomolecules, building blocks of Bio-macromolecules.

UNIT II: Carbohydrates

Conformation of monosaccharides, structure and function of important derivatives of monosaccharides like glycosides, deoxy sugar, myoinositol, aminosugars, disaccharides and polysaccharides.Structural polysaccharides- cellulose and chitin.Storage polysaccharides- starch and glycogen.Structure and biological functions of glucosaminoglycans or mucopolysaccharides.Carbohydrate of glyco-protein and glycolipids.Role of sugar in biological recognition. Blood group substances, Ascorbic Acid.Carbohydrate metabolism, Kreb's Cycle, Glycolysis, Glycogenesis and Glycogenolysis, Gluconeogenesis, Pentose Phosphate Pathway.

UNIT III: Lipids

Fatty acids, essential fatty acids, structure and function of triglyceralsglycerophospholipids, Sphingolipids cholesterol, bile acids, prosta-

glandins.Lipoproteins-composition and function, role in atherosclerosis.Properties of lipid aggregates- micelles bilayers,liposomes and their possible biological functions. Biological membranes, Fluid Mosaic model of membranestructure.Lipid metabolism,ß-oxidation of fatty acids.

UNIT IV: Amino acids, Peptides and Proteins

Chemical & enzymatic hydrolysis of proteins to peptides, amino acid sequencing. Secondary structure of proteins, forces responsible for holding of secondary structure. α-helix, β-sheets, super secondary structure, triple helix structure of collagen.Tertiary structure of protein- folding and domainstructure.Quaternary structure.

Amino Acid metabolism, degradation and biosynthesis of amino acid, sequence determination. Chemistry of Oxytocin and tryptophan releasing hormones (TRH)

UNIT V: Nucleic Acid

Purine andpyrimidine bases of nucleic acid, base pairing via H-bonding.Structure of ribonucleic acid (RNA) and deoxyribonucleic acid (DNA), double helix model of DNA and forces responsible for holding it.Chemical and enzymatic hydrolysis of nucleic acids.The chemical bases of heredity, an overview of replication of DNA,transcription, translation and genetic code.Chemical synthesis of mono and trinucleosides.

Book Suggested:

1. Principles of Biochemistry, A.L. Lehninger, Worth Publishers.
2. Biochemistry, L.Stryer, W. H. Freeman.
3. Biochemistry, J. David Rawn, Neil Patterson
4. Biochemistry,Voet&Voet John Wiley
5. Outline of Biochemistry, E.E. Conn and P.K. Stumpf, John Wiley.

CO-PO & PSO Correlation

Course Name: Biology for Chemists										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	2									2
CO 2						2		1		
CO 3						3				1
CO 4	1							1		
CO 5						1				3

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**1st**
Name of the Course:	**Chemistry Lab-I**	**Course Code:**	**MCH 1105**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: I	**Chemistry Lab-I [MCH 1105]**
Students will be able to	
CO1	Determines the procedure for semi micro analysis of inorganic salt mixture
CO2	Purify the organic compounds by using re-crystallization, distillation and paper/TLC techniques.
CO3	Independently perform synthesis of simple organic compounds.
CO4	Distill water and other solvents
CO5	Identify various ions present in water and mixture of salt
CO6	Estimate the ions present in the sample by different techniques

Syllabus:
Inorganic Chemistry

Qualitative Analysis: Semi-micro qualitative analysis of an inorganic mixture containing three catations (one less familiar cation) and three anions (one interfering anion)

Basic Radicals: Ag, Pb, Hg, Bi, Cu, Cd, As, Sb, Sn, Fe, Al, Cr, Zn, Mn, Co, Ni, Ba, Sr, Ca, Mg, Na, K, Ce, Th, Zr, W, Te, Ti, Mo, U, V, Be, Li, Au, Pt.

Acid Radicals: Carbonate, Sulphite, Sulphide, Nitrite, Nitrate, Acetate, Flouride. Chloride, Bromide, Iodide, Sulphate, Borate, Oxalate, Phosphate, Silicate, Thiosulphate, Ferrocyanide, Ferricyanide, Sulphocyanide, Chromate, Arsenate and Permanganate.

Interfering anions: Oxalate, tartrate, phosphate and chromate

Less familiar cations: Tl, Mo, Th, Zr, V and U.

Organic Chemistry

A. Qualitative Analysis

i) Separation and identification of the components of organic binary mixtures, some of which containing compounds with more than one functional group.

ii) Purification Techniques: Crystallization, distillation, sublimation and fractional distillation. Determination of melting point and mixed melting point.

B. Chromatography

i) Thin layer chromatography (TLC): Separation, Purification and Identification of compounds of Binary Mixture; identification of unknown organic compounds by comparing the R_f values with known standards. Column chromatography.

ii) Paper Chromatography: Separation and identification of the sugars in the given mixture of gulucose, fructose and sucrose and determination of $R_f$values.

C. Quantitative Analysis

i) Determination of the percentage or number of Hydroxyl group in an organic compound by Acetylation method.

ii) Estimation of Amines/Phenols using Bromate - Bromide Solution / or Acetylation method.

iii) Determination of equivalent weight of carboxylic compound.

D. *Demonstration of Stereochemical aspects of the compounds through molecular* models.

Book Suggested:

1. Harwood, L.M.and Moody, C.J. Experimental Organic Chemistry, 1st edition, 1989, Blackwell Scientific Publishers.
2. Vogel, A.I. Textbook of Practical Organic Chemistry, 6th edition,1978, ELBS, Longman Group Ltd.
3. Mann, F.G. and Saunders, B.C. Practical Organic Chemistry, 4th edition, New Impression, 1975, Orient Longman Pvt. Ltd.
4. Leonard, J. and Lygo, B. Advanced Practical Organic Chemistry, 1995, Chapman and Hall,.
5. Armarego, W. L. and Chai, C. Purification of Laboratory Chemicals, 2012, Butterworth-Heinemann.
6. Young, J. A. Improving Safety in the Chemical Laboratory: A Practical Guide. 2nd Edition, 1991, Wiley Publishing.
7. B.S. Furnis, A.J. Hannaford, P.W.G. Smith and A.R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, ELBS/Longman, 1989.

8. Shriner, Fuson and Cartin,Systematic Identification of Organic Compounds, 1964.
9. Fieser, Experiments in Organic Chemistry, 1957.
10. Dey, Sitaraman and Govindachari, A Laboratory Manual of Organic Chemistry, 3rd Edition, 1957.
11. P.R. Singh, D.C. Gupta and K.S. Bajpal, Experimental Organic Chemistry, Vol. I and II, 1980.
12. Vogel's quantitative analysis 6 Edn. Mendham, Denny; Pearson Education 2002
13. Synthesis and Technique in Inorganic chemistry , G. S.Girlomi; R.J. Angleci 3rd edn.; University Science Books.
14. Synthesis and characterization of Inorganic compounds W.AJolly
15. Inorganic syntheses Vols II, VI Academic Press.
16. Experimental Inorganic / Physical Chemistry ;Mounir A. MalatiHorwood/1999.
17. Quantitative Chemical Analysis ; 5th edn.; Harris ; Freeman ; 1999.
18. Advanced Practical Inorganic Chemistry ; Adams ; Raynor, Wiley ; 1995.

Advanced Experimental Inorganic Chemistry ;Ayodha Singh ; Campus Books 2002.

CO-PO & PSO Correlation

Course Name: Chemistry Lab-I [MCH 1105]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	2						3			
CO 2		1						2		
CO 3	1							1		
CO 4						2			2	
CO 5	2						2			
CO 6		2							2	

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**1st**
Name of the Course:	**Communication Skills**	**Course Code:**	**MCH 1106**
Credits :	**2**	**No of Hours :**	**30**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: I	**Communication Skills [MCH 1106]**
Students will be able to	
CO1	Acquire knowledge of personal grooming such as, good manners and etiquettes public speaking skills via extempore speeches and prepared speeches, presented before the class which eventually helps build self confidence
CO2	Learn the different types of resumes and develop different types of interview skills and learn about various aspects of group discussion
CO3	Develop a positive attitude which keeps them self-motivated
CO4	Perform SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis and setting their short term and long term goals

Syllabus:

Unit-I COMMUNICATION AND INTERPERSONAL SKILLS:
Communication, the importance of open and clear communication and how to practice the same; Public speaking and communication gaps; Listening Skills, active listening skills and how to give and receive healthy feedback; Collaborative communication; Effect of body language, tone and words.

Unit-II INTRODUCTION TO PERSONALITY DEVELOPMENT:
The concept of personality - Dimensions of personality, The concept of success and failure: What is success? Hurdles in achieving success - Overcoming hurdles, Factors responsible for success – What is failure - Causes of failure, SWOT analysis.

Unit-III ATTITUDE & MOTIVATION ATTITUDE:
Concept, Significance and Factors affecting attitudes, Positive attitude – Advantages, Negative attitude- Disadvantages, Ways to develop positive attitude, and Differences between personalities having positive and negative attitude. Concept of motivation – Significance, Internal and external motives, Importance of self- motivation, Factors leading to de-motivation.

Unit-IV OTHER ASPECTS OF PERSONALITY DEVELOPMENT:
Body language, Goal Setting, Conflict and Stress Management, Decision-making skills, Leadership and qualities of a successful leader, Team-work, Time management, Good manners and etiquette.

Unit -V EMPLOYABILITY QUOTIENT RESUME BUILDING: Resume Writing, the art of participating in Group Discussion, Facing the Personal Interview, Frequently Asked Questions.

REFERENCE BOOKS

1. Raman, Meenakhshi, and Prakash Singh, Business Communication. O U P, New Delhi, 2008.
2. Hurlock, E.B (2006). Personality Development, 28th Reprint. New Delhi: Tata McGraw Hill.
3. Stephen P. Robbins and Timothy A. Judge (2014), Organizational Behavior 16th Edition: Prentice Hall.
4. Communication in a Global Market Place.3rd ed. John Wiley India, New Delhi, 2007.
5. Guffey, Mary Ellen., Business Communication: Process and Product. 3rd ed. Thomson and South-western, 2004.

CO-PO & PSO Correlation

Course Name: Communication Skills [MCH 1106]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1			3							
CO 2		2								
CO 3				2						
CO 4			2			1				

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**II**
Name of the Course:	**Inorganic Chemistry-II**	**Course Code:**	**MCH 1201**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: II	**Inorganic Chemistry-II [MCH 1201]**
Students will be able to	
CO1	Determines the structure of complex using electronic spectra
CO2	Illustrate an understanding of the principles of theories of metal-ligand bond.
CO3	Demonstrate an understanding of spectra of complexes
CO4	Analyze Orgel & Tanabe – Sugano diagrams of transition metal complexes
CO5	Interpret stereochemistry & properties of complexes.

Syllabus:

Unit I:Electronic Spectra and Magnetic Properties of Transition Metal Complexes:

Spectroscopic ground states, Correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1 - d^9 states), Selection rules, mechanism for breakdown of the selection rules, intensity of absorption, band width, spectra of d-d metal complexes of the type [M $(H_2O)_6$] n+, spin free and spin paired ML_6 complexes of other geometries, Calculations of Dq, B and parameters, spin forbidden transitions, effect of spin-orbit coupling, Spectrochemical and Nephelouxetic series.

Unit II: Magnetic Properties of Transition Metal Complexes

Magnetic properties of complexes of various geometries based on crystal field model, spin free-spin paired equillibria in octahedral stereochemistry.variation of the Racah parameter, spectrochemical series, band intensities, factors influencing band widths.

Unit III: Metal – π complexes

Complexes of π-Acceptor Ligands: π- acceptor character of CO, N_2, O_2, NO molecules in terms of MOEL diagrams, acid ligands of other groups of periodic table, Semi-bridging in metal carbonyls and isocyanides of metals. Magnetic, IR and X-ray

diffraction evidence of their structure, acidity and softness, Symbiosis and antisymbiosis, pi complexes of unsaturated organic molecules (bonding with C_2H_4 only). Structures & the IR spectral properties representative transition metal carbonyl complexes

Unit IV: Metal Clusters

Higher boranes, carboranes, metalloboranes and metallocarboranes. Metal carbonyl and halide clusters, compounds with metal-metal multiple bonds.

Unit V: Isopoly and heteropoly acids and salts

Isopoly and heteropoly acids of Mo and W. Preparation, properties and structure.Classification, Preparation, properties and structures of borides, carbides, nitrides and silicide's.SILICATES- Classification and structure.SILICONES-preparation, properties and application.

Books Suggested

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harpes& Row;
3. Chemisiryol the Elements, N.N. Greenwood and A. Earnshow, Pergamon.
4. Inorganic Electron ioSpeciroscopy, A. B. P. Leve r, Elsevier.
5. Magnetochemistry, R.L. Cariin, Springer Vertag,
6. Comprehensive Coordination Chemistry eds., Q. Wilkinson, R.D. Gillars and J.A. McCleverty, Pergamon.

CO-PO & PSO Correlation

Course Name: Inorganic Chemistry-II [MCH 1201]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	2						3			
CO 2		1					2			2
CO 3	1						1		2	
CO 4	1						1		1	
CO 5		1					2			

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**II**
Name of the Course:	**Organic Chemistry-II**	**Course Code:**	**MCH 1202**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: II	**Organic Chemistry-II [MCH 1202]**
Students will be able to	
CO1	Understand the nucleophilic substitution reactions shown by organic molecules and know the mechanistic pathways
CO2	Learn the characteristic features of electrophilic substitutions and understand the different kinds of mechanisms in both aromatic and aliphatic compounds
CO3	Learn the addition reactions in carbon-carbon unsaturated and carbon-hetero atom multiple bonds
CO4	Understand the mechanisms of elimination reactions
CO5	Understand the free radical reactions shown by organic molecules and know the mechanistic pathways
CO6	Understand the structural and stereochemical implications of these reactions on different organic substrates

Syllabus:

UNIT I: Electrophilic Substitution reactions

(a) Aliphatic Electrophilic Substitution: Bimolecular mechanism- S_E2 S_E1 and S_Ei mechanism, Electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

(b) Aromatic Electrophilic Substitution: The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring system. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Gattermann Koch reaction, Vilsmeir reaction.

UNIT II: Nucleophilic Substitution reactions

(a) Aliphatic nucleophilic Substitution: The S_N2, S_Ni, mixed S_N2 and S_Ni and SET mechanism. The neighboring group mechanism, neighboring group participation by π and σ bonds. The S_Ni mechanism. Nucleophilic substitution at an allylic aliphatic trigonal and at a vinylic carbon. Reactivity effects of

substrate structure, attacking nucleophile, leaving group and reaction medium, ambident nucleophile.

(b) Aromatic Nucleophilic Substitution: The S_NAr, S_N1, benzyne and $S_{RN}1$ mechanisms. Reactivity- effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser and Smiles rearrangement.

UNIT III: Free Radical reactions

(a) Types of free radical reactions, free radical substitution mechanism, Mechanism at an aromatic substrate, neighboring group assistance. Reactivity for aliphatic and aromatic substrates at a bridge-head. Reactivity in the attacking radicals. The effect of solvents on reactivity.

(b) Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids. Auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium - salts, Sandmeyer reaction. Free radical rearrangement, Hunsdiecker reaction.

UNIT IV: Addition reactions

(a) Addition to Carbon-Carbon Multiple Bonds
Mechanism and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemo-selectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings, hydroboration, Michael reaction, epoxidation.

(b) Addition to Carbon-Hetero Multiple bonds:
Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters nitriles. Addition of Grignard's reagents, organo-zinc and organo-lithium reagents to carbonyl and unsaturated carbonyl compounds, Wittig reaction. Mechanism of condensation reactions involving enolates- Aldol, Knoevenagel. Claisen, Mannich. Benzoin, Perkin and Stobbe reactions. Hydrolysis of ester and amides, ammonolysis of esters.

UNIT V: Elimination reactions

The E2, E1 and E1cB mechanisms and their spectrum. Orientation of double bond. Reactivity- effects of substrate structures, attacking base, the leaving group and the medium. Mechanism and orientation of pyrolytic elimination

Books Suggested:

1. Advanced Organic Chemistry, Reaction Mechanism and Structure, Jerry March, John Wiley.

2. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry - C.K. Ingold, Cornell University Press.
5. Organic Chemistry, R.T. Morrison and R.N. Boyed, Prentice-Hall.
6. Modern Organic Reactions H.O. House, Benjamin.
7. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon. Blackie Academic and Professional.

Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh Macmillan

CO-PO & PSO Correlation

Course Name: Organic Chemistry-II [MCH 1202]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	2							3		
CO 2	1	2						3		
CO 3	3							2		
CO 4	1							2		
CO 5	2							3		1
CO 6						1				1

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**II**
Name of the Course:	**Physical Chemistry-II**	**Course Code:**	**MCH 1203**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: II	**Physical Chemistry-II [MCH 1203]**
Students will be able to	
CO1	Learn and understand the theories of reaction rates and applications of reaction kinetic chemistry
CO2	Understand the concepts of electrochemistry and conductometric titrations
CO3	Learn and understand the concepts of surface catalysis
CO4	Learn and understand the kinetics of fast reactions

Syllabus:

Unit 1: Electrochemistry

Nernst equation, electrochemical cells, concentration cells with and without liquid junction, application of electrochemical cell, thermodynamics of reversible electrodes and reversible cells. activity-coefficients, mean activity coefficients; Debye-Huckel treatment of dilute electrolyte solutions, derivation of Debye-Huckel limiting law, extended Debye-Huckel law, conductometric titrations.

Unit 2: Reaction Kinetics

Introduction, rates of chemical reactions, mechanisms of chemical reactions and steady state approximation, laws of photochemistry, kinetics of photochemical reactions, collision and transition state theories, stearic factor, treatment of unimolecular reactions, ionic reactions: salt effect.

Unit 3: Fast Reaction

Introduction to time-resolved techniques for absorption and emission measurements, relaxation method, study of kinetics of fast reactions by millisecond stopped-flow, nanosecond flash photolysis techniques, detection and kinetics of reactive intermediates, measurement of fluorescence and phosphorescence lifetimes, photoinduced electron transfer rates.

Unit 4: Adsorption and Catalysis

Adsorption of solids, Gibbs adsorption isotherm, BET adsorption isotherm, Langmuir and Fredulich Isotherms.Homogeneous catalysis and heterogeneous catalysis, enzyme catalysis.Kinetics of catalytic reactions.

Book Suggested:

1. Barrow, G. M. Physical Chemistry, 5th Edition, 2007, Tata McGraw-Hill.
2. Kapoor, K. L. Text Book of Physical Chemistry, Volume 1, 4, 5th Edition, 2011, MACMILLAN Publisher.
3. Atkins, P. and De Paula, J. Atkins' Physical Chemistry.9th Edition, 2009, Oxford University Press.
4. McQuarrie, D. A. and Simon, J. D. Physical Chemistry: A Molecular Approach, 1stedition, 1998, Viva Books,.
5. Moore, J. W. and Pearson, R. G. Kinetics and Mechanism, 3rd edition, 1981, John Wiley and Sons.
6. Silbey, R. J. Alberty, R. A. and Bawendi, M. G. Physical Chemistry, 4th Edition, 2004, Wiley-Interscience Publication.
7. Engel T., Reid, P. and Hehre, W. Physical Chemistry, 3rd Edition, 2012, Pearson Education.
8. Puri, B.R. Sharma L.R. and Pathania M.S. Principles of Physical Chemistry, 46th Edition, 2013, Vishal Publishing Company.
9. Laidler, K. J. Chemical Kinetics, 3rd Edition, 1987, Pearson Education Ltd.
10. Engel T. and Reid, P. Thermodynamics, Statistical Thermodynamics, & Kinetics, 3rd edition, 2013, Pearson Education.
11. Lakowicz, J. R. Principles of Fluorescence Spectroscopy, 3rd edition, 2006, Springer.
12. Raj, G. Surface Chemistry (Adsorption), 4th Edition, 2002, Goel Publishing House.

CO-PO & PSO Correlation

Course Name: Physical Chemistry-II [MCH 1203]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	2								3	
CO 2	1								2	
CO 3						2			1	2
CO 4						1			2	

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**II**
Name of the Course:	**Group theory & Spectroscopy**	**Course Code:**	**MCH 1204**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: II	**Group theory & Spectroscopy [MCH 1204]**
Students will be able to	
CO1	Learn and understand the concept of group theory
CO2	Understand the concept of building a character table, hybridization and crystal symmetry
CO3	Learn and understand the concept of Atomic and Molecular spectroscopy
CO4	Understand the concept of IR and Raman Spectroscopy is well understood
CO5	Learn and understand the concepts of microwave and photoelectron spectroscopy

Syllabus:

UNIT I: Symmetry and Group Theory

Symmetry elements and symmetry operation, definitions of group, subgroup, relation between orders of a finite group and its subgroup. Conjugacy relation and classes. Generators, Point symmetry group. Representations of group operators, The great orthogonality theorem (without proof) and its explanation. Irreducible and reducible representation. Bases of representation, Character of a representation. Character table and its meaning. Reduction formula.

UNIT II: Unifying Principles

Electromagnetic radiation, interaction of electromagnetic radiation with matter: absorption, emission, transmission, Uncertainty relation and natural line width and natural line broadening, transition probability, results of the time dependent perturbation theory, transition moment, and intensity of spectral lines.

UNIT III: Vibrational Spectroscopy

Infrared Spectroscopy

Review of linear harmonic oscillator, vibrational energies of diatomic molecules, zero point energy, force constant and bond strengths; anharmonicity, Morse potential energy diagram, vibration-rotation spectroscopy, P, Q, R branches. Born-Oppenheimer approximation, Breakdown of Oppenheimer approximation; vibrations of polyatomic molecules Selection rules, normal modes of vibration, group

frequencies, overtones, hot bands, factors affecting the band positions and intensities, far IR region, metal-ligand vibrations, normal co-ordinate analysis.

Raman Spectroscopy

Classical and quantum theories of Raman effect. Pure rotational, vibrational and vibrational rotational Raman spectra, selection rules, Mutual exclusion principle. Resonance Raman spectroscopy, coherent anti Stokes Raman spectroscopy (CARS).

UNIT IV: Electronic Spectroscopy

Atomic Spectroscopy

Energies of atomic orbitals, vector representation of momenta and vector coupling, electronic configuration, Russell-Saunders terms and coupling schemes, magnetic effects: spin-orbit coupling and Zeeman splitting, spectra of hydrogen atom and alkali metal atoms.

Molecular Spectroscopy

Energy levels, molecular orbitals, vibronic transitions, vibrational progressions and geometry of the excited states, Franck-Condon principle, electronic spectra of polyatomic molecules. Emission spectra; radiative and non-radiative decay, internal conversion, spectra of transition metal complexes, charge-transfer spectra.

UNIT V: Microwave Spectroscopy

Classification of molecules, rigid rotor model, effect of isotopic substitution on the transition frequencies, intensities, non-rigid rotor. Stark effect, nuclear and electron spin interaction and effect of external field. Applications.

Photoelectron Spectroscopy

Basic principles, photo-electric effect, ionization process, Koopman's theorem.Photoelectron spectra of simple molecules, ESCA, chemical information from ESCA.Auger electron spectroscopy – basic idea.

Books Suggested:

1. Modern Spectroscopy, J.M.Hollas, John Wiley, 4th edition, 2004, Sussex.
2. Applied Electron Spectroscopy for Chemical Analysis Ed. H. Windawi and F.L.Ho, Wiley Inter science.
3. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Harwood, 1st edition, 1990.
4. Physical Methods in Chemistry, R.S.Drago, Sauders College.
5. Introduction to Molecular Spectroscopy, G.M.Barrow, McGraw Hill
6. Basic Principles of Spectroscopy, R.Chang, McGraw Hill.
7. Theory and Applications of UV Spectroscopy, H.H.Jaffe and M.Orchin, IBH-Oxford.
8. Introduction to Photoelectron Spectroscopy, P.K.Ghosh, John Wiley.
9. Introduction to Magnetic Resonance, A. Carrington and A.D. Maclachalan, Harper & Row.
10. Inorganic spectroscopic methods, A.K. Brisdon, Oxforuniversity Press, Oxford Chem. Primers, 1997, New York.
11. Spectroscopy, S. Walker and H. Straw, Chapman and Hall ltd.

12. Energy levels in atom and molecules, W.G. Richards and P.R. Scott, Oxford University Press, Oxford Chemistry Primer vol. 26, 1994, New York.
13. Introduction to Spectroscopy, Pavia, Brooks/Cole Cenage, 4th edition, 2009, Belmont.
14. EPR: Elemental theory and applications, J.A. Well. J.R. Bolton,Wiley, 2nd edition, 2007, New Jeresy.
15. Electron Paramagnetic resonance of transition ions, A. Abraham and B. Bleaney, Clarendon Press, 1970, Oxford.
16. Essentials of Nuclear Chemistry, H.J. Arnikar, John Wiley, 4th edition, 1995, New Delhi.
17. Fundamental of Molecular Spectroscopy, C. N. Banwell and E. McCash, Tata McGraw Hill, 4th edition, 1994, New Delhi.
18. Symmetry ans Spectroscopy of Molecules, , K.V. Reddy, New Age International (P) Ltd., Ist edition, 1998, New Delhi.Fundamental Concepts of Inorganic Chemistry, A. K. Das and M. Das, Vol. 7,1st edition, 2014, CBS Publisher Pvt. Ltd., New Delhi.
19. Molecular Spectrocopy, P.S. Sindhu, Tata McGraw Hill , 1985, New Delhi.

CO-PO & PSO Correlation

Course Name: Group theory & Spectroscopy [MCH 1204]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	2								3	
CO 2	1							2		
CO 3		1							2	
CO 4						1			1	
CO 5						1			2	

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**II**
Name of the Course:	**Chemistry Lab-II**	**Course Code:**	**MCH 1205**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: II	**Chemistry Lab-II [MCH 1205]**
Students will be able to	
CO1	Separate and identify the metal ions in a given material sample by volumetric and gravimetric methods
CO2	Separation of mixture of metallic ions by paper chromatography
CO3	Synthesize organic compounds involving two or more steps
CO4	Estimate organic compounds
CO5	Determination of different physical properties in given material

Syllabus:

Inorganic Chemistry

Quantitative analysis: Separation and determination of two metal ions in ores, alloys, or mixtures in solution, one by volumetric and the other by gravimetric methods.

Quantitative Analyses Estimation of Cations in two- cation systems using gravimetric and volumetric (EDTA or Redox) methods.

a) To estimate copper and zinc in the given solution
b) To estimate iron and Nickel in the given solution
c) Quantitative analysis of a mixture of iron (volumetry) and copper (gravimetry)
d) To determine magnesium against EDTA using EBT as an indicator

2. PAPER CHROMATOGRAPHY:

a) Paper chromatography separation of Ni(II), Co(II), Mn(II) and Zn(II) ions
b) Paper chromatography separation of Hg(II), Cu(II), Pb(II), Bi(II) and Cd(II) ions

Organic Chemistry

A. ***Organic Synthesis:*** Preparation of pure and crystalline compound with confirmation of melting point

i) Synthesis of chalcones via Claisen-Schmidt condensation.
ii) Reduction of benzophenone to benzhydral using NaBH4.
iii) Conversion of benzaldehyde to cinnamic acid (Knoevenagel condensation)
iv) Bromination - Preparation of p-Bromo Aniline from Acetanilide.
v) Nitration - Preparation of p-Nitro Aniline from Acetanilide
vi) Hofman Bromide Reaction - Preparation of Anthranilic Acid from Pthallic anhydride.
vii) Aldol Condensation - Dibenzal acetone from Bazaldehyde.
viii) Sandmeyer Reaction -
   a. o-Chloro Benzoic Acid from Anthranilic Acid,
   b. p-Chloro toluene from Toludine.

B. Quantitative Analysis

i) Estimation of Carbonyl group by Hydrazone method.
ii) Estimation of Glycine by titration.
iii) Determination of DO, COD and BOD of water sample
iv) Estimation **of carboxyl group by titration / silver salt-method.**

C. ChemDraw-Sketch:

Draw the structure of simple aliphatic, aromatic, heterocyclic organic compounds with substituents. Get the correct IUPAC name and predict the UV, IR and 1H-NMR signal analysis.

Physical Chemistry

1. Determination of strength of a given base by titrating with an acid conductometrically.
2. Determination of solubility and solubility product of sparingly soluble salts (e.g., $PbSO_4$, $BaSO_4$) conductometrically.
3. Determination standard electrode potential of Fe^{2+}/Fe^{3+} system by potentiometer using potassium permanganate solution.
4. Determination of pK_a of acetic acid and glycine by pH meter using NaOH.
5. Determination of relative and absolute viscosity of a given liquid.
6. Determination of surface tension of alcohols.
7. Determination of refractive indices of given liquids.
8. Determination of concentrations of heme proteins using spectrophotometer
9. Preparation of buffers and measurement of their pH
10. Verification of the Lambert Beer's law.

11. Structural analysis of amino acids and proteins using FTIR and CD spectrometer.
12. Determination of the T_m values of DNA and proteins.
13. Study of the thermal/cold denaturations of proteins using UV-visible and CD spectroscopic techniques.
14. Molecular weight of a non-electrolyte by cryoscopy method.
15. Determination of stability constant of Fe(III)-salicyclic acid complex by spectrophotometer.

Book Suggested:

1. Harwood, L.M. and Moody, C.J. Experimental Organic Chemistry, 1st edition, 1989, Blackwell Scientific Publishers.
2. Vogel, A.I. Textbook of Practical Organic Chemistry, 6th edition,1978, ELBS, Longman Group Ltd.
3. Mann, F.G. and Saunders, B.C. Practical Organic Chemistry, 4th edition, New Impression, 1975, Orient Longman Pvt. Ltd.
4. Leonard, J. and Lygo, B. Advanced Practical Organic Chemistry, 1995, Chapman and Hall,.
5. Armarego, W. L. and Chai, C. Purification of Laboratory Chemicals, 2012, Butterworth-Heinemann.
6. Young, J. A. Improving Safety in the Chemical Laboratory: A Practical Guide. 2nd Edition, 1991, Wiley Publishing.
7. B.S. Furnis, A.J. Hannaford, P.W.G. Smith and A.R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, ELBS/Longman, 1989.
8. Shriner, Fuson and Cartin, Systematic Identification of Organic Compounds, 1964.
9. Fieser, Experiments in Organic Chemistry, 1957.
10. Dey, Sitaraman and Govindachari, A Laboratory Manual of Organic Chemistry, 3rd Edition, 1957.
11. P.R. Singh, D.C. Gupta and K.S. Bajpal, Experimental Organic Chemistry, Vol. I and II, 1980.
12. Vogel's quantitative analysis 6 Edn. Mendham, Denny; Pearson Education 2002
13. Synthesis and Technique in Inorganic chemistry , G. S.Girlomi; R.J. Angleci 3rd edn.; University Science Books.
14. Synthesis and characterization of Inorganic compounds W.AJolly
15. Inorganic syntheses Vols II, VI Academic Press.
16. Experimental Inorganic / Physical Chemistry ;Mounir A. MalatiHorwood/1999.

17. Quantitative Chemical Analysis ; 5th edn.; Harris ; Freeman ; 1999.
18. Advanced Practical Inorganic Chemistry ; Adams ; Raynor, Wiley ; 1995.
19. Advanced Experimental Inorganic Chemistry ;Ayodha Singh ; Campus Books 2002.
20. Nad, A. K., Mahapatra, B. and Ghoshal, A. An Advanced Course in Practical Chemistry, 2014, New Central Book Agency (P) Ltd.
21. Maity S. and Ghosh, N. Physical Chemistry Practical, 2012, New Central Book Agency (P) Ltd.
22. Elias, A. J. Collection of Interesting General Chemistry Experiments, 2008, Universities Press.
23. Khosla, B.D., Garg, V.C., and Gulati A.R., Senior Practical Physical Chemistry, 2007, S. Chand& Sons.
24. Yadav, J.B. Advanced Practical Physical Chemistry, 2008, Krishna Prakasan Media.
25. Das, R.C. and Behra, B. Experimental Physical Chemistry, 1983, Tata McGraw-Hill.
26. James, A.M. and Prichard, F.E. Practical Physical Chemistry, 3rdedition, 1974, Longman, Harlow.
27. Ghosh, J.C., Experiments in Physical Chemistry, 1990, BharatiBhavan.

CO-PO & PSO Correlation

Course Name: Chemistry Lab-II [MCH 1205]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	1								2	
CO 2		2							3	
CO 3		1						3		
CO 4		1						2		
CO 5		1								2

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**III**
Name of the Course:	**Inorganic Chemistry-III**	**Course Code:**	**MCH 2101**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: III	**Inorganic Chemistry-III [MCH 2101]**
Students will be able to	
CO1	Understand solid state chemistry of inorganic molecules and learn various crystal defects
CO2	Learn principles and applications of X-ray diffraction methods
CO3	Learn and understand electronic properties and band theory of semi-conductors
CO4	Understand the fundamentals of Auger spectroscopy and Scanning Electron Microscopy and its applications
CO5	Learn principles of ESR and NMR spectroscopy

Syllabus:

Unit I:

Solid state: Forms of solids, Theory- the crystal systems and Bravais lattices, Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices, - Miller indices and labelling of planes.

Crystal defects and Non-stoichiometry: Perfect and imperfect crystals, intrinsic and extrinsic defects - point defect, line and plane defects, vacancies - Schotty defects and Frankel defects. Thermodynamics of Schotty and Frenkel defect, formation of color centres, nonstoichiometry and defects.

Unit II:

Solid State Reactions: General principles: experimental procedures, kinetics of solid state reactions, vapour phase transport methods, interaction or ion exchange reaction, electrochemical reduction methods, preparation of this films, growth of single crystal, high pressure and hypothetical method.

Unit III: Electronic properties and Band theory of semiconductors:

Metals, Insulators and Semiconductors, Electronic structure of solid, band structure of metals, insulators and semiconductors, Intrinsic and extrinsic semiconductors, doping of semiconductors and conduction mechanism, the band gap, temperature dependence of conductivity, carrier density and carrier mobility in semiconductors, synthesis and purification of semiconducting materials, single crystal growth, zone refining, fractional crystallization, semiconductor devices, rectifier transistors, optical devices, photoconductors, photovoltaic cells, solar batteries.

Unit IV: Diffraction methods:

Symmetry properties - crystallographic point groups and space groups. Determination of space group with examples. - X-ray diffraction - powder and rotating crystal methods - systematic absences and determination of lattice types - analysis of X-ray data for cubic system - structure factor and Fourier synthesis.

Unit V:

Fundamentals of electron and neutron diffraction: Principle, instrumentations and application of Auger spectroscopy and Scanning Electron Microscopy for chemical characterization, electron diffraction of gases and vapours, The Wierl equation and co-related method, application of electron diffraction. Neutron diffraction: Introduction, differences between neutron and X- ray diffraction. Application to structure modification and magnetic compounds.

Electron spin resonance: Principles of ESR, hyperfine splitting in simple systems, Instrumentation, factors affecting G values, applications to inorganic complexes.

Nuclear magnetic resonance of paramagnetic substances in solution: Principle Instrumentation of NMR, the chemical shift, mechanism of electron shielding and factors contributing to the magnitude of chemical shift. Local & remote effect, spin-spin splitting, applications of spin coupling to structural determination, double Resonance techniques. The contact and Pseudo contact shifts Factors affecting nuclear relaxation,

Books Suggested

1. Modern Spectroscopy, J.M. Hollas, John Wiley.
2. Applied Electron Spectroscopy lor Chemical Analysis Ed. H. Windawi and F.L. Ho. Wiley Interscience.
3. NMR, NOR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Harwood.
4. PhysicaI' Methods in Chemistry, R.S. Drago, Saunders College.
5. Chemical Applications of Group Theory, F. A. Cotton.
6. Introduction to Molecular Spectroseopy, Q.M. Barrow, McCraw Hill.

7. Basic Principles of Spectroscopy. R. Chang, McOraw Hill.
8. Theory and Applications of UV Spectroscopy, H.H. Jatie and M. Orehin, IBH-Oxford.
9. Introduction to Photoelectron Spectroscopy, P. K. Ghosh, John Wiley.
10. Introduction to Magnetic Resonance, A. Carrington and A.D. Maclachalan, Harper & Row.
11. Crystallography - Philips
12. Solid State chernistry-Garner (Butterworth; London)
13. Solid State Chemistry -D.K.Chakraborty (New Age int Publication)
14. Solid State Chemistry- N. BHannay (Prentice Hall, New Jersay)

Physical Chemistry- Waller J. Moore 6 Physical Chemistry - P.W. Atkins

CO-PO & PSO Correlation

Course Name: Inorganic Chemistry-III [MCH 2101]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	1	1					2			
CO 2	2	1	2							2
CO 3	1									1
CO 4	2	1	2							2
CO 5	2	1	2					2		

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**III**
Name of the Course:	**Organic Chemistry-III**	**Course Code:**	**MCH 2102**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: III	**Organic Chemistry-III [MCH 2102]**
Students will be able to	
CO1	Understand the structural and stereochemical implications on photochemical reactions
CO2	Determine the mechanism of photochemical reactions in various organic substrate
CO3	Learn concepts and applications of UV-Vis spectroscopy
CO4	Learn the concept IR spectroscopy and are able to find out the IR stretching frequency of organic functional groups
CO5	Students learn the principles, techniques and applications the of NMR spectroscopy for the structural elucidations
CO6	Know the instrumentation, ionization techniques and fragmentation patterns, of chemical compounds using mass spectrometry

Syllabus:

UNIT I:

Photochemical Reactions

Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry.

Determination of Reaction Mechanism

Classification, rate constants and life times of reactive energy states – determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions. Types of photochemical reactions – photo-dissociation, gas-phase photolysis.

UNIT II:

Photochemistry of alkenes:

Intramolecular reactions of the olefinic bond – geometrical isomerism, cyclization reactions, rearrangement of 1,4– and 1,5– dienes.

Photochemistry of Carbonyl Compounds:

Intramolecular reactions of carbonyl compounds – saturated, cyclic and acylic, γ,β-unsaturated and β,α-unsaturated compounds. Cyclohexadienones.

Photochemistry of Aromatic Compounds

Isomerisations, additions and substitutions

Miscellaneous Photochemical Reactions

Photo-Fries reactions of anilides. Photo-Fries rearrangement. Barton reaction. Singlet molecular oxygen reactions. Photochemical formation of smog. Photodegradation of polymers. Photochemistry of vision.

UNIT III:

Ultraviolet and Visible Spectroscopy

Various electronic transitions (185–800 nm), Beer–Lambert Law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polynes Fleser-Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds. Steric effect in biphenyls.

Infrared Spectroscopy

Instrumentation and sample handling, Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugatged carbonyl compounds) Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance, FTIR. IR of gaseous, solids and polymeric materials. Optical Rotatory Dispersion (ORD) and Circular Dichroism (CD). Defination, deduction of absolute configuration, octant rule for ketones.

UNIT IV: Nuclear Magnetic Resonance Spectroscopy

Chemical shift values and correlation for protons bonded to carbon (Aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carbodylic acids, amines, amides & mercapto), chemical exchange, effect of deuteration, complex spin-spin interaction between two,three, four and five nuclei

(first order spectra), virtual coupling. Stereochemistry, hindered rotation, Karplus curve-variation of coupling constant with dihedral angle. Simplification of complex spectra nuclear magnetic double resonance, contact shift reagents, solvent effects. Fourier transform technique, nuclear Overhauser effect (NOE). Resonance of other nuclei-F,P.

UNIT V

Carbon-13 NMR Spectroscopy

General considerations, chemical shift (Aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants. Two dimension NMR spectroscopy – COSY, NOESY, DEPT, INEPT, APT and INDEQUATE techniques.

Mass Spectrometry

Introduction, ion production – El, Cl, FD and FAB, factors affecting fragmentation, ion analysis, ion abundance. Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, McLafferty rearrangement. Nitrogen rule. High resolution mass spectrometry. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

Books Recommended:

1. Fundamentals of Photochemistry, K. K. Rohtagi-Mukherji, Wilcy-Eastern.
2. Molecular Photochemistry, N. J. Turro, W. A. Benjamin.
3. Introductory Photochemistry, A. Cox and T. Camp. McGraw-Hill.
4. Photochemistry, R. P. Kundall and A. Gibert, Thomson Nelson.
5. Organic Photochemistry, J. Coxon and B. Halton, Cambridge University Press.
6. Textbook of Organic Chemistry 1st Ed., P. S. Kalsi, New Age International (P) Ltd. Pub.
7. Organic Chemistry, R. T. Morrison, & R. N. Boyd, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Organic Spectroscopy, W. Kemp, Palgrave
9. A Complete Introduction to Modern NMR Spectroscopy, Roger S. Macomber, Willey Publication, 1997

10. Modern NMR Spectroscopy : A Guide for Chemists. J. K. M. Sanders, B. K. Hunter. Oxford UniversityPress, 1993

11. Principles of nuclear magnetic resonance in one and two dimensions. R. R. Ernst, Geoffrey Bodenhausen, and Alexander Wokaun. Oxford University Press, 1987

12. Spectrometric Identification of Organic Compounds, R. M. Silverstein, F. X. Webster, D. J. Kiemle, D. L. Bryce, Willey, 8th Edition (2015).

CO-PO & PSO Correlation

Course Name: Organic Chemistry-III [MCH 2102]										
COs	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	2							2		
CO 2	3		1					2		
CO 3	3		1					2		1
CO 4	2		1					2		1
CO 5	3		2					2		1
CO 6	2		1					1		1

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**III**
Name of the Course:	**Physical chemistry-III (Quantum Chemistry)**	**Course Code:**	**MCH 2103**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: III	**Physical chemistry-III (Quantum Chemistry) [MCH 2103]**
Students will be able to	
CO1	Basic idea about quantum chemistry
CO2	Mathematics associated with quantum statistics including certain aspects of linear algebra
CO3	Quantum chemistry and how to apply this knowledge to atomic and molecular structure
CO4	Learn the concept of probability distribution is learnt

Syllabus:

Unit - I:

Brief review of failure of classical mechanics. Origin of quantum theory, black body radiation, atomic spectra, photoelectric effect, matter waves, wave nature of the electron, Wave Particle duality. the wave equation, the theory of hydrogen atom, particle in one dimensional box, transformation of coordinates, Separation of variables and their significance. The dynamics of microscopic systems: The Schrodinger equation, the uncertainty principle, the interpretation of the wave function.

Unit - II:

Formalism of Quantum Mechanics: Postulates of Quantum Mechanics, Eigen function and Eigen values, Operators, Acceptability of wave functions, Normalized and orthogonal wave functions. Principles of superposition, Schmidt Orthogonalisation, Hermitian operators , Theorems related to commutator operations, Stern- Gerlach experiment and spin of electron. Spin Eigen function. Concept of angular momentum, angular momentum operators. Ladder operators.

Unit - III:

Quantum Mechanics of some simple systems: Practical in a box: One dimensional Box - application to spectra of linear conjugated molecular. Degeneracy in multidimensional box. Potential well of finite depth (Tunneling effect) Rigid rotator, Linear harmonic oscillator, the formal solutions, energy levels, degeneracy, properties of wave functions and selection rules.

Unit - IV:

The hydrogen Problem: Schrodinger equation for hydrogen atoms (polar co. ordinates) and its solution. The radial distribution function and its significance, shape of atom orbitals.

Unit - V:

A brief introduction to hydrogen like atoms. Helium atoms. Approximate methods: Perturbation theory and Self-consistent field theory, chemical bonding and hybridization. Approximate methods: The Variation theorem and principles, its use to obtain optimum molecular orbital and energies.

REFFERENCE BOOKS

1. Introductory Quantum Chemistry by A. K. Chandra. Tata McGraw-Hill. 1988.

2. Basic Physical Chemistry by W. J. Moore, Prentice Hall, 1986.

3. Physical Chemistry, by P. W. Atkins , ELBS, 1986.

4. Quantum Chemistry, W. Kauzmann, Academic press.

5. Quantum Chemistry by Hanns.

6. Theoretical Chemistry by S. Glasstone , Van Nostrand .

7. Physical Chemistry by Alberty .

8. Quantum Chemistry by Prasad

9. Huckel Molecular theory by Keith Yates Paper No.PCH-302:

CO-PO & PSO Correlation

Course Name: Physical chemistry-III (Quantum Chemistry) [MCH 2103]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	2								1	
CO 2	1								1	
CO 3	2		2						1	1
CO 4	1								1	

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**III**
Name of the Course:	**Computers for Chemists**	**Course Code:**	**MCH 2104**
Credits :	**2**	**No of Hours :**	**30**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: III	**Computers for Chemists [MCH 2104]**
Students will be able to	
CO1	Understand basics of I/O devices and operating system
CO2	Learn and understand programming in C
CO3	Use computer programming and its applications in chemistry
CO4	Operate various packages like MS-Word, Power point and Excel

Syllabus:

UNIT I: Introduction to Computers and Computing

Basic structure and functioning of computers with a PC as an illustrative example. Memory, I/O devices. Secondary storage. Computer languages. Operating systems with DOS as an example. Introduction to UNIX and WINDOWS. Data Processing, principles of programming. Algorithms and flow-charts.

UNIT II: Programming in C

Elements of the computer language. Constants and variables. Operations and symbols. Expressions. Arithmetic assignment statement. Input and Output. Format statement. Termination statements. Branching statements such as IF or GO TO statement. LOGICAL variables. Double precision variables. Subscripted variables and Dimension. DO statement. FUNCTION and SUBROUTINE. COMMON and DATA statements. (Students learn the programming logic and these language features by 'hands on' experience on a personal computer from the very beginning of this topic)

UNIT III: Programming in Chemistry and use of Computer Programmes,

Development of small computer codes Involving simple formulae in Chemistry such as Vander Waals Equation, pH Titrations, Kinetic. Radioactive Decays. Evaluation of Lattice Energy and lonic radii from experimental data. Linear simultaneous

equations to solve secular equation (within Huckel Theory), Elementary structural features, such as, bond lengths, bond angle, dihedral angles, etc. of molecules extracted from a database such as Cambridge data base.

UNIT IV: Use of Computer Programmes-I

The students will learn how to operate a PC and how to run standard programmes and packages. Execution of linear regression, X-Y plot, numerical integration and differentiation as well as differential equation solution programmes.

UNIT V: Use of Computer Programmes-II

Programmes with data preferably from Physical Chemistry Laboratory. Further, the students will operate the packages MS- WORD, POWER POINT AND EXCEL.

Books suggested:

1. Computer and Common Sense, R. Hunt and J. Shelley Prentice Hall.
2. Computational Chemistry A.C. Norris.
3. Micro Computer Quantum Mechanics. J.P. Kilingbeck. Adam Hilger.
4. Computer Programming in FORTRAN IV, V. Rajaraman, Prentice Hall.
5. An Introduction to Digital Computer Design, V. Rajaraman and T. Radhakrishanan Prentice Hall.

CO-PO & PSO Correlation

Course Name: Computers for Chemists [MCH 2104]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	1									1
CO 2	1									1
CO 3	1	1								2
CO 4	1									1

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**III**
Name of the Course:	**Chemistry Lab-III**	**Course Code:**	**MCH 2105**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: III	**Chemistry Lab-III [MCH 2105]**
Students will be able to	
CO1	Learn preparation of inorganic compounds and their characterizations
CO2	Understand the double stage organic preparations
CO3	Learn extraction techniques and purification
CO4	Learn spectroscopic estimation of organic compounds
CO5	Learn and understand the effect of ionic strength on the rate constant
CO6	know concepts of kinetics and determine rate constant & activation energy of chemical reaction
CO7	Understand surface catalysis and adsorption concepts
CO8	Learn concept of adsorption isotherm

Syllabus:

Inorganic Chemistry

4. **PREPARATIONS:-** Preparation of selected inorganic compound and their characterizations. Handling of air and moisture sensitive compounds

a) $VO(acac)_2$
b) $TiO(C_9H_8NO)_2.\ 2H_2O$
c) cis-K $[Cr(C_2O_4)_2(H_2O)_2]$
d) Na $[Cr\ (NH_3)_2(SCN)_4]$
e) Prussian Blue, Turnbull's Blue.
f) $[Co\ (NH_3)_6]\ [Co(NO_2)_6]$
g) cis-$[Co(trien)\ (NO_2)_2]Cl.\ H_2O$
h) Hg $[Co(SCN)_4]$
i) $[Co(Py)_2Cl_2]$
j) $[Ni\ (NH_3)_6]Cl_2$
k) $Ni(DMG)_2$
l) $[Cu(NH_3)_4]SO_4.H_2O$

Organic Chemistry

A. Organic Synthesis:

i) Oxidation - Adipic Acid by Chromic Acid oxidation of cyclohexanol.

ii) Friedal Craft's Reaction - β-Benzoyl Propionic acid from Succinic anhydride and Benzene.

iii) Diazotization -

iv) Preparation of methyl orange from Sulphanilic Acid.

v) Phenyl Azo- β-Naphthol from Aniline.

vi) Preparation of Acridone from N- Phenyl anthranilic acid.

vii) Grignard's reaction: Synthesis of tripheny Imethanol from Benzoic acid.

viii) Beckmann rearrangement: Benzanilide fron Benzene

ix) Benzilic acid rearrangement: Benzilic acid from Benzoin

x) Skraup's **synthesis: Quinoline from aniline**

B. Extraction of Natural products

i) Caffeine from tea leaves

ii) Casein from milk

iii) Lactose from milk

iv) Nicotine dipicrate from tobacco

v) Lycopene from tomatoes

vi) β-carotene from carrots

vii) Citral from lemon glass

C. Spectrophotometric (UV/VIS) Estimations

i) Amino acids
ii) Proteins
iii) Carbohydrates
iv) Cholesterol
v) Ascorbic acid
vi) Aspirin
vii) Caffeine

Physical Chemistry Lab

1. To verify Freundlich and Langmuir adsorption isotherms for adsorption of acetic acid on activated charcoal.
2. Determination of partition coefficient of benzoic acid between organic solvent and water.
3. Determination of partition coefficient of iodine between water and octanol and determination of equilibrium constant of tri-iodide.
4. Determination of rate constant of hydrolysis of an ester and to study the effect of ionic strength on reaction rate.
5. To study kinetics of inversion of cane sugar by optical rotation measurement.
6. Determination of activation energy of a reaction by spectrophotometer.
7. Energy of activation of acid catalyzed hydrolysis of methyl acetate.
8. Kinetics of acid-catalysed reaction between acetone-iodine
9. Determination of order of $S_2O_8^{2-} + I^- \rightarrow SO_4^{2-} + I_2$ reaction
10. Determination of energy of activation of $S_2O_8^{2-} + I^- \rightarrow SO_4^{2-} + I_2$ reaction
11. Studies on the effect of variation of ionic strength on the rate of $S_2O_8^{2-} + I^- \rightarrow SO_4^{2-} + I_2$ reaction
12. Determination of the rate constant for the oxidation of iodide ions by hydrogen peroxide studying the kinetics as an iodine clock reaction.

Book Suggested:

1. Harwood, L.M. and Moody, C.J. Experimental Organic Chemistry, 1st edition, 1989, Blackwell Scientific Publishers.
2. Vogel, A.I. Textbook of Practical Organic Chemistry, 6th edition,1978, ELBS, Longman Group Ltd.
3. Mann, F.G. and Saunders, B.C. Practical Organic Chemistry, 4th edition, New Impression, 1975, Orient Longman Pvt. Ltd.
4. Leonard, J. and Lygo, B. Advanced Practical Organic Chemistry, 1995, Chapman and Hall,.
5. Armarego, W. L. and Chai, C. Purification of Laboratory Chemicals, 2012, Butterworth-Heinemann.

6. Young, J. A. Improving Safety in the Chemical Laboratory: A Practical Guide. 2nd Edition, 1991, Wiley Publishing.
7. B.S. Furnis, A.J. Hannaford, P.W.G. Smith and A.R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, ELBS/Longman, 1989.
8. Shriner, Fuson and Cartin, Systematic Identification of Organic Compounds, 1964.
9. Fieser, Experiments in Organic Chemistry, 1957.
10. Dey, Sitaraman and Govindachari, A Laboratory Manual of Organic Chemistry, 3rd Edition, 1957.
11. P.R. Singh, D.C. Gupta and K.S. Bajpal, Experimental Organic Chemistry, Vol. I and II, 1980.
12. Vogel's quantitative analysis 6 Edn. Mendham, Denny; Pearson Education 2002
13. Synthesis and Technique in Inorganic chemistry , G. S.Girlomi; R.J. Angleci 3rd edn.; University Science Books.
14. Synthesis and characterization of Inorganic compounds W.AJolly
15. Inorganic syntheses Vols II, VI Academic Press.
16. Experimental Inorganic / Physical Chemistry ; Mounir A. Malati Horwood/1999.
17. Quantitative Chemical Analysis ; 5th edn.; Harris ; Freeman ; 1999.
18. Advanced Practical Inorganic Chemistry ; Adams ; Raynor, Wiley ; 1995.
19. Advanced Experimental Inorganic Chemistry ; Ayodha Singh ; Campus Books 2002.
20. Nad, A. K., Mahapatra, B. and Ghoshal, A. An Advanced Course in Practical Chemistry, 2014, New Central Book Agency (P) Ltd.
21. Maity S. and Ghosh, N. Physical Chemistry Practical, 2012, New Central Book Agency (P) Ltd.
22. Elias, A. J. Collection of Interesting General Chemistry Experiments, 2008, Universities Press.
23. Khosla, B.D., Garg, V.C., and Gulati A.R., Senior Practical Physical Chemistry, 2007, S. Chand & Sons.
24. Yadav, J.B. Advanced Practical Physical Chemistry, 2008, Krishna Prakasan Media.
25. Das, R.C. and Behra, B. Experimental Physical Chemistry, 1983, Tata McGraw-Hill.

26. James, A.M. and Prichard, F.E. Practical Physical Chemistry, 3rdedition, 1974, Longman, Harlow.

Ghosh, J.C., Experiments in Physical Chemistry, 1990, Bharati Bhavan.

CO-PO & PSO Correlation

Course Name: Chemistry Lab-III [MCH 2105]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	1		1				2			
CO 2	1							2		
CO 3	1		1							1
CO 4	1		1							2
CO 5									1	
CO 6	2		1						2	
CO 7	2								1	
CO 8	2								1	

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**III**
Name of the Course:	**Industrial/Academic Research Training & Seminar**	**Course Code:**	**MCH 2106**
Credits :	**2**	**No of Hours :**	**30**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: III	**Industrial/Academic Research Training & Seminar [MCH 2106]**
Students will be able to	
CO1	Identify a problem/topic related to a specific field of Chemical sciences
CO2	Carry out literature survey and summarize regarding the scope of the topic
CO3	Compile a report for presentation

Syllabus:

The paper will consist of (a) Field work/Lab work related to the project.

(b) Preparation of dissertation based on the work undertaken.

(c) Presentation of project work in the seminar on the assigned topic in the P.G. Department of Chemistry, OP Jindal University, open viva there on.

NB:- The students will select topics for the project work in consultation with a teacher of the department. Topics Project work related to the following Industrial/socially relevant topics may be given to the students of M.Sc. IV Semester (a) Environmental study such as Analysis of water, soil, air etc. (b) Industrial goods analysis such as (i) Analysis of Cement (ii) Analysis of minerals available in Jharkhand State (iii) Synthesis of useful commercial products based on raw materials available in Jharkhand state such as Lac, lime-stone etc. (iv) Isolation of Constituents of medicinal plants available Jharkhand State.

Each student has to submit Four copies of the dissertation work duly forwarded by the HOD/Faculty advisor of Department concerned.

The forwarded copies will be submitted in the Department of Chemistry, OP Jindal University, for evaluation (Seven days before the seminar).

CO-PO & PSO Correlation

Course Name: Industrial/Academic Research Training & Seminar [MCH 2106]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1		2	2							1
CO 2	2	1	2							1
CO 3			1	1						1

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**IV**
Name of the Course:	**Environmental Chemistry**	**Course Code:**	**MCH2201**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: IV	**Environmental Chemistry [MCH 2201]**
Students will be able to	
CO1	Understand the interaction between nature and organism
CO2	Learn various quality parameters related to air, water & soil
CO3	Understand the chemical & photochemical interactions happening in environment
CO4	Learn and understand the techniques for the abatement of pollution
CO5	Learn about environmental toxicology and various disasters of past

Syllabus:

Unit –I

Introduction. Composition of atmosphere, vertical temperature, heat budget of the earth atmospheric system, vertical stability atmosphere. Biogeochemical cycles of C, N, P, S and 0. Bio-distribution of elements.

Unit –II

Hydrosphere: Chemical composition of water bodies-lakes, streams, rivers and wet lands etc. Hydrological cycle. Aquatic pollution - inorganic, organic, pesticide, agricultural, industrial and sewage, detergents, oil spills and oil pollutants. Water quality parameters - dissolved oxygen, biochemical oxygen demand, solids, metals, content of chloride, sulphate, phosphate, nitrate and micro-organisms. Water quality standards. Analytical methods for measuring BOO, DO, COD, F, Oils, metals (As, Cd, Cr, Hg, Pb, Se etc.), residual chloride and chlorine demand. Purification and treatment of water.

Unit –III

Soils: Composition, micro and macro nutrients, Pollution'- fertilizers, pesticides, plastics and metals. Waste treatment.

Unit –IV

Atmosphere: Chemical composition of atmosphere - particles, ions and radicals and their formation. Chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S, 0 and their effect, pollution by chemicals, petroleum, minerals, chlorofluorohydrocarbons. Green house effect, acid rain, air pollution controls and their chemistry. Analytical methods for measuring air pollutants. Continuous monitoring instruments. 23

Unit –V:

Industrial Pollution: Cement, sugar, distillery, drug, paper and pulp, thermal power plants, nuclear power plants, metallurgy. Polymers, drugs etc. Radionuclide analysis. Disposal of wastes and their management.

Unit –VI:

Environmental Toxicology: Chemical solutions to environmental problems, biodegradability, principles of decomposition, better industrial processes. Bhopal gas tragedy, Chernobyl, Three mile island, Sewozo and Minamata disasters.

Books Suggested

1. Environmental Chemistry, S. E. Manahan, Lewis Publishers.
2. Environmental Chemistry, Sharma & Kaur, Krishna Pubilshers.
3. Environmenlal Chemistly, A. K. De, Wiley Easlem.
4. Environmental Pollution Analysis, S.M. Khopkar, Wiley Eastern
5. Standard Method of Chemical Analysis, FJ. Weleher Vol. III. Van Nostrand Reinhold Co.
6. Environmental Toxicology, Ed. J. Rose, Gordon and Breach Science Publication.
7. Elemental Analysis of Airborne Particles, Ed. S. Landsberger and M. Crealchman, Gordon and Breach Science Publication.
8. Environmentai Chemistry, C. Baird, W. H. Freeman

CO-PO & PSO Correlation

Course Name: Environmental Chemistry [MCH 2201]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	1									1
CO 2	2									2
CO 3	2		1					2		
CO 4	1		2							1
CO 5	2									2

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**IV**
Name of the Course:	**Project / Dissertation**	**Course Code:**	**MCH2202**
Credits :	**8**	**No of Hours :**	**120**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: IV	**Project / Dissertation [MCH 2202]**
Students will be able to	
CO1	Identify a problem/topic related to a specific field of Chemical sciences
CO2	Carry out literature survey and
CO3	Study various aspects of problem/topic
CO4	Compile a report for presentation

Syllabus:

Project work will be primarily based on research oriented topics. On completion of the Project work, student will submit project report in the form of dissertation which will be examined by external/internal examiner. The examination of Project work shall consist of Presentation and comprehensive viva-voce.

CO-PO & PSO Correlation

Course Name: Project / Dissertation [MCH 2202]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1		2	2							1
CO 2	2									1
CO 3	2									1
CO 4	1	1				1				1

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**IV**
Name of the Course:	**Heterocyclic Chemistry**	**Course Code:**	**MCH2203**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: IV	**Heterocyclic Chemistry [MCH 2203]**
Students will be able to	
CO1	Learn nomenclature of different heterocyclic compounds.
CO2	Understand synthesis and reactivity of fused, six membered and smaller heterocyclic compounds

Syllabus:

UNIT-I: Nomenclature of Heterocycles

Replacement and systematic nomenclature (Hantzsch-Widman system) for monocyclic fused and bridged heterocycles. Aromatic Heterocycles General chemical behaviour of aromatic heterocycles, Classification (structural type), criteria of aromaticity (bond lengths, ring current and chemical shifts in 1H NMR-spectra. Empirical resonance energy, delocalization energy and Dewar resonance energy, diamagnetic susceptibility exaltations). Heteroaromatic reactivity and tautomerism in aromatic heterocycles.

UNIT-II: Non-aromatic Heterocycles

Strain-bond angle and torsional strains and their consequences in small ring heterocycles. Conformation of six-membered heterocycles with reference to molecular geometry, barrier to ring inversion, pyramidal inversino and 1,3-diaxial interaction. Stereo-electronic effects anomeric and related effects, Attractive interactions-hydrogen bonding and intermolecular nucleophilic, electrophilic interactions. Heterocyclic Synthesis. Principles of heterocyclic synthesis involving cyclization reactions and cycloaddition reactions.

UNIT-III: Small Ring Heterocycles

Three-membered and four-membered heterocycles-synthesis and reactions of azirodines, oxiranes, thiranes, azetidines, oxetanes and thietanes. Benzo-Fused Five-Membered HeterocyclesSynthesis and reactions including medicinal applications of benzopyrroles, bezofurans and benzothiophenes.

UNIT-IV: Meso-ionic Heterocycles

General classification, chemistry of some important meso-ionic heterocycles of type-A and B and their applications. Six-membered Heterocycles with one Heteroatom. Synthesis and reactions of pyrylium salts and pyrones and their comparison with pyridinium & thiopyrylium salts and phridones. Synthesis and reactions of quionlizinium and benzopyrylium salts, coumarins and chromones.

UNIT-V: Higher Heterocycles

Six membered Heterocycles with two or more Heteroatoms. Synthesis and reactions of diazones, triazines, tetrazines and thiazines. Seven-and Large-membered Heterocycles. Synthesis and reactions of azepines, oxepines, thiepines, diazepines thiazepines, azocines, diazocines, dioxocines and dithiocines.

Suggested References:

1. Heterocyclic Chemistry Vol. 1-3, R.R. Gupta, M. Kumar and V.Gupta, Springer Verlag.
2. The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.
3. Heterocyclic chemistry J.A. Joule, K. Mills and G.F. Smith, Chapman and Hall.
4. Heterocyclic Chemistry, T.L. Gilchrist, Longman Scietific Techinal.
5. Contemporary Hetrocyclic Chemistry, G.R. Newkome and W.W. Paudler, Wiley-Inter Science.
6. An Introductiion to the Heterocyclic Compounds, R.M. Acheson, Johnwiely.
7. Comprehensive Heterocyclic Chemistry, A.R. Katrizky and C.W. Rees, eds. Pergamon Press.

CO-PO & PSO Correlation

Course Name: Heterocyclic Chemistry [MCH 2203]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	3							2		
CO 2	2							2		

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**IV**
Name of the Course:	**Materials Chemistry**	**Course Code:**	**MCH2204**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: IV	**Materials Chemistry [MCH 2204]**
Students will be able to	
CO1	Understand structures, properties, and applications of important materials
CO2	Learn their preparation procedures & characterization

Syllabus:

Unit I: Glasses, Ceramics, Composite and Nanomaterials:

Glassy state, glass formers and glass modifiers, applications, Ceramic structures, mechanical properties, clay products. Reformatories, characterizations, properties and applications. Microscopic composites; dispersion - strengthened and particle - reinforced, fibre - reinforced composites, macroscopic composites. Nanocrystalline phase, preparation procedures, special properties, and applications.

Magnetic Materials (Ferrites) Introduction, structure and classification, hard and soft ferrites, synthesis of ferrites by various methods (precursor and combustion method), characterization of ferrites by Mossbauer spectroscopy, significance of hysteresis loop and saturation magnetization in ferrites, magnetic properties of ferrites, applications of ferrites.

Unit II: High Tc Materials:

Defect perovskites, high Tc superconductivity in cuprates, preparation and characterization of 1-2-3 and 2-1-4 materials, and normal state properties; anisotropy; temperature dependence of electrical resistance; optical photon modes, superconducting state; heat capacity; coherence length, elastic constants, position lifetimes, microwave absorption - pairing and multi-gap structure in high Tc materials , applications of high Tc materials.

Unit III: Polymeric Materials: Molecular shape , structure and configuration, crystallinity, stress- strain behavior, thermal behavior , polymer types and their applications, conducting and ferro - electric polymers.

Unit IV: Synthesis of Inorganic materials Synthesis of solid state materials using different techniques ceramic techniques, co precipitation techniques, sol gel techniques, precursor techniques, high temperature & high pressure synthesis.

Thin films and Langmuir- Blodgett Films: Preparation techniques; evaporation / sputtering, chemical processes, MOCVD, sol - gel etc. Langmuir- Blodgett (LB) film, growth techniques, photolithography, properties and application of thin and LB films.

Unit V: Materials of Solid Devices: Rectifiers, transistors, capacitors IV-V compounds, low dimensional quantum structure; optical properties.

Liquid crystals: Nature and structure, Design of liquid crystalline materials, Supramolecular liquid crystals, Liquid crystal displays, Inorganic liquid crystals

Ionic conductors: Types of ionic conductors, mechanism of ionic conduction, interstitial jumps, vacancy mechanism, diffusion, super ionic conductors, phase transition & mechanism of conduction in super ionic conductors, examples and applications of ionic conductors.

REFFERNCE BOOKS

1. Solid State Physics, N. W. Ashcrott and N. D. Mermin, Saunders College

2. Material Science and Engineering, An introduction, W. D. Callister, Willey.

3. Principals of Solid State, H. V. keer, Willey Eastorn.

4. Materials Science, J. C. Anderson , K. D. Leaver, J. M. Alexander and R. D. Rawlings, ELBS

5. Thermotropic Liquid Crystals, Ed, G. W. Gray, John Willey.

6. Textbook of liquid crystals, Kelkar and Halz , Chemie Verlag

CO-PO & PSO Correlation

Course Name: Materials Chemistry [MCH 2204]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	3		2					2		
CO 2	2		2							2

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**IV**
Name of the Course:	**Synthetic & natural polymers**	**Course Code:**	**MCH2205**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: IV	**Synthetic & natural polymers [MCH 2205]**
Students will be able to	
CO1	Become familiar with the basic concepts of polymers, mechanism and kinetics of polymerization, polymerization techniques, molecular weight determination.
CO2	Learn processing of thermoplastic and thermosetting polymers
CO3	Understand polymer structure on the properties such as mechanical, electrical and optical properties
CO4	concept of conducting polymers and their applications.

Syllabus:

Unit I: Classification of Polymers:

Homopolymers, Co-polymers, Linear polymers, Branched polymers, Cross linked or three dimensional polymers, Block co-polymers, Organic and inorganic polymers, Natural and synthetic polymers, Chain and step growth polymers, Thermoplastic and thermosetting, Fibers, Foams, Adhesives and elastomers.

Unit II: Mechanisms of Polymerization:

Step growth-, Radical-, Chain-, Ring opening-, Cationic-, and anionic polymerization, Catalysts in polymerization. Copolymerization: Importance of copolymerization, Types of co-polymers, Co-polymer composition, Methods of determination of reactivity ratio, and co-polymerization behavior, Mechanism and kinetics.

Unit II: Techniques of Polymerization: Bulk, Solution, Emulsion, Suspension and interfacial polymerization. Polymer Molecular Weights: Molecular weight determination using viscometry, Osmometry, Light scattering, Ultracentrifuge, Gel permeation chromatography and end group analysis.

Unit III: Application and Processing of polymers: Phenol-formaldehyde, Urea-formaldehyde, Melamineformaldehyde, Epoxy Resins and curing Agents, Polyamides: Nylon-6, Nylon-6,6, Processing of thermoplastics and thermosetting resins for films, Fibers, Foams, Sheets and tubing.

Unit IV: Structure and Properties of polymers: Morphology and order in crystalline polymers, polymer structure and physical properties.

Unit V: Conducting Polymers: Synthesis of conducting polymers, Preparation of conducting polymers for various devices like electronic devices, Chemical sensors, Solar cells, Light emitting devices, Biomedical devices Natural Polymers: Structures, Properties and applications of shellac, Lignin, Rubber, Starch and proteins. Chemical modification of cellulose and polystyrene, Polyelectrolyte's, Polymer liquid crystals.

Recommended Books

1. Gowarikar, V. R., Polymer Science, New Age International Pvt. Ltd., New Delhi (1997).

2. Odian, G., Principles of Polymerization, John Wiley & Sons (2001).

3. Peacock, A., and Calhoun, A., Polymer Chemistry-properties and applications, Hanser Publishers, Munich, (2006).

4. Chandra, R., and Adab, A., Rubber and Plastic Waste, CBS Publishers & Distributors, New Delhi, (1994).

5. Bahadur, P., and Sastry, N. V., Principles of Polymerisation, Narosa Publishing House, New Delhi (2002).

CO-PO & PSO Correlation

Course Name: Synthetic & natural polymers [MCH 2205]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	3		2						1	1
CO 2	2		1							1
CO 3	2		2							1
CO 4	2									1

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**IV**
Name of the Course:	**Supramolecular Chemistry**	**Course Code:**	**MCH2206**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: IV	**Supramolecular Chemistry [MCH 2206]**
Students will be able to	
CO1	Molecular recognition and nature of bindings involved in biological systems
CO2	Structure of supramolecules of various types in solution and solid state
CO3	Understand the design and synthesis of supramolecules to mimic biological system
CO4	Applications of supramolecules in miniaturization of molecular devices

Syllabus:

Unit –I: Introduction:

Concepts and development, Nature of binding interactions in supramolecular structures: ion-ion, ion-dipole, dipole-dipole, H-bonding, cation-π, anion-π, π-π and vander waal interactions, Supramolecular Chemistry in Life, Ionophores, Porphyrin and other tetrapyrrollic macrocycles, Coenzymes, Neurotransmitters, DNA and biochemical self-assembly. Host–guest

Unit –II: Chemistry: Synthesis and structures of crown ethers, Lariat ethers, Podands, Cryptands, Spherands, Calixarene, Cyclodextrins, Cyclophanes, Cryptophanes, Carcerands and hemicarcerands, Host-guest interactions, Preorganisation and complimentarity, Lock and key analogy, Binding of cationic, Anionic, Ion pair and neutral guest molecules.

Unit –III: Supramolecular Polymers:

Self-assembly molecules: Design, Synthesis and Properties of the molecules, Self-assembly by H-bonding, Catenanes, Rotaxanes, Dendrimers and Supramolecular gels. Relevance of supramolecular chemistry to mimic biological system.

Unit –IV: Molecular Devices:

Molecular Electronic devices, Molecular wires, Molecular rectifiers, Molecular switches and Molecular logic gates. Examples of recent developments in supramolecular chemistry from current literature.

Recommended Books

1. Lehn, J. M., Supramolecular Chemistry-Concepts and Perspectives, Wiley –VCH (1995).

2. Beer, P.D., Gale, P. A., and Smith, D. K., Supramolecular Chemistry, Oxford University Press (1999). 3. Steed, J. W., and Atwood, J. L., Supramolecular Chemistry, Wiley (2000)

CO-PO & PSO Correlation

Course Name: Supramolecular Chemistry [MCH 2206]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	2		1				2			
CO 2	2						1			
CO 3	1		2				1			1
CO 4	1		1							1

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**IV**
Name of the Course:	**Advanced Quantum Chemistry**	**Course Code:**	**MCH2207**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: IV	**Advanced Quantum Chemistry [MCH 2207]**
Students will be able to	
CO1	Learn Schrodinger equation for a particle in a box and quantum chemical description
CO2	Acquire knowledge of Electronic and Hamiltonian operators for molecules.
CO3	Quantum chemical description of angular momentum and term symbols for a one and many electron systems
CO4	Born-Oppenheimer approximation, the Pauli principle, Hund's rules, Hückel theory and the variation principle

Syllabus:

Unit I: Fundamentals of Quantum Mechanics (A) Introduction to quantum mechanics:

Scope and applicability of quantum mechanics The Schr¨odinger equation , Linear vector spaces: Definitions, Inner and outer products, Dual spaces and Dirac ,Operators: Basic operator Classes of operators: linear, hermitian, unitary etc, Diagonalization and eigenvalue equations Change of basis The Propagator Functions of matrices Commutators; Campbell-Baker-Hausdorff theorem (notes) Connection between functions and Dirac notation, Postulates of QM, Review of simple problems in 1D , The classical limit: Ehrenfest's theorem , Second quantization; example of harmonic oscillator , Introduction to path integrals , Angular momentum: Commutation rules Spherical harmonics Ladder operators

Unit II: Approximate Methods

Variational method: Variational theorem Equivalence of Raleigh-Ritz procedure and diagonalization , Time-independent perturbation theory

Unit III: Advanced Fundamentals

Spin, Addition of angular momenta, Degenerate perturbation theory, Time-dependent perturbation theory, Interaction of light with matter 2

Unit IV: Molecular Quantum Mechanics and Spectroscopy

The molecular Hamiltonian: Details of the Born-Oppenheimer approximation, Separation into electronic, vibrational, rotational terms, Relationship between diatomic potential energy curves and spectroscopic constants, Rotational spectroscopy, Vibrational spectroscopy (FG matrix method, etc), Electronic spectroscopy and Franck-Condon rules

Unit V: Electronic Structure Theory

Electronic structure of atoms, Electronic structure of diatomics, Electronic structure of polyatomics, Hartree-Fock theory: Two-electron problem Hartree products Antisymmetry and Slater determinants Generalization to N-electrons Self-consistent-field Hartree-Fock-Roothan procedure, Introduction to correlated methods: Configuration Interaction (CI) Many-body perturbation theory (MBPT) Coupled-cluster theory, A survey of quantum chemical methods

Suggested Books

1. R. Shankar, Principles of Quantum Mechanics, 2nd ed. (Plenum, New York, 1994). Intermediatelevel physics book covering the pure quantum part, some lecture material drawn directly from here.

2. A. Szabo and N. S. Ostlund, Modern Quantum Chemistry, Introduction to Advanced Electronic Structure Theory, 1st ed., revised (Dover, 1989).

3. I. N. Levine, Quantum Chemistry, 5th ed. (Prentice Hall, Englewood Cliffs, NJ, 2000). Covers most of the topics in this course at a slightly lower level.

4. G. Strang, Linear Algebra and its Applications, 3rd Ed., (Harcourt Brace Jovanovich, San Diego, 1988). Good intro to linear algebra.

5. D. A. McQuarrie, Quantum Chemistry (University Science Books, Mill Valley, CA, 1983). Very readable introductory text.

6. E. Merzbacher, Quantum Mechanics, 3rd ed. (Wiley, New York, 1998). Advanced physics text.

CO-PO & PSO Correlation

Course Name: Advanced Quantum Chemistry [MCH 2207]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	2	1				1			2	1
CO 2	3								3	1
CO 3	2				1				2	1
CO 4	2							1	2	
CO 5	2				1			1	2	

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**IV**
Name of the Course:	**Applied Electrochemistry**	**Course Code:**	**MCH2210**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: IV	**Applied Electrochemistry [MCH 2210]**
Students will be able to	
CO1	Lean and understand basics of conversion and storage of electrochemical energy
CO2	Understand properties of Electrochemical energy storage systems
CO3	Determine surface mechanism of the corrosion of the metals, thermodynamics and the stability of metals
CO4	Understand Kinetics of Electrode reaction

Syllabus:

UNIT-I: Conversion and storage of electrochemical energy

Pollution problem. History of fuel cells, direct energy conversion by electrochemical means. Maximum intrinsic efficiency of an electrochemical converter. Physical interpretation of the Carnot efficiency factor in electrochemical energy converters. Power outputs. Electrochemical Generators (Fuel Cells): Hydrogen oxygen cells, Hydrogen Air cell, Hydrocarbon air cell, Alkaline fuel cell, Phosphoric and fuel cell, direct NaOH fuel cells, applications of fuel cells.

UNIT-II: electrochemical energy storage

Properties of Electrochemical energy storage: Measure of battery performance, Charging and discharging of a battery, Storage Density, Energy Density. Classical Batteries: (i) Lead Acid (ii) Nickel-Cadmium, (iii) Zinc manganese dioxide. Modern Batteries : (i) Zinc-Air (ii) Nickel-Metal Hydride, (iii) Lithium Battery, Future Electricity storers : Storage in (i) Hydrogen, (ii) Alkali Metals, (iii) Non aqueous solutions.

UNIT-III: corrosion and stability of metals

Civilization and Surface mechanism of the corrosion of the metals; Thermodynamics and the stability of metals, Potential -pH (or Pourbaix) Diaphragms; uses and abuses, Corrosion current and corrosion potential -Evans diagrams. Measurement of corrosion rate: (i) Weight Loss method, (ii) Electrochemical Method. Inhibiting Corrosion: Cathodic and Anodic Protection. (i) Inhibition by addition of substrates to the electrolyte environment, (ii) by charging the corroding method from external source, anodic Protection, Organic inhibitors, The fuller Story Green inhibitors. Passivation: Structure of Passivation films, Mechanism of Passivation, Spontaneous Passivation Nature's method for stabilizing surfaces.

UNIT-IV: kinetic of electrode process

Essentials of Electrode reaction. Current Density, Over-potential, Tafel Equation, Butler Volmer equation. Standard rate constant (K0) and Transfer coefficient (a), Exchange Current. Irreversible Electrode processes: Criteria of irreversibility, information from irreversible wave. Methods of determining kinetic parameters for quasi-reversible and irreversible waves: Koutecky's methods, Meits Israel Method, Gellings method. Electrocatalysis: Chemical catalysts and Electrochemical catalysts with special reference to porphyrin oxides of rare earths. Electro-catalysis in simple redox reactions, in reaction involving adsorbed species. Influence of various parameters.

UNIT-V: Potential sweep methods

Linear sweep Voltammetry, Cyclic Voltammetry, theory and applications. Diagnostic criteria of cyclic voltammetry. Controlled current microelectrode techniques: comparison with controlled potentials methods, chronopotentiometry, theory ad applications. Bulk Electrolysis Methods: Controlled potential coulometry, Controlled Coulometry, Electroorganic synthesis and its important applications. Stripping analysis: anodic and cathodic modes, Pre electrolysis and Stripping steps, applications of Stripping Analysis. Bioelectrochemistry: bioelectrodics, Membrane Potentials, Simplistic theory, Modern theory, Electrical conductance in biological organism: Electronic, Protonic electrochemical mechanism of nervous systems, enzymes as electrodes.

Recommended books:

1. Modern Electrochemistry Vol. I, IIa, Vol. IIB, J'OM Bockris and A.K.N. Reddy, Plenum Publication, New York.

2. Polarographic Techniques by L. Meites, Interscience.
3. "Fuel Cells : Thjeir electrochemistry". McGraw Hill Book Company, New York.
4. Modern Polarographic Methods by A.M. Bond, Marcell Dekker.
5. Polarography and allied techniques by K. Zutshi, New age International publicatin. New Delhi.
6. "Electroaalytical Chemistry by Basil H. Vessor & Galen W. ; Wiley Interscience.
7. Electroanalytical Chemistry by Basil H. Vessor & alen w. ; Wiley Interscience.
8. Topics in pure and Applied Chemistry, Ed. S. K. Rangrajan, SAEST Publication, Karaikudi (India).

CO-PO & PSO Correlation

Course Name: Applied Electrochemistry [MCH 2210]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	2				1				3	1
CO 2	1	1					1		2	1
CO 3	2	1					1		1	
CO 4	2	1					1		2	
CO 5	2				1		1	1	1	

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**IV**
Name of the Course:	**Industrial & Green Chemistry**	**Course Code:**	**MCH2209**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: IV	**Industrial & Green Chemistry [MCH 2209]**
Students will be able to	
CO1	Learn chemical processes used in industrial organic synthesis
CO2	Importance, industrial production procedures of gases, basic organic chemicals, detergents, and sugars.
CO3	Understand the fundamentals and applications of Green Chemistry

Syllabus:

Unit –I

Industrial Organic Syntheses: The raw material and basic processes, Chemical processes used in industrial organic synthesis, Petrochemicals, Production of methanol, Ethanol, Acetaldehyde, Acetic acid, Isopropyl alcohol, Ethylene glycol, Glycerine, Acetone, Phenol, Formaldehyde, Ethyl acetate, 1,3- butadinene and styrene.

Unit –II

Sugar: Introduction, Manufacture of cane sugar, Extraction and Purification of juice, Defection, Sulphitation and Carbonation, Concentration and Evaporation, Crystallization, Separation of crystals, Drying, Refining, Grades, Recovery of sugar from molasses, Bagasse, Preparation of celotex, Manufacture of sucrose from beet root, Testing and estimation of sugar, Double sulphitation process,

Unit –III

Detergents: Introduction, Principal groups of synthetic detergents, Classification of surface active agents, Anionic, Cationic, Amphoteric and non-ionic detergents, Soaps, Alkyl and alkyl aryl sulphonates, Amide sulphonates, Miscellaneous compounds, Ecofriendly detergents containing enzymes.

Unit IV

Green Chemistry: Principles of Green Chemistry, Concept of atom economy, Tools of Green Chemistry: Alternative feedstocks/starting materials, Reagents, Solvents, Product/target molecules, Catalysis and process analytical chemistry. Evaluation of chemical product or process for its effect on human health and environment, Evaluation of reaction types and methods to design safer chemicals. Evaluating the effects of Chemistry: Toxicity to humans, Toxicity to wildlife, Effects on local environment, Global environmental effects. Planning a green synthesis.

Unit –V

Applications of Green Chemistry: Green synthesis of Ibuprofen, Design and application of surfactants for carbon dioxide for precision cleaning in manufacturing and service industries, Polyester regeneration technology, Microbes as environmentally benign synthetic catalysts, Environmentally safe marine antifoulant, Use of molting agents to replace more toxic and environmentally harmful insecticides, Carbon dioxide as blowing agent, Oxidant activators to replace chlorine based delignification process in paper and pulp industry, Biodegradable polyaspartate polymers for inhibitors and dispersing agents, Recent applications in green chemistry.

Recommended Books

1. Howard, W.L., Introduction to Industrial Chemistry, Wiley-Interscience (1986).

2. Weissermel, K., and Arpe, H.J., Industrial Organic Chemsitry, VCH (1997) 3rd ed.

3. Sheldon, R.A., Arends, I., and Hannefed, U., Green Chemistry and Catalysis, Wiley-VCH Verlag GmbH and Co. (2007).

4. Anastas, P., and Williamson, T. C., Green Chemistry Frontiers in Benign Chemical Synthesis and Processes, Oxford University Press (1999).

5. Ahluwalia, V. K., and Kidwai, M., New Trends in Green Chemistry, Anamaya Publishers (2004)

CO-PO & PSO Correlation

Course Name: Industrial & Green Chemistry [MCH 2211]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	2				1	1	2	1		
CO 2	2						1	1		1
CO 3	2	1			1	1	1	1		2

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**IV**
Name of the Course:	**Organic Synthesis**	**Course Code:**	**MCH2221**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: IV	**Organic Synthesis [MCH 2221]**
Students will be able to	
CO1	Understand use of reagents In Organic synthesis functional group transformations
CO2	Learn industrial applications of some named reactions
CO3	Learn Selective Synthetic Methods- Regioselective, Regiospecific and Stereo selective synthesis
CO4	Understand retrosynthesis and functional group interconversion

Syllabus:

Unit – I

Reagents In Organic Chemistry Uses of the following reagents in organic synthesis and functional group transformations. Sodium borohydride, Lithium aluminium hydride, tri-n-butyl tin hydride, Lithium dimethyl cuprate, Lithium diisopropyl amide, Trimethyl silyl iodide, dicyclohexylcarbodiimide, OsO4, DDQ, SeO2, PCC. Phase Transfer Catalysts – Benzyltriethylammonium halides – Crown ethers.

Unit - II Organic Reactions - I Formation of C-C single bond: Aldol condensation, Claisen ester reaction , Stobbe condensation, Knoevenagel reaction, Michael addition, Dieckmaan condensation – Stork enamine reaction – Mannich reaction, Reformatsky reaction Formation of C=C double bond: Wittig reaction, Perkin reaction, Claisen – Schmidt condensation, Peterson's synthesis. - 15 –

Unit - III Organic Reactions - II Cannizaro and cross Cannizaro reactions, Benzoin condensation, Wolff-Kishner reduction, Clemmenson reduction, MPV reduction, Birch reduction. Riemer-Tiemann reaction – Gattermaan reaction - Chichibabin reaction. Uses of organoboron compounds in organic synthesis. Some industrial applications of organic reactions.

Unit - IV Selective Synthetic Methods Need for protection of functional groups during chemical reactions – protection of hydroxyl, mercapto, amino, carbonyl and carboxylic groups. Regioselective synthesis – halogenation of alkanes, ambident nucleophiles, Regiospecific syntheis – reductions using Baker's yeast. Stereo selective reaction – bromination of dicarboxyacetylene, Shaarpless asymmetric epoxidation, synthesis of 2-butanol by using diisopinocampeylborane. Stereospecific reaction – bromination of fumaric and maleic acids.

Unit - V Planning Organic Synthesis An introduction to retrosynthesis - Synthon, Synthetic equivalent, Target molecule, Functional group interconversion - Disconnection approach – One group disconnection – Disconnection of alcohols, olefins and ketones - Logical and illogical disconnections. Two group disconnection-1,2-, 1,3-, 1,4-, 1,5- and 1,6-dioxygenated skeletons and dicarbonyls. Retro Diels – Alder reaction – Pericyclic reactions – Retrosynthesis of some heterocycles containing two nitrogen atoms. Retrosynthetic analysis of Camphor, Longifiline, Reserpine and Cortisone

Text Book and References

1. R.K. Bansal Organic Reaction Mechanisms, New Age International, 1996.

2. F.A. Carey, R. J. Sunberg, Advanced Organic Chemistry Part A, Springer, 5 th edition, 2007

3. W. Carruthers, Some Modern Methods in Organic Synthesis, Cambridge, 1971

4. E.J. Corey, Reactions and Reagents in Organic Synthesis, VCH, 1988

5. C.H. Depuy, O.S. Chapman, Elements of Organic Photochemistry, Prentice Hall, 1975.

6. I.L. Finar, Organic Chemistry Vol.II, ELBS, 1977.

7. R.O.C. Norman, Modern Methods in Organic Synthesis, Macmillan, 1967

8. S.P. Singh, S.M.Mukherjee, Reaction Mechanisms in Organic Chemistry, Macmillan, 1984

9. P. Sykes, Guide Book to Mechanism in Organic Chemistry, Prentice Hall, 6 th Edition, 1986.

CO-PO & PSO Correlation

Course Name: Organic Synthesis [MCH 2221]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	2				1		1	2		
CO 2	3						2	2		
CO 3	3	1						2		1
CO 4	2	1				1		3		

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**IV**
Name of the Course:	**Chemistry of Natural Products**	**Course Code:**	**MCH2222**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: IV	**Chemistry of Natural Products [MCH 2222]**
Students will be able to	
CO1	Know occurrence and isolation of natural products
CO2	learn the biosynthesis of natural products
CO3	Learn physiological action of natural products
CO4	learn how to elucidate the structures of some natural products

Syllabus:

UNIT-I : Terpenoids:

Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination, biosynthesis and synthesis of the following representative molecules: Monoterpenoids: Citral, geraniol (acyclic), α-terpeneol, menthol (monocyclic). Sesquiterpenoids: Farnesol (acyclic), zingiberene (monocyclic), santonin (bicyclic), Diterpenoids: Phytol and abietic acid.

UNIT- II Carotenoids and Xanthophylls:

General methods of structure determination of Carotenes: βcarotene, α- carotene, γ-carotene, lycopene and vitamin A. Xanthophylls: Spirilloxanthin, Capsorubin, Fucoxanthin. Carotenoid acids (Apocarotenoids): Bixin and Crocetin. Bio synthesis of carotenoids

UNIT-III Alkaloids:

Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants. Structure, synthesis and biosynthesis of the following: Ephedrine, Coniine, Nicotine, Atropine, Quinine and Morphine.

UNIT-IV Steroids:

Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry. Isolation, structure determination and synthesis of Cholesterol, Androsterone, Testosterone, Estrone, Progestrone. Biosynthesis of steroids

UNIT-V Plant Pigments:

Occurrence, nomenclature and general methods of structure determination. Isolation and synthesis of Anthocyanins (Cyanin and pelargonidin), polyphenols: Flavones (chrysin), Flavonols(quercitin) and isoflavones (daidzein) coumarin, Quinones (lapachol), Hirsutidin. Biosynthesis of flavonoids: Acetate pathway and Shikimic acid pathway.

Books recommended:

1. Natural Products- Chemistry and Biological Significance, J. Mann, R.S. Davidson, J. B. Hobbs, D.V. Banthrope and J. B. Harborne, Longman, Essex.

2. Organic Chemistry Vol. II, I.L. Finar, ELBS.

3. Stereo selective synthesis- A Practical Approach, M. Nogradi, VCH.

4. Rodd's Chemistry of Carbon Compounds, Ed. S. Coffey, Elsevier.

5. Chemistry, Biological and Pharmacological Properties of Medicinal Plants From the Americas, Ed.Kurt Hostettmann, M.P. Gupta and A. Marston, Harwood Academic Publishers.

6. Introduction to Flavonoids, B.A.Bohm, Harwood Academic Publishers.

7. New Trends in Natural Product Chemistry, Atta-ur-Rahman M. I. Choudhary, Harwood Academic Publishers. 8

. Insecticides of Natural Origin, Sukh Dev, Harwood Academic Publishers.

CO-PO & PSO Correlation

Course Name: Chemistry of Natural Products [MCH 2222]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	3				1			2		
CO 2	2	1						1	1	
CO 3	2	1			1			2		1

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**IV**
Name of the Course:	**Material Characterization Techniques**	**Course Code:**	**MCH2223**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: IV	**Material Characterization Techniques [MCH 2223]**
Students will be able to	
CO1	Understand thermal Analysis techniques
CO2	Learn principle, construction and working of various spectroscopic techniques
CO3	Learn diffraction method for determination of crystal structure

Syllabus:

UNIT-I

Importance of Material characterization, Classification of techniques for characterization, Thermal Analysis techniques: Principle, Working and application of DTA, TGA, TMA and DSC

UNIT-II

Principle, Construction and Working of TEM, SEM, STEM with their merits, demerit and applications, techniques of replica preparation, UV-Visual(UV-VIS), IR & Raman spectroscopy, X-ray Fluoroscopy (XRF), Atomic absorption spectrometer(AAS), Atomic Emission spectroscopy (AES), XPS (ESCA), Auger Electron Spectroscopy.

UNIT-III

FTIR, EDS & WDS; Electron Probe Micro Analysis (EPMA); Nuclear Magnetic Resonance (NMR) Technique.

UNIT-IV

Diffraction method; X-ray diffraction, determination of crystal structure, lattice parameter, crystallite size by diffraction techniques / low angle X-ray scattering technique.

UNIT-V

Electrical resistivity in bulk and thin films, Hall effect, Magneto resistance, Impedance spectroscopy, Magnetic property measurements, Magnetic hysteresis loops, time and temperature dependent magnetization measurement.

Reference Books:

1. F. Weinberg, Editor, Tools & Techniques in Physical Metallurgy, Vol. I & Vol. II, Marcel Dekker, 1970.
2. John P. Sibilia, A guide to Material Characterization & Chemical Analysis, VCH Publishers, 1988.
3. J.M. Walls, Editor, Methods of Surface Analysis: Techniques & Applications, Cambridge University Press, 1990.
4. B.D. Cullity, Elements of X-ray diffraction, Addison-Wesley Publishing Company, INC, 1978.
5. Bernhard Wounderlich, Thermal Analysis, Academic Press, INC, 1990.
6. B.L. Gabriel, SEM: A user's manual for materials Science, American Society for Metals, 1985.
7. An Introduction to Materials Characterization by P. R. Khangaonkar, Penram International Publishing (India) Pvt. Ltd.

CO-PO & PSO Correlation

Course Name: Material Characterization Techniques [MCH 2223]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	3	1			1		1	1		
CO 2	3	1			1			3		
CO 3	3	1					1	1	1	

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**IV**
Name of the Course:	**Computational methods in Chemistry**	**Course Code:**	**MCH2224**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: IV	**Computational methods in Chemistry [MCH 2224]**
Students will be able to	
CO1	Learn basic programming and numerical method feature of Fortran/C
CO2	Learn about networking and search using Internet
CO3	Learn advanced scientific packages

Syllabus:

Unit_I: FORTRAN/C:

Programming and numerical method feature of FORTRAN/C:

Basic theory a) Solution of equation: Bisection, Regula Falsi, Newton – Raphson and related method for solving polynomial and transcendental equation, convergence. errors and ill – containing b) Liner simultaneous equation: Gaussian elimination, Gauss – Seidel method, Gauss Jordan method. pivoting strategy, errors and ill.

UNIT-II

c) Numerical Differentiation and Integration: Newton – Cote's formulae, Romberg integration, errors in integration formulae. d) Numerical solution of Differential equation: Solution of simple differential equation by Taylor series and Runge – Kutta methods.

Unit – III:

Internet: Introduction to networking and search using Internet.

Unit – IV:

Running of advanced scientific packages.

Project: The student will develop utilities such as analysis of spectra, simulation programs which will supplement laboratory of theory exercises in Physical, Organic, Inorganic or Analytical chemistry.

Recommended Books:

1.Computational Chemistry, A. C. Norris, John Wiley.

2. Computer Programming in FORTRAN 77, Rajaraman, Prentice Hall.

3. Numerical Analysis, C. E. Frogberg, Macmillan.

4. Numerical Analysis, A Practical Approach, M.J. Maron, John Wiley.

5. Numerical Methods for Scientists and Engineers, H. M. Anita, Tata McGraw Hill.

6. Computers in Chemistry, K.V. Raman

CO-PO & PSO Correlation

Course Name: Computational methods in Chemistry [MCH 2224]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	2				1	1				2
CO 2	2	1								2
CO 3	2	1								2

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**IV**
Name of the Course:	**Analytical Chemistry**	**Course Code:**	**MCH2225**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: IV	**Analytical Chemistry [MCH 2225]**
Students will be able to	
CO 1	Understand sample preparation, digestion and statistical analysis
CO 2	Learn various separation & extraction techniques – their theory, instrumentation, types and applications
CO 3	Understand fundamentals and applications of thermo-analytical and Electrochemical techniques

Syllabus:

UNIT –I Sample Preparation, Digestion And Statistical Analysis

A. Sampling - Collection, Preservation and preparation of sample, Techniques of sampling solids, liquids and gases, Operation of drying and preparing a solution of the analyte. Principle, methodology and application of different types of digestions such as acid digestion, base digestion, enzymatic and microwave digestion for liquid and solid materials.

B. Evolution and procession of Analytical Data, Precision and Accuracy, Types of Errors, Propagation of errors, Normal Distribution Curve, Standard deviation, Confidence limit, Graphical presentation of result-Method of average, Method of Linear least square, Significant figures, Statistical aid to hypothesis testing-t-test, F-test, Correlation coefficient, Rejection of data.

UNIT –II Separation Techniques

A. Efficiency of extraction, Selectivity of extraction, Extraction system, Method of Extraction, applications.

B. Principle, classification of chromatographic techniques, Technique and applications of paper chromatography, Thin-layer chromatography, HPLC, Column chromatography. Gas Chromatography

UNIT –III Thermal and Automated Methods

A. Principle, Instrumentation, Application of TGA, DTA and DSC methods. B. Automated methods, Principle, instrumentation and application off low injection analysis.

UNIT –IV Electrochemical Techniques

A. Principles and instrumentation of pH potentiometry, coulometry and conductometry.

B. Basic principles, Diffusion current, polarized electrode, Micro electrode, Dropping Mercury Electrode, llkovic equation, Polarographic wave, Qualitative analysis Stripping methods, Cyclic Voltammetry, Amperometric titration:- curves, Differential pulse polarography and Squarewave polarography.

Book Suggested :

1. Fundamental of Analytical Chemistry- Skoog D.A. and West D.M.
2. Saunders, College Publication.
3. Textbook of Quantitative Inorganic Analysis-Vogel A.I.
4. Principles and Practice of Analytical Chemistry-Fifield F. Wand Kealey
5. D. Black well Science
6. Instrumental Analysis R. Braun, McGraw Hill, International Edition.
7. Analytical Chemistry, Christian, G.D., WSE/Wiley.
8. Instrumental Analysis, Willard Meritt Dean, CBS.
9. Chemical Analysis, Brawn, McGrawHill.
10. Fundamental of Analytical Chemistry-Skoog D.A. and WestD.M.
11. Principles of instrumental Analysis, Skoog Holler -Niemann.
12. Instrumental Analysis, Wizard Dean and Merit.
13. Principle and Practical Analytical chemistry, Fifield and Kealey.

CO-PO & PSO Correlation

Course Name: Analytical Chemistry [MCH 2225]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	2				1				1	1
CO 2	1	1							1	1
CO 3	1	1							1	1

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**IV**
Name of the Course:	**Battery Technology**	**Course Code:**	**MCH2226**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: IV	**Battery Technology [MCH 2226]**
Students will be able to	
CO1	Understand the concept of electrochemical energy storage
CO2	Learn the fundamentals of battery chemistry
CO3	Learn and understand development of electrode materials and electrolytes

Syllabus:

Unit – I: Introduction to Electrochemical energy storage:

Introduction to battery technologies, Electromotive force- Reversible cells- Relation between electrical energy and energy content of a cell-Free energy changes and electromotive force in cell, Current challenges in Energy storage Technologies.

Unit – II: Major Battery Chemistries, Development and testing: Battery performance evaluation- Primary battery - Service time- Voltage data- Service life – ohmic load curve- Effect of operating temperature on service life. Secondary batteries- Discharge curves, Terminal voltages- Plateau voltage, Lead acid Batteries, Li-ion batteries, Construction and application.

Unit – III: Recent Technologies: Recent development of electrode materials in lithium ion batteries- Recent development of solid electrolytes and their application to solid state Batteries-Polymer solid electrolytes for lithium ion conduction– Thin Film solid state Batteries: Fundamentals, Constriction and application – Super Capacitors: Fundamental, Construction and application.

Unit – IV: Batteries for Automotives – Future prospects: Degrees of vehicle electrification - Battery size vs. application -USABC and DOE targets for vehicular energy storage systems - Analysis and Simulation of batteries - Equivalent circuit and life modeling – Environmental concerns in battery production – recycling of batteries

Unit – V: Laboratory Demonstrations:

BOOK SUGGESTED :

1. T.Minami, M.Tatsumisago,M.Wakihara,C. Iwakura,S. Kohijiya, Solid state ionics for batteries, Springer Publication, 2009
2. Sandeep Dhameja, Electric Vehicle Battery Systems, Newnes publication, 2001. .
3. Bard, Allen J., and Larry R. Faulkner. Electrochemical Methods: Fundamentals and Applications. 2nd ed.,Wiley– VCH, Verlag, GmbH, 2000.
4. Masataka Wakihara and Osamu Yamamoto, Lithium ion Batteries Fundamental and Performance,Wiley–VCH, Verlag GmbH, 1999.

Robert A.Huggins, Advanced Batteries – Materials science aspects,Springer, 2009.

CO-PO & PSO Correlation

Course Name: Battery Technology [MCH 2226]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	2	1							2	
CO 2	2	1					1		2	
CO 3	1	1					1		1	

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**IV**
Name of the Course:	**Biochemistry**	**Course Code:**	**MCH2227**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: IV	**Biochemistry [MCH 2227]**
Students will be able to	
CO1	Learn about functions and structure of biologically important carbohydrates, amino acids, lipids, enzymes and nucleic acids
CO2	Understand the biosynthesis of these compounds

Syllabus:

Unit – I

Classification of carbohydrates. Functions of biologically important mono saccharides, disaccharides, homo polysaccharides, and hetero polysaccharides. Carbohydrate metabolism: glycolysis, citric acid cycle, gluconeogenesis, glycogen metabolism (overview only, structures not required). Diabetes mellitus (elementary details).

Unit – II

Amino acids: classification and acid-base properties. Biologically important peptides. Proteins– classification, functions, denaturation and renaturation. Orders of protein structure: Primary, secondary (α-helix, β-pleated sheet), supersecondary, tertiary, and quaternary structures. Urea cycle, (overview only, structures not required).

Unit – III

Classification of lipids. Structure and functions of cholesterol. Lipid metabolism: β-oxidation of fatty acids, biosynthesis of fatty acids (overview only, structures not required). Coronary heart disease (elementary details). - 18 –

Unit – IV

Enzymes: Classification and nomenclature. Specificity, factors affecting enzyme activitysubstrate, pH and temperature. Michaelis - Menten equation and L-B plot. Coenzymes and Isoenzymes (brief account only). Allosteric enzymes. Applications of enzymes in clinical diagnosis, therapeutics and industry.

Unit – V

DNA structure- Watson and Crick model. A, B, and Z forms of DNA. DNA denaturation. Differences between DNA and RNA.Major classes of RNA- structure and biological functions.

Text Books

1. D.L.Nelson, M.M.Cox, Lehninger Principles of Biochemistry, Freeman, 6 th edition, 2012.
2. R.K. Murray et al., Harper's Illustrated Biochemistry, 30th edition, McGraw Hill, 2015.
3. U. Satyanarayana, Biochemistry, Allied Publishers, latest edition.

CO-PO & PSO Correlation

Course Name: Biochemistry [MCH 2227]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	2							2		
CO 2	1	1						2		1

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Sc.**	**Semester :**	**IV**
Name of the Course:	**Bioinorganic Chemistry**	**Course Code:**	**MCH2228**
Credits :	**4**	**No of Hours :**	**60**
Max Marks:	**100**		

COURSE OUTCOMES:

Semester: IV	**Bioinorganic Chemistry [MCH 2228]**
Students will be able to	
CO1	Learn structure and functions of Metalloporphyrins and Metalloenzyme
CO2	Learn and understand natural and synthetic oxygen carriers
CO3	Learn transport and storage of metals in biological system
CO4	Understand basics of Supramolecular Chemistry

Syllabus:

UNIT-I

Metalloporphyrins: (ref. Books No. 1,5,6): Porphyrins and their salient features, characteristic absorption spectrum of porphyrins, chlorophyll (structure and its role in photosynthesis). Transport of Iron in microorganisms (sidrophores), types of siderophores (catecholate and Hydroxamato siderophores). (b) Metalloenzymes: (Ref. Book No. 1,2): Definitions: Apoenzyme, Coenzyme, Metalloenzyme, structure and functions of carbonic anhydrase A & B, carboxy peptidases.

UNIT-II

Oxygen Carriers: (Ref. Book No. 1,8): a) Natural oxygen carriers: Structure of hemoglobin and myoglobin, Bohr effect, Models for cooperative interaction in hemoglobin, oxygen Transport in human body (-perutz machanism), Cyanide poisoning and its remedy. Non-heme proteins (Hemerythrin &Hemocyanin). b) Synthetic oxygen carriers: Oxygen molecule and its reduction products, model compounds for oxygen carrier (Vaska's Iridium cjomplex, cobalt complexes with dimethyl glyoxime and schiff base ligands).

UNIT-III

Transport and storage of metals: (Ref. Books No. 1,2) The transport mechanism, transport of alkali and alkaline earth metals, ionophores, transport by neutral macrocycles and anionic carriers, sodium/potassium pump, transport and storage

of Iron (Transferrin & Ferritin). Inorganic compounds as therapeutic Agents (Ref. Books N. 1,4,8):- Introduction chelation therapy, synthetic metal chelates as antimicrobial agents, antiarthritis drugs, antitumor, anticancer drugs (Platinum complexes), Lithium and mental health.

UNIT-IV

Supramolecular Chemistry (Ref. Book 9): Introduction, Some important concepts, Introduction to Recognition, information and complementarity, Principles of molecular receptor designs, Spherical recognition (cryptates of metal cations) Tetrahedral recognition by macrotricycliccryptands, Recognition of ammonium ions, Recognition of neutral molecules and anionic substrates (anionic coordination)

Suggested books

1. The Inorganic Chemistry of Biological processes - M. N. Hughes.

2. Bio Inorganic Chemistry - Robert Wittay

3. Advanced Inorganic Chemistry (4th Edition) - Cotton and Wilkinson.

4. Topics in current chemistry (Inorganic Biochemistry) vol. 64 (1976) - Davison and Coworkers.

5. An Introduction to Biochemcial Reaction Mechanism - James N.Lowe and Lloyalt Ingraham.

6. General Biochemistry - Fruton J.S. and Simmonds S.

7. Plant Physiology - Robeert N. Devtin. 8. Inorganic chemistry - James E. Huheey.

9. Supramolecular Chemistry (Concepts and Perspectives) - Jean Marie Lehn(VCH-1995).

CO-PO & PSO Correlation

Course Name: Bioinorganic Chemistry [MCH 2228]										
CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO 1	2	1					1	1		1
CO 2	1	1						1		1
CO 3	1						1	1		1
CO 4	2	1						2		

Note: 1: Low 2.: Moderate 3: High