M.Sc. (Chemistry) Part-I

Session: 2024-2025

Semester-I

Course code	Title of the paper	Hours per week			Total Credits	University Exams (hrs.)	Maximum marks		
		L	T	P			IA	SE	Total
Core Subjects									
MCHEM 1101T	Inorganic Chemistry	5	0	0	5	3	30	70	100
MCHEM 1102T	Organic Chemistry	5	0	0	5	3	30	70	100
MCHEM 1103T	Physical Chemistry	5	0	0	5	3	30	70	100
Elective Subjects									
MCHEM 1104 T	Mathematics for Chemists **or** Biology for Chemists	5	0	0	5	3	30	70	100
Practical Subjects									
MCHEM1 105L	Practical Inorganic Chemistry -I	0	0	6	3.75	6	30	70	100
MCHEM1 106L	Practical Analytical Chemistry -I	0	0	6	3.75	6	30	70	100

Note: B.Sc. (NM) students will take Biology for Chemist and B.Sc. (M) will take Mathematics for Chemist as elective subject.

M.Sc. (Chemistry) Part-I

Session: 2025-2026

Semester-II

Course code	Title of the paper	Hours per week			Total Credits	University Exams (hrs.)	Maximum marks		
		L	T	P			IA	SE	Total
Core Subjects									
MCHEM 1201T	Inorganic Chemistry	4	0	0	4	3	30	70	100
MCHEM1 202T	Organic Chemistry	4	0	0	4	3	30	70	100
MCHEM 1203T	Physical Chemistry	4	0	0	4	3	30	70	100
Elective Subjects									
MCHEM1204 T	Computer Fundamental & Programming with C	4	0	0	4	3	30	70	100
Practical Subjects									
MCHEM1107L	Organic Chemistry Practical-II	0	0	6	3	6	30	70	100
MCHEM1108L	PhysicalChemistry Practical-II	0	0	6	3	6	30	70	100

M.Sc. Chemistry (Semester I& II):

Programme Outcomes (POs):

Upon the completion of M.Sc. chemistry the students will be able to:

PO1. Gain a thorough and logical understanding of the advance topics in chemistry.

PO2. Join further research based projects and are also eligible for doing M. Phil and Ph. D

PO3. Use their research skills to formulate, produce, characterize, and analyze new compounds for specific applications.

PO4. Be equipped with practical exposure in the field of science to find new cures and discovering new molecules through a wide variety of techniques studied during the course.

PO5. Start out in the lab and then move on to other laboratory career such as process chemistry, formulation chemistry, quality control or quality assurance. They may also move to non-laboratory careers such as teaching, regulatory affairs, project management and production.

Programme Specific Outcomes (P.S.O.):

1. Students have the knowledge of basic concepts of inorganic, organic and physical chemistry.
2. Students will also acquire the knowledge of some concepts of mathematics, biology and computer which can be applied in chemistry.
3. To give students a comprehensive understanding of the principles of Chemistry.
4. To gain the skill to design and carry out scientific experiments and interpret the data.

SEMESTER-I
MCHEM1101T
Inorganic Chemistry

Max Marks: 100
External Exam: 70 marks
Internal Assessment: 30 marks
Passing Marks: 35%

Time allowed: 3hrs
Credits: 04

INSTRUCTIONS FOR THE PAPER SETTER

The question paper will consist of three sections: A, B, and C. Sections A and B will have four questions from the respective sections of the syllabus and will carry12 marks each. Section C will consist of 11 short-answer questions from the entire syllabus and will carry 2 marks each.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions selecting two questions from each of Section A & B and Section C will be compulsory.

Course Outcomes (C.O.):

1. To have a quantum mechanical treatment of chemical bonding.
2. To study the important aspects of bioinorganic chemistry.
3. To gain an insight of the spectral and magnetic properties of metal complexes.

Section –A

Chemical Bonding: The ionic bond, covalent bond, the variation method, ground state energy of hydrogen atom, the secular equations, the molecular orbital theory, electron distribution in hydrogen molecule ion, symmetric and antisymmetric energy states, the classical interaction energy, resonance, contribution of ionic terms, sp3 hybridization, three centered bond, Linnetts doublet-quartet approach, the Pauli's exclusion principle.

Pi Bonding Ligand Complexes: Pi Acid Ligands: CO as prototype, other pi acid ligands-isocyanide ligands, dinitrogen, the CS ligands, the NO ligands, pi acid ligands: Trivalent phosphorus compound, multiple bonds from ligands to metal, pi complexes of unsaturated organic molecules: alkene & alkyne, enyl ligands, aromatic ring systems.

Chemical Bonding and structure:
Ionic bonding: Size effects, radius ratio rules and their limitations. Packing of ions in crystals, lattice energy, Born-Lande equation and its applications, Born-Haber cycle and its applications. Solvation energy, polarizing power and polarizability, ionic potential, Fazan's rules. Defects in solids. Covalent bonding: Lewis structures, formal charge. Valence Bond Theory, Molecular orbital Theory, hybridizations, VSEPR theory. Partial ionic Character of covalent bonds, bond moment, dipole moment and electro negativity differences. Concept of resonance, resonance energy, resonance structures. Schrodinger equation for the H-atom.
Coordinate bonding: Werner theory of coordination compounds, double salts and complex salts, Lewis acid-base. Ambidentate and polydentate ligands, chelate complexes. IUPAC nomenclature of coordination compounds. Coordination numbers, Geometrical isomerism. Stereoisomerism in square planar and octahedral complexes. Hydrogen bonding. Metallic bonding: qualitative idea of band theory, conducting, semi conducting and insulating properties.

Section –B

Chemistry of coordination compounds:
Isomerism, reactivity and stability: Determination of configuration of cis- and trans- isomers by chemical methods. Labile and inert complexes, substitution reaction on square planer complexes, trans effect. Stability constants of coordination compounds and their importance in inorganic analysis.

Elementary Crystal Field Theory: splitting of d^n configurations in octahedral, square planar and tetrahedral fields, crystal field stabilization energy; pairing energy. Jahn-Teller distortion. Metal-ligand bonding, sigma and pi bonding in octahedral complexes and their effects on the oxidation states of transitional metals.

Spectra and magnetism: Electronics spectra of complexes, Tanabe-Sugano diagrams tetragonal distortions from octahedral symmetry, charge transfer spectra, magnetic properties of complexes. Orbital and spin magnetic moments, spin only moments of and their correlation with effective magnetic moments, d-d transitions; L-S coupling, spectroscopic ground states, selection rules for electronic spectral transitions; spectro-chemical series of ligands.

Bioinorganic Chemistry

Introduction, the biochemistry of Iron : iron storage and transport ferritin, transferrin, bacterial iron transport, hemoglobin and myoglobin, nature of the heme-dioxygen binding, model systems, cooperativity in hemoglobin cytochromes, other iron - porphyrin bimolecule peroxidases & catalases, cytochrome P_{450} enzymes, other natural oxygen carriers - hemerythrins, iron - sulfur proteins. The biochemistry of other metals: zinc (carboxypetidase A, carbonic anhydrase, metallothioneins), copper (superoxide dismutase (CuZn SOD), hemocyanins, oxidases), cobalt (cyanocobalamin), molybdenum (nitrogenases) & tungsten. Miscellaneous other elements: vanadium, chromium & nickel metal ions, chelates in chemotherapy, synthetic metal chelates as antimicrobial agents, lithium and mental health, gold and its compounds, metal complexes as antitumour agents, chelation therapy.

Recommended Books:

1. Advanced Inorganic Chemistry-Cotton and Wilkinson (3rd,4th and 5thEd.),1930
2. Theoretical Inorganic Chemistry-Dayand Selbin, 1962.
3. Inorganic Chemistry-Shriver, Atkins and LangFord, 7th edition, 2010.
4. Inorganic Chemistry of Biological Processes-M.N.Hughes,2nd edition, 1981
5. Bio-Inorganic Chemistry-R.W. Hay (John Wiley and Sons), 1984.
6. Inorganic chemistry: Principles of Structure and reactivity by James E. Huheey, E.A. Keiter, R.L.Keite,1973.

SEMESTER-I
MCHEM1102T
Organic Chemistry

Max Marks: 100
External Exam:70 marks
Internal Assessment: 30 marks
Passing Marks: 35%

Time allowed: 3 hrs
Credits: 04

INSTRUCTIONS FOR THE PAPER SETTER

The question paper will consist of three sections: A, B, and C. Sections A and B will have four questions from the respective sections of the syllabus and will carry12 marks each. Section C will consist of 11 short-answer questions from the entire syllabus and will carry 2 marks each.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions selecting two questions from each of Section A and B and Section C will be compulsory.

Course Outcomes (C.O.):

1. To understand the basic concepts and mechanism in organic chemistry.
2. To have a basic idea of Aromaticity, non-aromaticity and anti-aromaticity in carbocyclic and heterocyclic compounds.
3. Students will acquire knowledge about various reactive intermediates and their participation in reactions.
4. The students will acquire knowledge of mechanistic aspects in nucleophilic substitution.
5. The students will get knowledge of mechanisms of addition reactions of C=C and C=O bonds and elimination reactions.
6. To study the molecular orbital symmetry elements and possibility of thermally and photo-chemically allowed pericyclic reactions.
7. To get an idea about the various kinetic and thermodynamic factors which control the organic reactions.

Section –A

Nature of Bonding in Organic Molecules

Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's Rule, anti-aromaticity, homo-aromaticity.

Reactive Intermediate

i. **Carbocations:** Generation, Structure, Stability, Application of NMR spectroscopy in the detection of carbocation, allylic and benzylic carbocations. Stereochemistry and reactions.
ii. **Non classical carbocations:** Phenonium ion, norbornyl system, explaination based on rearrangement.
iii. **Carbanions:** Generation, Structure, stability, stereochemistry, Tautomerism, Prototropy and general reactions.
iv. **Carbenes and Nitrenes:** Formation, Structure, Singlet & Triplet carbene, Stereochemsitry and reactions.
v. **Arynes:** Formation,Structure and reactions.
vi. **Free radicals:** Formation, Structure, Stability, Stereo-chemistry and reactions.

Reactions of Free Radicals

a. Polymerisation
b. Halogenation: Chlorination, Bromination, Bromination by NBS, Iodination, Fluorination, Polar effects in halogenation.
c. Addition Reactions: Free radical addition of HBr, HCl, HI thiols and halogens.
d. Auto-oxidation
e. Rearrangements

Chemistry of non-covalent interactions: Crownethers, Cryptands, Rotaxans, Catanes

Methods used for determination of reaction mechanism (Non-Kinetic method)
Use of optical, Stereochemical and isotopic techniques. Reaction studies from identification of products. Trapping of intermediate, crossover experiments, use of catalyst, use of isotopes in reaction mechanism studies in case of Benzyne, Claisen's and Favorskii's reactions.

Section –B

Pericyclic Reactions: Molecular Orbital symmetry, Frontier Orbitals of ethylene, 1, 3- butadiene, 1, 3, 5- hexatriene and allyl system. Classification of Pericyclic reactions. Woodward-Hoffman rule, correlation diagrams. FMO and PMO approach.

Electrocyclic reactions: conrotatory and disrotatory motions 4n, 4n+2 and allyl systems.

Cycloadditions: Antarafacial and Suprafacial additions, 4S+2S systems and 2S+2S additions of alkene.

Sigmatropic rearrangement - Suprafacial and Antarafacial shift involving hydrogen carbon moieties. [1,3], [1,5], [1,7], [3,3] and [5,5]- sigmatropic rearrangement, Claisen and Cope rearrangement reactions.

Elimination reactions: E1, E2 and E_1cB mechanism, Stereochemistry product ratio, orientation of double bond, Hofman's Rule, Saytzeff's Rule, Factors governing E1 and E2 mechanism.

Cyclic Elimination: Amine oxide, Esters, Xanthate, and Free elimination reactions, Dehalogenation by Zinc. Triple bond by elimination. Elimination versus substitution. Effect of solvent, temperature. Nature of base and structure of reactants.
Aromatic Elimination: Benzyne, Nucleophillic aromatic substitution, addition elimination.

Recommended Books

1. Modern Organic Reactions, H.C. House, Benjamin, 1972.
2. Advanced Organic Chemistry by Carey Sundberg (Volume I and II), 2007
3. Advanced Organic Chemistry by Jerry March, 2006.
4. Pericyclic Reactions, S.M. Mukherji, Macmillan, India, 3rd edition, 2008.
5. Pericyclic Reactions by Ian Fleming (Oxford University, Press), 2015
6. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan, 2021.

SEMESTER-I
MCHEM1103T
Physical Chemistry

Max. Marks:100
External Exam:70 marks
Internal Assessment: 30 marks
Passing Marks: 35%

Time allowed: 3hrs
Credits: 04

INSTRUCTIONS FOR THE PAPER SETTER
The question paper will consist of three sections: A, B, and C. Sections A and B will have four questions from the respective sections of the syllabus and will carry12 marks each. Section C will consist of 11 short-answer questions from the entire syllabus and will carry 2 marks each.

INSTRUCTIONS FOR THE CANDIDATES
Candidates are required to attempt five questions selecting two questions from each of Section A & B and Section C will be compulsory.

Course Outcomes (C.O.):

1. To study advanced idea of thermodynamics.
2. To learn thermodynamic phenomenon of coupled biological reactions.
3. To provide an insight into the characteristics of different types of solutions and electrochemical phenomena.
4. To learn ionic equilibria and electrical properties of ions in solution.

Section –A

Thermodynamics

Recall: Concepts involved in first and second law of thermodynamics, Entropy, free energy and chemical equilibrium. Thermodynamic equation of state and Maxwell relations.

Non-ideal Systems: Excess functions for non-ideal systems. Activity and activity coefficients and their determination. Concept of fugacity and its experimental determination. Partial molal properties and their determination.

Third law of Thermodynamics: Identification of statistical and thermodynamic entropy. Nernst postulate, Plank's contribution. Alternate formulation of third law. Cooling effect by adiabatic and De-magnetisation. Evaluation of absolute entropy.

Thermodynamic and living systems: Simultaneous or coupled reactions. Coupled reactions and metabolism. Free energy utilisation in metabolism. Terminal oxidation chain. Overall metabolic plan. General thermodynamic consideration of living systems.

Statistical Thermodynamics: Basic introduction to statistical thermodynamics

Partition function and Thermodynamic properties: Partition function and its factorization. Translational, rotational, vibrational; electronic and nuclear partition functions. Expressions for internal energy, entropy, Helmholtz function, Gibb's function, pressure, work and heat in terms of partition function. Thermodynamic properties of ideal gases. Vibrational, rotational, electronic and nuclear contributions to the thermodynamic properties.

Section –B

Electrochemistry

Ion-solvent interactions: Born model of ion-solvent interactions, Structural models of ion- solvent interations. Experimental determination of salt-solvent interactions. Relative heat of solvation of ions in the hydrogen scale. Evaluation of ion-solvent interactions from experimental data of salt-solvent interactions.

Ion-ion interactions: Debye-Huckel theory of ion-ion interactions.Verification of Debye-Huckel limiting law. Activity coefficients at moderate concentrations and higher concentrations. Activity coefficients as a function of ion-ion and ion-solvent interactions. Mean activity coefficients and their experimental determination.

Conductance and Ionic Mobilities: Conductance of electrolytic solution. Variation of equivalent conductance with concentration. Debye-Huckel-Onsager theory. Modification of Debye-Huckel-Onsager equation. Ionic conductance, Ion-association and ion-pair formation. Ion-triplets in electrolyte solutions. Ion-triplets and conductance.

Applied Electrochemistry

Electrical Double layer: Electro-kinetic phenomenon. Null point and its determination. Structure of electrical double layer, parallel plate condenser theory, diffuse layer theory and adsorption theory of double layer.

Electro-catalysis: A chemical catalyst and an electrochemical catalyst, Electro-catalysis in redox reactions. Electro-catalysis in reactions involving adsorbed species. Some specific feature of electro-catalysis.

Corrosion of Metals: Classification of corrosion processes, theories of corrosion processes, passivation of metals. Corrosion monitoring and methods of corrosion prevention.

Recommended Books

1. Bockris and Reddy, Modern Electrochemistry, Vol.I & II, 2nd edition, 1999.
2. Antropov,Theoretical Electrochemisty, 2nd edition, 1987.
3. Glasstone, Electrochemistry, 2011.
4. Aston and Fritz, Thermodynamic and Statistical Thermodynamics, 1959.
5. Lee, Seers and Turcotte; Statistical Thermodynamics, 1973.
6. Dickerson, Molecular Thermodynamics, 1970.
7. Glasstone, Thermodynamics for Chemists, 2008.

SEMESTER-I
MCHEM1104T
Mathematics for Chemist
(For Students without Mathematics in B.Sc.)

Max. Marks:100
External Exam: 70 marks
Internal Assessment: 30 marks
Passing Marks:35%

Time allowed: 3hrs
Credits: 04

INSTRUCTIONS FOR THE PAPER SETTER
The question paper will consist of three sections: A, B, and C. Sections A and B will have four questions from the respective sections of the syllabus and will carry12 marks each. Section C will consist of 11 short-answer questions from the entire syllabus and will carry 2 marks each.

INSTRUCTIONS FOR THE CANDIDATES
Candidates are required to attempt five questions selecting two questions from each of Section A and B and Section C will be compulsory.

Course Outcomes (C.O.):
After completion of this course, the students will be able to

1. Understand the topics matrices, differentiation and integration.
2. Evaluate problems of differential equation and partial differentiation.
3. Analyse basic concepts related to trigonometric functions and straight line.
4. This knowledge helps them to become expertise in all subjects of chemistry and apply them to practical examples.

Section –A

Matrix Algebra and Coordinate Geometry
Addition and Multiplication of Matrices, determinants (up to 3rd order), inverse, adjoint and transpose of matrices. Cartesian system of co-ordinates in the plane, slope of a line, parallel and perpendicular lines. **Various forms of equations of a line**: parallel to axis, slope intercept form, the point slope form, two-point form, intercept form.

Trigonometry
Degree, gradient and radian measure of positive and negative angles, relation between degree, gradient and radian, definition of trigonometric functions with the help of unit circle, Periodic functions, Concept of periodicity of trigonometric functions.

Section –B

Calculus
Differential Calculus: Functions, limit, continuity and differentiability, rules for differentiation, applications of differential calculus including maxima and minima. Partial differentiation, Euler's theorem.
Integral calculus: Basic rules for integration, integration by parts, partial fraction and substitution definite integrals and Reduction formulae.

Elementary Differential Equations

Method of Variables, separable and exact differential equation, first order differential equations. Homogeneous and linear equations. Applications to chemical kinetics, secular equilibria, quantum chemistry etc. Solutions of differential equations by the power series method, Fourier series, solutions of harmonic oscillator and Legendre equation, spherical harmonics.

Recommended Books

1. The Chemistry Mathematics Book, E. Steiner, Oxford University Press, 1996.
2. Mathematics for Chemistry, Doggett and Sucliffe, Longman, 1995.
3. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill, 1928.
4. Chemical Mathematics, D. M. Hirst, Longman, 2011.
5. Applied Mathematics for Physical Chemistry, J. R. Barrante, Prentice Hall, 2011.
6. Basic Mathematics for Chemists, Tebbutt Wiley, 1998.
7. Plane trigonometry, S. L. Loney, 2005.
8. Co-ordinate geometry, S. L. Loney, 1895.

SEMESTER-I
MCHEM1104T
Biology for Chemist
(For Students without Biology in B.Sc.)

Max. Marks: 100
External Exam: 70 marks
Internal Assessment: 30 marks
Passing Marks: 35%

Time allowed: 3hrs
Credits: 04

INSTRUCTIONS FOR THE PAPER SETTER
The question paper will consist of three sections: A, B, and C. Sections A and B will have four questions from the respective sections of the syllabus and will carry12 marks each. Section C will consist of 11 short-answer questions from the entire syllabus and will carry 2 marks each.

INSTRUCTIONS FOR THE CANDIDATES
Candidates are required to attempt five questions selecting two questions from each of Section A and B and Section C will be compulsory.

Course Outcomes (C.O.):

1. The students understand the core principles & topics of Biochemistry and to enable students to acquire knowledge of biomolecules in biology that are based upon chemistry.
2. To increase the knowledge and understanding of principles that governs the structures of macromolecules and their interactions.
3. To enable students to understand function of Nucleic acids & proteins and functioning of these molecules which interact within the cell to promote proper growth, division and development.
4. To make the students understand the metabolic pathway of different biomolecules.

Section –A

Biomolecules: Introduction of biomolecules, building blocks of biomolecules.

Cell Structure & Functions: Structure of prokaryotic & eukaryotic cells, Intracellular organelles and their functions, Comparison of plant and animal cells. Overview of metabolic process-catabolism and anabolism. ATP-the Biological energy currency.

Cell Division: Cell division stages of mitosis & meiosis. Significance of cell division and fertilization.

Carbohydrates: Conformation of monosaccharides, structure & functions of important derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, amino sugars, N-acetyl muramic acid, Sialic acid, disaccharide & Polysaccharides. Structural polysaccharides-cellulose, pectin and chitin. Storage Polysaccharides-starch and glycogen. Carbohydrates of glycoproteins and glycol lipids, Ascorbic acid. Carbohydrate metabolism-Kreb's Cycle, glycolysis, glycogenesis and glycogenolysis, gluconeogenesis, Pentose phosphate Pathway.

Lipids: Fatty acids, essential fatty acids, structure and function of triglycerots glycerophospholipids, Sphingolipids, cholesterol, Bile acids, prostaglandins, 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 membrane structure.

Section –B

Structure of Proteins: Chemical and enzymatic hydrolysis of Proteins to peptides, amino acid sequencing. Secondary structure of proteins, forces responsible for holding of secondary structure: a). triple helix, b). sheets, super secondary structure, triple helix structure of collagen/Tertiary structure of protein-folding and domain structure, Quaternary structure.

Enzymes and Hormones: Enzymes as biological catalyst and mode of their action. Michaelis-menton equations, Enzymes classification, Allostericenzymes, Zymogens. Chemistry of oxytocin and tryptophan releasing harmone (TRH).

Structure of Nucleic Acids: Purines and Pyrimidine bases of nucleic acids, base pairing via H-bonding. Structure of Ribonuclic acids (RNA) and Deoxyribonucleic acids (DNA), double helix model of DNA and forces responsible for holding its Chemical and enzymatic hydrolysis of Nucleic acids.

Replication of DNA: The chemical basis of heredity and overview of replication of DNA.

Protein Synthesis & Genetic Code: Transcription, translation and genetic code.

Recommended Books

1. Principles of Biochemistry, A. L. Lehninger, Worth Publishers, 7th Ed., 2017.
2. Biochemistry, L. Stryer, W. H. Freeman, 2015.
3. Biochemistry, J. David Rawn, Neil Patterson., 1989.
4. Outlines of Biochemistry, E. E. Conn and P. K. Stumpf, John Wiley.
5. Fundamentals of Biochemistry, J. L. Jain, S. Jain, N. Jain, S. Chand.

SEMESTER-I
MCHEM1105L
Practical Inorganic Chemistry-I

Max. Marks:100
External Exam: 70 marks **Credits: 03**
Internal Assessment: 30 marks
Passing Marks: 35%

Course Outcomes (C.O.):

1. Students are able to estimate metal ions and ligands in prepared complexes using titration method.
2. To make the students expertize in preparation of metal complexes.
3. Students gain the knowledge about IR studies of prepared complexes.
4. Students are able to analyze total dissolved solids and chlorides in water using appropriate methods.

PREPARATION AND ESTIMATIONS

1. Preparation of tris-thioureacuprous chloride.
2. Preparation of hexathioureaplumbousnitrate $[Pb(CH_4N_2S)_6](NO_3)_2$ and IR studies of these samples.
3. Estimation of lead.
4. Preparation of $K_3[Fe(C_2O_4)_3]$.
5. Preparation of $Hg[Co(NCS)_4]$
6. Preparation of $(NH_3)_2HgCl_2$.
7. Estimation of Hg.
8. Mercuration of phenol and separation of the compound into o and p isomers and IR studies of these samples.
9. Preparation of $K_3[Cr(C_2O_4)_3]$
10. Estimation of oxalate.
11. Preparation of $Cu_2[HgI_4]$.
12. Estimation of cobalt.

Water Analysis:

1. Determination of the amount of bleaching powder required to disinfect a water sample by Horrock's test.
2. Determination of chemical oxygen demand of a waste water sample.
3. Determination of total dissolved solids dried at103-105°C.
4. Determination of chloride content of water sample by Mohr's method or Vohlard's method

Recommended Books

1. Advanced Practical Inorganic Chemistry, Gurdeep Raj, Krishna Prakashan Media (P)Ltd., 2013.
2. Vogel's Qualitative Inorganic Analysis Paperback by Svehla/Sivasankar, 2012.
3. Advanced Practical Chemistry, Jagdamba singh, L.D.S. Yadav, Pragati Prakashan, 2023.

Namelka

SEMESTER-I
MCHEM1106L
Analytical Chemistry Practical-I

Max. Marks: 100
External Exam: 70 marks
Internal Assessment: 30 marks
Passing Marks: 35%

Credits: 03

Course Outcomes (C.O.):

1. Students are able to learn the principle and working of pH meter.
2. Students are able to learn the principle and working of conductometer.
3. Students are able to find the percentage purity and strength of different solutions using different methods.
4. Students are able to learn the principle and working of potentiometer and colorimeter.

SECTION-A

1. To determine the percentage purity of given sample of $ZnSO_4.7H_2O$ by complexometric titration.
2. Determine the percentage purity of the given sample of $NiSO_4.7H_2O$ by complexometric titration using Eriochrome black-T.
3. To determine the composition of Calcium and Magnesium in the mixture of the given solution.
4. To find the strength of ascorbic acid in the given solution of Vitamin C tablet by titrating against
   (I) Standard I_2 solution
   (II) Standard Sodium thiosulphate solution.
5. To determine the percentage purity of sample of KBr using adsorption indicator.
6. To determine the amount of H_2O_2 in the given solution by titrating against.
   (I) Standard $KMnO_4$
   (II) Standard Sodium thiosulphate solution.
7. To find out the percentage purity of KI by titrating it against standard KIO_3 solution.

SECTION-B

1. To determine the strength of HCl solution by titrating it against NaOH pH-metrically.
2. To determine the strength of acetic acid solution by titrating it against NaOH pH-metrically.
3. To determine the composition of the mixture of HCl & CH_3COOH by titrating it against NaOH pH-metrically.
4. Determine the strength of HCl solution by titrating it against NaOH conductometrically.
5. Determine the strength of CH_3COOH solution by titrating it against NaOH conductometrically.

6. To determine the composition of the mixture of HCl & CH_3COOH by titrating it against NaOH conductometrically.
7. Determine the strength of $FeSO_4.7H_2O$ solution by titrating it against $KMnO_4$ potentiometrically.
8. Determine the strength of $CuSO_4.7H_2O$ Colorimetrically.
9. Determine the strength of $K_2Cr_2O_7$ solution Colorimetrically.

Recommended Books

1. Advance Practical Physical Chemistry by J. P. Yadav. Krishna Prakashan Media, 2016.
2. Advance Physical Chemistry Experiments by Gurtu & Gurtu. Pragati Parakashan, 2011
3. University Practical Chemistry by P. C. Kamboj. Vishal Publishing Co., 2013.

SEMESTER-II
MCHEM1201T
Inorganic Chemistry

Max. Marks: 100
External Exam: 70 marks
Internal Assessment: 30 marks
Passing Marks: 35%

Time allowed: 3hrs
Credits: 04

INSTRUCTIONS FOR THE PAPER SETTER

The question paper will consist of three sections: A, B, and C. Sections A and B will have four questions from the respective sections of the syllabus and will carry12 marks each. Section C will consist of 11 short-answer questions from the entire syllabus and will carry 2 marks each.

INSTRUCTIONSFORTHECANDIDATES

Candidates are required to attempt five questions selecting two questions from each of Section A and B and Section C will be compulsory.

Course Outcomes (C.O.):

1. Concepts of symmetry and group theory in solving chemical structural problems.
2. Enable the students to predict the point group of important molecules. To understand the idea of space groups and to learn the theory of molecular symmetry.
3. Use of character tables, Application of symmetry and group theory in spectroscopy.
4. To gain skill to apply group theory to vibrational and electronic spectroscopy.
5. The students will acquire knowledge of properties and applications of compounds of main group elements.

Section –A

Group Theory

Order, classes of group, representation of a group, transformation of coordinates matrices, matrix representation of symmetry operation, reducible and irreducible representations and C_{2v}, C_{3v}, D_{4h}, Td, Oh, character tables, symmetry, the method of finding the number of irreducible representation in a reducible representation, separation of d-orbitals under influence of octahedral, tetrahedral, sq. planar and trigonal bipyramidal symmetry, the separation of P, D, F etc. free ion terms into symmetry labelled electric field terms under the influence of octahedral field, the directed valence for Td and Oh symmetry, direct product for Oh, Td, C_{3v}, D_{4h} and D_{5h} and the method of descending symmetry for d^2 configuration.

Applications of Group Theory

Suitable metal orbitals and ligand orbitals combination to form molecular orbitals in coordination complexes Oh, Td and square planar complexes, symmetry consideration regarding selection rules and spectral intensties, vibronic coupling, vibronic polarization in centrosymmetric complexes Oh and D_{4h} and non-centrosymmetric complexes C3v, Td polarization of electronically allowed transitions, selection rules, fundamentals, overtones and combinations in vibrational spectroscopy-the symmetry symbols for normal modes of vibrations. IR and Raman activity of their fundamentals and nature of vibrations in terms of change in internal coordinates in simple molecules likeTrans N_2F_2, SF_6, Fermi resonance.

Section –B

Chemistry of Main Group elements

Hydrogen : transition metal hydrides, the group I A elements-organometallic compounds of alkali-metals, the group II A - organo-beryllium and organo-magnesium compounds, the group III A elements-structure and bonding of polyhedral boranes, structural study by NMR, Wade's rules, carboranes and other hetro-boranes, organoboron compounds, organoaluminium compounds, compounds with C-N bonds, thiocarbonates, dithiocarbamates, zeolites, clays, silicates.

The group V A elements - Types of Covalence in nitrogen, stereochemistry, dinitrogen and nitrogen compounds as ligands, ammonia and amines, phosphorus-nitrogen compounds, the group VI A elements-chemical properties of dioxygen, singlet oxygen, dioxygen, superoxo and peroxo ligands, sulphur and sulphur-nitrogen compounds,sulphur-sulphur compounds as ligands, iso & heteropoly acids and anions of Mo and W. The group VII A Elements the charge-transfer complexes of halogens, polyiodide anions, pseudohalogens, the group VIII A elements - the chemistry of xenon, krypton and radon.

Recommended Books

1. Inorganic chemistry: Principles of Structure and reactivity by James E. Huheey, E.A. Keiter, R. L. Keiter, 2006.
2. Advanced Inorganic Chemistry by Cotton and Wilkinson, 5th edition, 1999.
3. Chemical Applications of GroupTheory - F. A. Cotton, 3rd edition, 2008 .
4. Introductory Group Theory for Chemists-George Davidson, 1971.
5. Introduction to Ligand Fields-B. N. Figgis, 1966.
6. Inorganic Chemistry-Shriver, Atkins and Langford, 7th edition, 2012.
7. Advanced Inorganic Chemistry- Cotton and Wilkinson (3rd , 4th and 5th Ed.), 2023.

SEMESTER-II
MCHEM1202T
Organic Chemistry

Max. Marks:100
External Exam: 70 marks
Internal Assessment: 30 marks
Passing Marks: 35%

Time allowed: 3hrs
Credits: 04

INSTRUCTIONS FOR THE PAPER SETTER

The question paper will consist of three sections: A, B, and C. Sections A and B will have four questions from the respective sections of the syllabus and will carry12 marks each. Section C will consist of 11 short-answer questions from the entire syllabus and will carry 2 marks each.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions selecting two questions from each of Section A and B and Section C will be compulsory.

Course Outcomes (C.O.)

1. To understand the stereochemistry and various possible conformations of organic compounds and their effects on the rate of reaction.
2. To get an idea about the various kinetic and thermodynamic factors which control the organic reactions.
3. The students will get knowledge of mechanisms of addition reactions of C=C and C=O bonds and elimination reactions.

Section –A

Stereochemistry

Stereoisomerism: Introduction and different types of stereoisomers. Fischer, Newman and sawhorse representations for organic molecules.

Optical Isomerism: Requirement for a compound to be optically active, compounds with one asymmetric centre. Dissymmetry as a cause of optical activity. Compoundswith two asymmetric centres. Racemic modification Racemisation: Thermal, anionic, cationic, freeradical, epimerisation, Mutarotation, Racemic compounds, mixtures and solid solutions.

Diastereoisomerism: Resolution of acids, bases, amino acids, alcohols, aldehydes and ketones, Absolute and Relative configuration, Different systems of rotation. Asymmetric induction, methods of determining the configuration. Cram's Rule and Prelog's Rule.

Conformational Isomerism: Meaning of conformation, Conformation and reactivity in alicyclic compounds. Conformation and physical properties, dipole moment, NMR, IR and X-rays, conformational effects on stability and reactivity. Ionic elimination. Intra molecular rearrangement, neighboring group participation. Elimination. Pyrolysis of acetate, xanthates and amine oxide. Relation of conformation to reactivity. Optical isomerism due to restricted rotation in biphenyls, allenes, alkylidenes and spiranes.

Ring Systems: Conformational studies in cyclohexane; mono and disubstituted cyclohexane. Its stability and reactivity. Studies in fused systems. Decalins and Perhydrophenanthrenes.

Geometrical Isomerism: Nomenclature (E & Z) Nature of geometrical isomerism and determination of Configuration Curtin-Hammet Principle Study of Physical properties of the isomers, Relative stability and interconversion of Geometrical isomers.

Section –B

Addition to carbon-carbon multiple bond

Mechanistic 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 bond, hydrogenation of aromatic rings. Hydroboration, Michael-reaction, sharpless asymmetric epoxidation.

Addition to Carbon-Hetero multiple bond

Mechanism of metal hydride reduction of carbonyl compounds and other functional groups. Dissolving metal reductions of carbonyl functions and conjugated systems. Addition of Grignard's reagent, organozinc, organocopper and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Clemmenson reduction, and Meerwein Pondroff Verley reduction. Wittig's Reaction, Wolf Kishner reduction.

Recommended Books

1. Advanced Organic Chemsitry-Reaction, Mechanism and Structure, Jerry March, Johny Wiley, 4th edition, 1992.
2. Stereochemistry of Carbon Compounds by Ernest, L. Eliel, Tata McGraw-HilI, 1962.
3. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International, 3rd edition, 2018.
4. Stereochemistry of Organic Compounds, P. S. Kalsi, New Age International, 5th edition, 2020.
5. Advanced Organic Chemistry, F.A. Carey and R. J. Sundberg, Plenum, 2008.
6. A Guide Book to Mechanism in Organic Chemistry, Peer Sykes, Longman, 6th edition, 2003.
7. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University, Press, 2nd edition, 1970
8. Principles of Organic Synthesis, R.O. C. Norman and J. M. Coxon, Blackie Academic & Professional, 1993.
9. Reaction Mechanism in Organic Chemistry, S. M. Mukherjii and S. P. Singh, Macmillan, 2018.

SEMESTER-II
MCHEM1203T
Physical Chemistry

Max. Marks:100
External Exam: 70 marks
Internal Assessment: 30 marks
Passing Marks: 35%

Time allowed: 3hrs
Credits: 04

INSTRUCTIONS FOR THE PAPER SETTER

The question paper will consist of three sections: A, B, and C. Sections A and B will have four questions from the respective sections of the syllabus and will carry12 marks each. Section C will consist of 11 short-answer questions from the entire syllabus and will carry 2 marks each.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt five questions selecting two questions from each of Section A & B and Section C will be compulsory.

Course Outcomes (C.O.):

1. To impart the students concepts of the fundamentals of quantum mechanics and its applications in the study of structure of atoms, bonding in molecules.
2. To understand the requirement of approximation methods in quantum mechanics.
3. To gain insight into valance bond theory molecular orbital theory and the concept of hybridization.
4. To provide an insight into the thermodynamic and kinetic aspects of chemical reactions and phase equilibria. To derive some thermochemical equations and kinetic equations.

Section –A

Quantum Mechanics

Introduction to exact quantum mechanical result

Fundamental concepts of quantum mechanics, setting up of operators for different observables, Hermitian, unitary and linear operators, postulates of quantum mechanics. Discussion of solution of Schrodinger equation to some model systems. (Viz. particle in a box, the harmonic oscillator, the rigid rotator).

Hydrogen and hydrogen like atoms

Solution of Schrodinger equation for hydrogen and hydrogen like atoms, physical representation of *s* and *p* orbitals, radial plots, angular plots, probability functions and plots.

Approximate Methods

The variation principle, perturbation theory (first order and non-degenerate), applications of variation method and perturbation theory to the helium atom.

Angular Momentum

Ordinary angular momentum, the quantum mechanical operators for angular momentum. Eigen function and Eigen values of angular momentum using ladder operators, addition of angular momentum.

Electronic Structure of Atom

Electronic states of complex atoms, anti-symmetry and Pauli's exclusion principle, Hartree method, Russel Saunder's terms and coupling schemes.

Molecular Orbital Theory

Huckel Theory of conjugated systems, bond order and charge density calculation, applications of Huckel molecular orbital theory of ethylene, butadiene, cyclopropenyl radical, cyclobutadiene systems. Introduction to extended Huckel theory.

Section –B

Chemical Kinetics

Introduction: Rate of reaction, empirical rate-equation, order and molecularity of a reaction, effect of temperature on reaction rates.

Theories of reaction rates: Number of bimolecular collisions and derivation of rate constant, steric factor & its calculation, factors determining effectiveness of collisions, Lindemann mechanism, statistical derivation of rate equation (Eyring equation), transmission co-efficient, tunneling effect, comparision of collision and transition state theories.

Fast reactions: Study of fast reactions by stopped flow technique, relaxation methods, magnetic resonance technique.

Thermodynamic treatment of reaction rates: free energy of activation, heat of activation and its relationship with various kinds of activation energies, relationship between steric factor and entropy of activation.

Kinetics in solution: Primary and secondary salt effects, effect of polarity and nature of solvent on rate of reaction.

Complex reactions: Various types of complex reactions, parallel first order reactions producing a common product, parallel higher order reactions, reactions approaching equilibrium, Michaelis-Menten mechanism for enzyme catalysis, consecutive reactions, oscillating reactions.

Recommended Books

1. Kinetics and Mechanism by A. A. Frost & R. G. Pearson, John-Wiley & Sons, Inc., New York, 1966.
2. Physical Chemistry by P.W. Atkins, 8th edition, 2009.
3. Chemical Kinetics Methods by C. Kalidas, New Age International Publishers, 4th edition, 2017.
4. The Foundation of Chemical Kinetics by S.W. Benson, 1960.
5. Introduction to Quantum Chemistry, A. K. Chandra, Tata McGraw Hill, 2017.
6. Quantum Chemistry by I. N. Levine, Prentice Hall, 2013.
7. Quantum Chemistry by W. Kauzmann, 1957.
8. Quantum Chemistry by Eyring, Walter and Kimball, 2022.

SEMESTER-II
MCHEM1204T
Computer Fundamental & programming with C

Max. Marks: 100
External Exam:70 marks
Internal Assessment: 30 marks
Passing Marks: 35%

Time allowed: 3hrs
Credits: 04

INSTRUCTIONS FOR THE PAPER SETTER
The question paper will consist of three sections: A, B, and C. Sections A and B will have four questions from the respective sections of the syllabus and will carry 12 marks each. Section C will consist of 11 short-answer questions from the entire syllabus and will carry 2 marks each.

INSTRUCTIONSFORTHECANDIDATES
Candidates are required to attempt five questions selecting two questions from each of Section A & B and Section C will be compulsory.

Course Outcomes (C.O.):

1. Understand the basic concepts of hardware & software, terminology of IT and familiar with various tools of Office.
2. Understand the basic terminology used in computer programming.
3. Foundation for the higher level of programming languages.
4. Develop confidence and ability for learning needed for Computer language.

Section –A

Organization of Computers: Block Diagram of Computer, Types of Computers, Characteristics, Application areas: Scientific Applications, Education, Health and E-commerce.

Word Processor: Introduction, Basic Editing, Formatting, Templates, Working with Graphics and Pictures, Tables, Mail Merge, Printing, and Publishing, Comparing, Merging and Protecting Documents.

Presentation: Introduction, Using Themes and Layouts, Inserting Text and Using WordArt, Inserting Graphics, Working with Videos, Movie-Clips, Animations and Transitions, Sounds, Editing, Saving.

Spreadsheet: Introduction, Worksheets and Workbooks, Entering data and texts, Formatting a Worksheet, Adding Elements to a Workbook, Charts, Formulas and Calculations, Statistical functions.

Section –B

Introduction to C: Problem Solving with Computers- Analysis, Design, Coding, Compilation, Testing and Debugging, Implementation and Maintenance. Character set, Constants, Variables, Rules for Defining Variables, identifier and Keywords, Data Types.
Operators and Expressions: Arithmetic, Relational, Logical, Assignment, Conditional, Unary, Bitwise, Comma, Operator Precedence and Associativity. Instructions – Type Declaration, Input/ Output Instructions. Control Statements: Decision Control Statements (if, if else, nested if else, switch), Jump Control Statements

(break, continue, goto), Loop Control Statements (for, while, do-while), nested loops.

Functions: Function Declaration and Prototype, Call, Definition, Types of Functions, Methods of Parameter passing-Call by Value, Call by Reference, Recursion. Introduction to Array, String, Structure and Pointers.

Recommended Books

1. Rajaraman, V. *Computer Basics and C Programming*. PHI Learning Pvt. Ltd., 2008.
2. Kanetkar, Yashavant. *Let us C*. BPB publications, 2018.
3. Rajaraman, V., and Neeharika Adabala. *Fundamentals of computers*. PHI Learning Pvt. Ltd., 2014.
4. Sinha, Pradeep K., and Priti Sinha. *Computer fundamentals*. BPB publications, 2004.

SEMESTER-II
MCHEM1207L
Organic Chemistry Practical-II

Max. Marks: 100
External Exam: 70 marks
Internal Assessment: 30 marks
Passing Marks: 35%

Credits: 03

Course Outcomes (C.O.):

1. Students are able to synthesize some organic compounds.
2. Students are able to characterize synthesized organic compounds by spectral techniques.
3. To provide the knowledge to separate and purify components of organic binary mixtures.
4. Students are able to prepare suitable derivatives of different functional group compounds.

Qualitative Organic Analysis

Separation and purification of components of binary mixture (Solid/solid, solid/liquid and liquid/liquid) on the basis of solubility behavior and solvent extraction and their identification and conformation by chemical tests and preparation of suitable derivative. Preparative TLC separation for IR and PMR spectral studies of the respective component.

Organic Synthesis

Benzoylation	:Hippuric acid
Oxidation	:Adipic acid/p-Nitrobenzoic acid
Aldol condensation	:Dibenzalacetone/Cinnamic acid
Sandmeyer's reaction	:p-Chlorotoluene
Benzfused Heterocycles	:Benzimidazole
Cannizzaro'sreaction	:p-Chlorobenzaldehyde as substrate
Friedel Crafts reaction	:S-Benzoylpropionic acid
Aromatic electrophilic	
Substitution	:p-Nitroaniline/p-Iodoaniline

The products may be characterized by spectral techniques.

Recommended Books

1. Vogel's Textbook of Practical Organic Chemistry, 5th Edition ELBS (Longman), 1996.
2. Practical Organic Chemistry by F. G. Mann and B. C. Saunders, 5th Edition, Orient Longman Limited, 1986.
3. Advanced Practical Chemistry, Jagdamba Singh, LDS Yadav, Pragati Prakashan.

SEMESTER-II
MCHEM1208L
Physical Chemistry Practical-II

Max. Marks: 100
External Exam: 70 marks
Internal Assessment: 30 marks
Passing Marks: 35%

Credits: 03

Course Outcomes:

1. Students are able to determine density of given liquids using Pyknometer.
2. Students are able to determine molecular weight of different polymers by viscosity method.
3. Students are able to detect molar refractivity of given solid.
4. Students are able to determine equilibrium constant for various reactions by partition method

Experiments:

1. To determine the Molecular weight of given polymer by viscosity method.
2. To find out the value of coefficient of expansion for the given liquid with the help of Pyknometer.
3. To determine the atomic Parachors of C, H & O.
4. To compare the cleansing powers of two samples of detergents by surface tension method.
5. To determine the interfacial tension between two immiscible solvents.
6. To find out the equilibrium constant for thereaction, KI+ I_2---KI_3 by partition method.
7. To determine the rate constant of the hydrolysis of ethyl acetate catalysed by an acid and also find out the half-life period of the reaction.
8. To determine the order of saponification of ethyl acetate with sodium hydroxide.
9. To find out the molar refractivities of homologous series of alcohols and also find out the atomic refractivities of C & H.
10. To find out the molar refractivity of the given solid.
11. To study the adsorption of acetic acid on activated charcoal & prove the validity of Freundlich Adsorption Isotherm.
12. To determine the density of given liquids with the help of Pyknometer.

Recommended Books

1. Practical Physical Chemistry, A. M. James and F. E. Prichard, Longman, 2012.
2. Advanced Physical Experiments, Gurtu and Gurtu, Pragati Prakashan, 2013.
3. Practical Physical Chemistry, Alexander and Findley, Longmans, Green, 1923.