**Structure and Syllabii of**

**M. Sc. Chemistry (Four Semesters) Course**

**Under Choice Based Credit System**

(Effective from the Academic Session 2016-17)

**COURSE SCHEME M.Sc. Programme: two-year (four semesters) under Choice based credit system**

**SYLLABUS M.Sc. (Chemistry) Programme**

**Credits requirement for completion of the Programme: 100**

**Credits Compulsory Courses : 51**

**Credits Elective Courses: 3**

**Credits Open Elective Courses: 4**

**Credits Specialisation Elective Courses: 40**

**Credits Seminar: 2**

**Credits Total : 100**

**Semester-wise distribution of Credits -**

**Semester I -24 (CT-12, ET-3, CP-9)**

**Semester II -23 (CT-12, OE-2, CP-9= 23)**

**Semester III -27 (CT-9, OE-2, SET-8, SEP-8)**

**Semester IV-26 (SET-16, SEP-8, SEMINAR-2)**

**CT-Compulsory Theory, ET- Elective Theory, CP- Compulsory Practical, OE-Open elective, SET- Specialisation elective theory, SEP-Specialisation elective Practical**

**SEMESTER I**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** |  | **Credits** | **Teaching Hours per week** | **Maximum Marks** | | |
| Internal Assessment**\*** | End-semester Examination | Total |
| CHEM 101 | Inorganic Chemistry-I | CT | 4 | 4 | 20 | 60 | 80 |
| CHEM102 | Physical Chemistry-I | CT | 4 | 4 | 20 | 60 | 80 |
| CHEM103 | Organic Chemistry-I | CT | 4 | 4 | 20 | 60 | 80 |
| CHEM104a | Mathematics for Chemists | ET | 3 | 3 | 15 | 45 | 60 |
| CHEM104b | Chemistry of Life Science | ET | 3 | 3 | 15 | 45 | 60 |
| CHEM104c | Introduction to pharmacy and pharmacology | ET | 3 | 3 | 15 | 45 | 60 |
| CHEM 105 | Inorganic Chemistry Practical-I | CP | 3 | 6 | 15 | 45 | 60 |
| CHEM 106 | Physical Chemistry Practical-I | CP | 3 | 6 | 15 | 45 | 60 |
| CHEM 107 | Organic Chemistry Practical-I | CP | 3 | 6 | 15 | 45 | 60 |
| **Total Credits/Marks** | |  | **24** | **33 (T-15, P-18)** | | | **480** |
| CT= Compulsory Theory, CP= Compulsory Practical, ET=Elective Theory, Student has to opt any one of the elective theory paper (ET) based upon the course in B,Sc. | | | | | | | |

**SEMESTER II**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** |  | **Credits** | **Teaching Hours per week** | **Maximum Marks** | | |
| Internal Assessment**\*** | End-semester Examination | Total |
| CHEM 201 | Inorganic Chemistry-II | CT | 4 | 4 | 20 | 60 | 80 |
| CHEM202 | Physical Chemistry-II | CT | 4 | 4 | 20 | 60 | 80 |
| CHEM203 | Organic Chemistry-II | CT | 4 | 4 | 20 | 60 | 80 |
| OE-201 | OPEN ELECTIVE | OE | 2 | 2 | 15 | 35 | 50 |
| CHEM 204 | Inorganic Chemistry Practical-II | CP | 3 | 6 | 15 | 45 | 60 |
| CHEM 205 | Physical Chemistry Practical-II | CP | 3 | 6 | 15 | 45 | 60 |
| CHEM 206 | Organic Chemistry Practical-II | CP | 3 | 6 | 15 | 45 | 60 |
| **Total Credits/Marks** | |  | **23** | **32 (T-14, P-18)** | | | **470** |
| OE= Open elective, Students of Chemistry department will study one open elective paper offered by other department from among the department of physical sciences and students of other department (s) of physical sciences may opt open elective paper (OE-201)offered by Chemistry department. | | | | | | | |

**SEMESTER III**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** |  | **Credits** | **Teaching Hours per week** | **Maximum Marks** | | |
| Internal Assessment**\*** | End-semester Examination | Total |
| CHEM 301 | Inorganic Chemistry General | CT | 3 | 3 | 15 | 45 | 60 |
| CHEM302 | Physical Chemistry General | CT | 3 | 3 | 15 | 45 | 60 |
| CHEM303 | Organic Chemistry General | CT | 3 | 3 | 15 | 45 | 60 |
| OE-301 | OPEN ELECTIVE | OE | 2 | 2 | 15 | 35 | 50 |
| CHEM 304 | Inorganic Chemistry Special-I | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM 305 | Inorganic Chemistry Special-II | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM 304 | Physical Chemistry Special-I | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM 305 | Physical Chemistry Special-II | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM 304 | Organic Chemistry  Special-I | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM 305 | Organic Chemistry  Special-II | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM 304 | Pharmaceutical Chemistry  Special-I | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM 305 | Pharmaceutical Chemistry Special-II | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM306 | Inorganic Chemistry Special Practical-I | SEP | 4 | 8 | 20 | 60 | 80 |
| CHEM307 | Inorganic Chemistry Special Practical-II | SEP | 4 | 8 | 20 | 60 | 80 |
| CHEM306 | Physical Chemistry Special  Practical-I | SEP | 4 | 8 | 20 | 60 | 80 |
| CHEM307 | Physical Chemistry Special  Practical-II | SEP | 4 | 8 | 20 | 60 | 80 |
| CHEM306 | Organic Chemistry Special  Practical-I | SEP | 4 | 8 | 20 | 60 | 80 |
| CHEM307 | Organic Chemistry Special  Practical-II | SEP | 4 | 8 | 20 | 60 | 80 |
|  |  |  |  |  |  |  |  |
| CHEM306 | Pharmaceutical Chemistry Special Practical-I | SEP | 4 | 8 | 20 | 60 | 80 |
| CHEM307 | Pharmaceutical Chemistry Special Practical-II | SEP | 4 | 8 | 20 | 60 | 80 |
| **Total Credits/Marks** | |  | **27** | **(83)T-35, P-48** | | | **550** |
| **SET=Specialization elective theory, SEP=Specialization elective theory (Student has to opt all three CT, One OE offered by other departments from among the physical sciences and any two SET and two SEP from the same specialization)** | | | | | | | |

**SEMESTER IV**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Title** |  | **Credits** | **Teaching Hours per week** | **Maximum Marks** | | |
| Internal Assessment**\*** | End-semester Examination | Total |
| CHEM 401 | Inorganic Chemistry Special-III | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM402 | Inorganic Chemistry Special-IV | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM403 | Inorganic Chemistry Special-V | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM 404 | Inorganic Chemistry Special-VI | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM 401 | Physical Chemistry Special-III | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM402 | Physical Chemistry Special-IV | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM403 | Physical Chemistry Special-V | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM 404 | Physical Chemistry Special-VI | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM 401 | Organic Chemistry Special-III | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM402 | Organic Chemistry Special-IV | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM403 | Organic Chemistry Special-V | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM 404 | Organic Chemistry Special-VI | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM 401 | Pharmaceutical Chemistry Special-III | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM402 | Pharmaceutical Chemistry Special-IV | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM403 | Pharmaceutical Chemistry Special-V | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM 404 | Pharmaceutical Chemistry Special-VI | SET | 4 | 4 | 20 | 60 | 80 |
| CHEM405 | Inorganic Chemistry Special Practical-III | SEP | 4 | 8 | 20 | 60 | 80 |
| CHEM406 | Inorganic Chemistry Special Practical-IV | SEP | 4 | 8 | 20 | 60 | 80 |
| CHEM405 | Physical Chemistry Special Practical-III | SEP | 4 | 8 | 20 | 60 | 80 |
| CHEM406 | Physical Chemistry Special Practical-IV | SEP | 4 | 8 | 20 | 60 | 80 |
| CHEM405 | Organic Chemistry Special Practical-III | SEP | 4 | 8 | 20 | 60 | 80 |
| CHEM406 | Organic Chemistry Special Practical-IV | SEP | 4 | 8 | 20 | 60 | 80 |
| CHEM405 | Pharmaceutical Chemistry Special Practical-III | SEP | 4 | 8 | 20 | 60 | 80 |
| CHEM406 | Pharmaceutical Chemistry Special Practical-IV | SEP | 4 | 8 | 20 | 60 | 80 |
|  | Seminar\* | C | 2 |  |  |  | 20 |
| **Total Credits/Marks** | |  | **26** | **96 (T-48,P-48)** | | | **500** |
| **Student has to opt four SET and Two SEP from same specialization and every student has to deliver one seminar on the topic assigned by the seminar committee.**  **\*2 credits per specialization, Student should prepare and submit a seminar report, typed by computer using chemistry software on the topic as assigned by seminar committee.** | | | | | | | |

**Open Elective Papers**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **For the Students of M.Sc. Chemistry** | | | | | | | | | | | | |
| A student will earn four credits by choosing any two papers out of the open elective papers offered by the departments in the faculty of sciences other than the department of Chemistry. | | | | | | | | | | | | |
| **Course Code** | **Course Title** | | **Credits** | | **Teaching Hours per week** | | **Maximum Marks** | | | | | |
| Internal Assessment**\*** | | | End-semester Examination | | Total |
| OE\* | Open Elective Paper -01 | | **2** | | **2** | | **15** | | | **35** | | **50** |
| OE\* | Open Elective Paper -02 | | **2** | | **2** | | **15** | | | **35** | | **50** |
| **Total Credits/Marks** | | | **04** | |  | | | | | | | **100** |
| **For the Students of Other Departments in the Faculty of Science** | | | | | | | | | | | | |
| The Department of Chemistry offers the following open elective papers to the students of second and third semesters of other departments in the faculty of sciences. | | | | | | | | | | | | |
| **Course Code** | | **Course Title** | | **Credits** | | **Teaching Hours per week** | | **Maximum Marks** | | | | |
| Internal Assessment**\*** | End-semester Examination | | Total | |
| OE-201 | | Environmental & Analytical Chemistry | | **2** | | **2** | | **15** | **35** | | **50** | |
| OE-301 | | Applied Chemistry | | **2** | | **2** | | **15** | **35** | | **50** | |
| **Total Credits/Marks** | | | | **04** | |  | | | | | **100** | |

**\*code will be provided by the respective department, opted by the student**

**Total Marks of all Four Semesters**

|  |  |  |
| --- | --- | --- |
| **Semester** | **Credits** | **Marks** |
| Semester I | 24 | 480 |
| Semester II | 23 | 470 |
| Semester III | 27 | 550 |
| Semester IV | 26 | 500 |
| **Grand Total** | 100 | 2000 |

Internal Assessment in theory papers will be made on the basis of sessional test (s) and other parameters as decided by the University from time to time, while in Laboratory papers it will be decided from continuous assessment in internal viva-voce examination of all the experiments performed. Current guidelines for determining Internal Assessment in theory papers are given as Annexure 1.

Each student will deliver one seminar of about 40 minutes duration on the topic to be allotted by the departmental seminar committee in 4th Semester of the M. Sc. Chemistry Course as per the schedule given by the department. The marks will be awarded by the seminar committee on the basis of performance in the seminar and the seminar report submitted by the student.

The special papers will be allotted to students on the basis of their preference-cum-merit (percentage of marks in the First Semester examination of M. Sc. Chemistry) basis.

**General objectives of the course**

Chemistry is the science of matter; the branch of the natural sciences dealing with the composition of substances, their properties and reactions. Chemistry is involved in almost everything with which we come in contact. The life processes of all organisms involve chemical changes. Chemistry enables the development of drugs to cure and alleviate diseases and prolong life span. It also connects the fundamental principles of physics to the other natural sciences - biology, botany, medicine, geology, ecology - in short, to the life sciences and the earth sciences. It is an experimental science and students need to be trained in practicals to get expertise in doing fine experiments and handle sophisticated instruments and statistically analyse the experimental data.

Master of Science (M.Sc.) in Chemistry is oldest **(1961)** post graduation course of University of Kurukshetra. The Curriculum is so designed that it offers four specializations to the M.Sc. Chemistry students, which includes Physical, Organic, Inorganic and Pharmaceutical Chemistry. Through this curriculum, choice based credit system (CBCS) is being implemented for all round development of the students, giving a fair weightage to their interest. It would allow the students to develop his /her abilities in the disciplines of his/her own interest. The students pursuing this course would have to develop in depth understanding of various aspects of the subject. The conceptual understanding of structure and behaviour of elements (atoms), energy changes associated with the reactions, principles and rules that unite these phenomenon in to comprehensive system, development of experimental skills, designing and implementation of novel synthetic methods, developing the aptitude for academic and professional skills, acquiring basic concepts for structural elucidation with hyphenated techniques, , understanding the fundamental biological processes and rationale towards computer assisted drug designing are among such important aspects. This curriculum has an immense potential for chemistry and post graduate students to develop as a good chemistry teacher or as a skilled chemists to undertake advanced research in laboratory or in Industry.

**M.Sc. Chemistry Semester-I**

**Inorganic Chemistry-I (CHEM-101)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION – A**

**Symmetry and Group Theory in Chemistry** Definitions of group, subgroup, relation between orders of a finite groups and its subgroups. Conjugacy relation and classes. Symmetry elements and symmetry operations, Point symmetry group. Schnflies symbols, representations of groups by matrices (representation for the Cn, Cnv, Cnh, Dnh etc. groups to be worked out explicitly). Character of a representation, reducible and irreducible representations. The great orthogonality theorem (without proof) and its importance, Derivation of character tables of C2v, C3v and D2h Character tables and their use. Molecular asymmetry, dissymmetry and optical activity.

**SECTION - B**

# Stereochemistry and Bonding in Main Group Compounds

# VSEPR Theory, Walsh diagrams (tri-atomic molecules), dπ-pπ bonds, Bent rule and energetics of hybridization, Huckel theory with reference to ethylene and butadiene, Some simple substitution reactions of covalently bonded molecules of boron, silicon and nitrogen.

**SECTION – C**

**Metal-Ligand Equilibria in Solution** Stepwise and overall formation constants 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 pH-metry and spectrophotometry.

Substitution reactions in octahedral complexes, theories of trans effect with respect to Pt(II) complexes. Brief account of electron transfer reactions, inert and labile complexes.

**SECTION - D**

**Metal-Ligand Bonding** Crystal field theory and its limitation , crystal field effects, John Teller distortion, nephelauxetic series, spin-orbital coupling, molecular orbital theory of octahedral, tetrahedral and square planar complexes (with and without п-bonding ).

**Books Suggested:**

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harper & Row.
3. Chemical Applications of Group Theory; F.A. Cotton, Wiley, New York.
4. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
5. The Chemical bond; J.N.Murrel, SFA Kettle and JM. Tedder; Wiley, New York.
6. Modern Aspects of Inorganic Chemistry; H.J. Emeleus and Sharpe.
7. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. McDaniel and J.J.Alexander; John Wiley and Sons.
8. Inorganic Chemistry, A Modern Introduction; T Moeller, John Wiley and Sons.

**M.Sc. Chemistry Semester-I**

**Physical Chemistry-I (CHEM-102)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**Section - A**

**Partial Molar Properties** Recapitulation of thermodynamic laws, Partial molar quantities, chemical potential and Gibbs-Duhem equation, variation of chemical potential with temperature and pressure, chemical potential for an ideal gas, chemical potential of ideal gas mixture (s), determination of partial molar volume, thermodynamic functions of mixing (free energy, entropy, volume and enthalpy), concept of escaping tendency and chemical potential.

**Real Gases: Concept of Fugacity and Activity**

Concept of fugacity, methods for determining the fugacity of a real gas, its variation with temperature and pressure, activity, choice of standard states, dependence of activity on temperature and pressure, determination of activity by (i) measurement of vapour pressure, (ii) distribution of solute between two immiscible solvents and (iii) emf measurement.

**Section – B**

**Chemical Kinetics**

Collision theory of reaction rates, the steric requirement, Arrhenius equation and activated complex theory (ACT), comparison of collision and activation complex theory, Potential energy surfaces (Only basic Idea), thermodynamic formulation of activated complex theory, chain reactions (hydrogen-halogen reaction), unimolecular reactions, Lindemann – Hinshelwood mechanism of unimolecular reactions.

**Section – C**

**Electrochemistry**

Debye-Hückel theory of ion-ion interaction and activity coefficient, applicability and limitations of Debye-Hückel limiting law, its modification for finite-sized ions, effect of ion-solvent interaction on activity coefficient. Physical significance of activity coefficients, mean activity coefficient of an electrolyte.

Debye-Huckel-Onsager (D-H-O) theory of electrolytic conductance, Debye-Falkenhagen effect, Wein effect. D-H-O equation - its applicability and limitations, Pair-wise association of ions (Bjerrum treatment), Modification of D-H-O theory to account for ion-pair formation.

Metal/Electrolyte interface, Concept of electrical double layer and its structure: Helmholtz-Perrin, Gouy-Chapman, and Stern models, electrokinetic phenomena, determination of zeta potential.

**SECTION-D**

**Surface Chemistry and Catalysis**

Gibbs adsorption equation, Langmuir adsorption isotherm and its derivation for non-dissociative and dissociative adsorption, BET adsorption isotherm, its derivation and applications.

Study of surfaces by STM, SEM. Heterogeneous catalysis, surface heterogeneity, surface catalyzed unimolecular and bimolecular reactions, temporary and permanent catalytic poisons, activation energy for surface reactions. Comparison of uncatalyzed and catalyzed reaction rates.

**Books Suggested:**

1. An Introduction to Chemical Thermodynamics, R.P. Rastogi and R.R. Misra, Vikas Pub.
2. Physical Chemistry, P.W. Atkins, Oxford University Press.
3. Thermodynamics for Chemists, S. Glasstone, Affiliated East-West Press.
4. Thermodynamics, I.M. Klotz and R.M. Rosenbers, Benzamin.
5. Chemical Kinetics, K.J. Laidler, McGraw Hill.
6. Kinetics and Mechanism, A. A. Frost and R.G. Pearson, John Wiley and Sons.
7. Electrochemistry, S. Glasstone, Affiliated East-West Press.
8. Physical Chemistry, G.W. Castellan, Narosa.
9. Heterogeneous Catalysis: Fundamentals and Applications, Julian R.H. Ross, Wiley-VCH; 2nd, Revised and Enlarged Edition edition (October 1, 2007)
10. Concepts of Modern Catalysis and Kinetics, I. Chorkendorff and J. W. Niemantsverdriet

**M.Sc. Chemistry Semester I**

**Organic Chemistry-I (CHEM-103)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION – A**

**Reaction Mechanism: Structure and Reactivity**

Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, effect of structure on reactivity - resonance and field effects, steric effect, quantitative treatment-The Hammett equation and linear free energy relationship, substituent and reaction constants and Taft equation. Kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining reaction mechanisms. Generation, structure, stability and reactivity of carbocations, carbanions, carbenes and nitrenes.

**SECTION – B**

**Mechanism of Nucleophilic Aliphatic Substitution**

The limiting cases SN1 and SN2, detailed mechanistic description and borderline mechanisms, nucleophilicity and solvent effects, competition between nucleophilicity and basicity, ambident nucleophiles, hard and soft nucleophiles and electrophiles, leaving group effects, steric and other substituent effects on substitution and ionization rates, stereochemistry of nucleophilic substitution. SNi, SN1', SN2' and SNi' mechanisms.

**Mechanism of Elimination Reactions**

The El, ElcB and E2 mechanisms, Orientation Effects in Elimination Reactions, Saytzeff and Hoffman rules, Stereochemistry of E2 Elimination Reaction and Eclipsing Effects in E2 Eliminations. Dehydration of Alcohols, Elimination not involving C-H Bonds, Pyrolytic eliminations.

**SECTION – C**

**Stereochemistry-I**

Symmetry elements, D-L, R-S, E-Z and threo-erythro nomenclature, interconversion of Fischer, Newman, Sawhorse and flying wedge formulae. conformational analysis, enantiomerism and diastereomerism of simple, cyclic (chair and boat configuration) and acyclic systems. Axial and planer chirality, optical isomerism in allenes, biphenyls (atropoisomerism), spiranes, hemispiranes. elementary ideas about stereochemistry of tertiary amines, quaternary salts, sulphur and phosphorous compounds.

**SECTION - D**

**Stereochemistry –II** Topicity of ligands and faces, their nomenclature and prostereoisomerism, stereogenecity, chirogenicity, pseudoasymmetry and prochiral centre. stereospecific and stereoselective reaction.Elementary idea of principle categories of asymmetric synthesis, Cram’s rule and its modification, Prelog rule and horeaus rule.Stereochemistry of sugars- C1 and 1C conformations of hexoses, c2’-endo and c3’-endo conformation of pentoses, homomorphous sugars, abnormal mutarotation and ∆-2 instability factor.Stereochemistry of decalins,

Chemical correlation of configuration-determination of relative configuration of 2-butanol, isoserine, alanine, malic acid, lactic acid and mandelic acid.

**Books Suggested:**

1. Advanced Organic Chemistry Reactions, 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. Boyd, 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 & Professional.
8. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.
9. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.
10. Stereochemistry of Organic Compounds, P.S, Kalsi, New Age International.

**M.Sc. Chemistry Semester I**

**Chemistry of Life Science Paper (CHEM 104A)**

**Credits-3**

**Time: 3 Hrs**

**Max. Marks: 45+15(IA)**

**Note:** Seven questions will be set; Question 1 will be compulsory covering all the sections. Two questions will be set from each section. The candidates are required to attempt five questions selecting at least one question from each section and compulsory question. All questions carry equal marks.

**SECTION - A**

**Carbohydrates 08** Structure and biological functions of important monosachharides (excluding detailed conformational analysis) and derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, amino sugars-N-acetylmuramic acid and sialic acid. Disaccharides- sucrose, lactose and maltose.

Structure and biological functions of Structural polysaccharides (cellulose and chitin) and Storage polysaccharides (starch and glycogen)

Heteropolysaccharides-glucosaminoglycans/mucopolysaccharides. Glycoconjugates- glycoproteins and glycolipids. Role of sugars in biological recognition. Blood group substances.

**Cell Structure and Metabolism 07**

Structure of prokaryotic and eukaryotic cells, intracellular organelles and their functions, comparison of plant and animal cells. Overview of metabolic processes - catabolism and anabolism. ATP - the biological energy currency. Carbohydrate metabolism: glycolysis and Kreb's cycle.

**SECTION – B**

**Lipids 07**

Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids

Lipid aggregates-micelles, bilayers, liposomes and their possible biological functions. Biological membranes. Fluid mosaic model of membrane structure.

Lipid metabolism - β-oxidation of fatty acids.

**Amino-acids, Peptides and Protein 08**

Peptide bond, Chemical and enzymatic hydrolysis of proteins to peptides, Sanger method and Edman degradation method for amino acid sequencing. Secondary structure of proteins-α-helix, β-sheet, forces responsible for holding the secondary structures of proteins.

**SECTION – C**

**Nucleic Acids and Genetic Code**

Structure and functions of nucleotides, nucleosides, DNA (Watson-Crick model, Chargaff’s rules) and RNA (m RNA, r-RNA and t-RNA)

Genetic code and its characteristics, codon-anticodon pairing (Wobble hypothesis)

**Replication, Transcription and Translation (Prokaryotes only)**

Replication of DNA: Maselson-Stahl experiment, mechanism of replication (Initiation, Elongation and Termination).

Transcription: Promoters site, Initiation, Elongation, Termination.

Translation: Activation of amino acids, Initiation, Elongation, Termination.

**Books 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 and Voet, John Wiley.
5. Outlines of Biochemistry, E. E.Conn and P. K. Stumpf, John Wiley.

**Or**

**M.Sc. Chemistry Semester I**

**Mathematics for Chemists (CHEM 104B)**

**Credits-3**

**Time: 3 Hrs**

**Max. Marks: 45+15 (IA)**

**Note:** Seven questions will be set; Question 1 will be compulsory covering all the sections. Two questions will be set from each section. The candidates are required to attempt five questions selecting at least one question from each section and compulsory question. All questions carry equal marks.

## SECTION - A

**Vectors**

Examples of scalar and vectors, definitions of vectors in two, three spaces, representation and simple properties of vectors, addition and subtraction of vectors, vector addition by the method of triangles, resolution of vectors into rectangular components, addition of vectors by components, multiplication and differentiation of vectors. Scalar product of vectors, vector product, concept of normalization, orthogonality and complete set of unit vectors. Illustration of applications to spectroscopy and quantum chemistry.

**Matrices and Determinants**

Definition of matrix, types of matrices, viz. row matrix, column matrix, null matrix, square matrix, diagonal matrix, addition, subtraction and multiplication by a number, matrix multiplication. Transpose and adjoint of matrix, elementary transformation, representation and applications (without development of theory) to solution of linear equations. Definition of determinant, properties of determinants, evaluation of determinants. Illustration or applications to group theory, problems in chemistry.

## SECTION - B

**Logarithm**

Need for logarithm in chemistry. Theory and application of logarithms for solving general and chemical problems.

## Graphical Representation of Equations

Rectangular coordinates, straight lines, slope and intercept of the equation, slope and point equation, two point equation, parallel lines, points of intersection, distance between two points, change of origin. Examples from problems in chemistry, curve fitting for least squares method.

**Elements of Algebraic and Trigonometric Functions**

The binomial expansion, some example from chemistry, sines, cosines and tangents, trigonometric identities, polar coordinates in trigonometric functions.

## Section-C

**Differential Calculus**

Theory, graphical significance of differentiation, rules of differentiation, Algebraic simplification, Partial differentiation, Exact and inexact differential with their application to thermodynamic principles.

**Integral Calculus**

Integral theory, methods of integration, viz. algebraic simplifications, substitution, integration by parts, integration by partial fractions, integration between limits, curve sketching, integral as area, , Illustration of application in chemistry.

**Differential Equation**

Simple differential equations, separable variables, homogeneous equations, exact differential equations, linear differential equations, partial differential equations, application to physico-chemical problems.

**Books Suggested:**

1. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill.
2. Mathematical Preparation for General Physics, J.B. Marian, R.C. Davidson Saunder Company.
3. Mathematical Methods for Science Students, G. Stephemen, ELBS.
4. Chemical Thermodynamics, R.C. Reid.

**Or**

**M.Sc. Chemistry Semester I**

**Introduction to Pharmacy and Pharmacology Paper (CHEM 104C)**

**Credits-3**

**Time: 3 Hrs**

**Max. Marks: 45+15(IA)**

**Note:** Seven questions will be set; Question 1 will be compulsory covering all the sections. Two questions will be set from each section. The candidates are required to attempt five questions selecting at least one question from each section and compulsory question. All questions carry equal marks.

**SECTION-A**

Introduction to Pharmaceutical sciences, its branches, naming of drugs, Generic drugs, routes of drug administration, drug development and its regulation.

Introduction of pharmacopeia (IP, BP, USP), introduction of national formularies, typical parts of monograph of Indian pharmacopeia, an introduction to content of IP.

**Dosage Forms-1**

Solid dosage forms: Tablets-Types, granulation, compression, additives used in formulations, coating, evaluation (including dissolution, disintegration, Hardness, Friability, weight variation).

Capsules-Soft and hard gelatin capsules, microencapsulation.

# SECTION-B

**Dosage Forms-II**

Semi solid dosage forms: Introduction, types, brief description of ointments and creams. Biphasic liquid dosage forms: Emulsions and suspensions-types, formulation, methods of preparation, stability

Monophasic liquid dosage forms: Types, brief description of mixtures and syrups.

Sterile dosage forms and ophthalmic products.

**Toxicology**

Intdoduction, acute and chronic toxicity, LD50 and ED50, therapeutic index, adverse drug effects, dose response relationship, therapeutic drug monitoring, General principles of management of poisoning, antidotes, Treatment of heavy metal poisoning and drugs (barbiturates, benzodiazepines, salicylates, morphine & morphine derivatives, alcohol)

# SECTION-C

**Pharmacokinetics**

Physicochemical factors in transfer of drugs across membranes, ADME (Absorption, distribution, metabolism-Phase I and Phase II reactions, Excretion) of drugs, important pharmacokinetic parameters-apparent volume of distribution, bioavailability, clearance, Half life.

**Pharmacodynamics**

Mechanism of drug action, drug targets, neurotransmitters and hormones, the receptor role, Drug Receptor Interactions, types of receptors, structure and functioning of ion channel receptors, G-protein coupled receptors, kinase-linked receptors.

## Books Recommended :

1. Foye’s principles of medicinal chemistry. David A. Williams, Thomas L. Lemke, Fifth Edition. Lippincott Williams & Wilkins.
2. Essentials of medicinal Pharmacology, K.D.Tripathi, 4th Edition . Jaypee Brothers Medical Publishers Ltd.
3. Medicinal chemistry Vol. I & II. A. Burger, Willey interscience, 1970
4. Pharmacology & Pharmacotherapeutics, Vol. I & II. R.S. Satoskar & S.C. Bhandarkar, Popular Prakashan 1978.
5. A Textbook of medicinal chemistry. P. Parimoo.
6. , The Pharmacological Basis of Therapeutics, L.L. Brunton, J.S. Lazo, K.L. Parker 11th ed., Magraw Hill, US, (2006).
7. Goodman and Gilman’s Pharmacological Basis of Therapeutics, McGraw-Hill.
8. Basic and Clinical Pharmacology, Lauge Medical Publication. 1995 B. G. Katzung
9. Introduction to Pharmacology by P.C. Dandya and S.K. Kulkarni.
10. Cooper and Gunn’s Dispensing for Pharmaceutical Students, Ed.S.J. Carter, CBS publishers & distributors.
11. Tutorial Pharmacy, Cooper and Gunn’s.
12. “Theory and Practice of Industrial Pharmacy” Lea & Fabiger, L.Lachman.
13. “A textbook of Pharmaceutical Chemistry”, Oxford Press, Bentley and Drivers.

**M.Sc. Chemistry Semester I**

**Inorganic Chemistry Practical-I (CHEM 105)**

**Credits-3**

**Time: 6 Hrs (Two sessions)**

**Max Marks: 45+15(IA)**

1. **Qualitative analysis:**

Total five radicals to be given containing two less common metal ions, one insoluble and two acid radicals:,,,,,.

Less common metal ions – W, Tl, Mo, Se, Ti, Zr, Th, V, U, Ce, Be (two metal ions in cationic and anionic forms)

Insoluble: Halides (AgCl, AgBr, AgI); Sulphates (PbSO4, BaSO4) and Oxides (Al2O3, Cr2O3, SnO2, TiO2, SiO2)

1. Cerimetric / Iodometric/Oxidimetry titrations

**Experiment Marks: 30**

**Lab record & Viva-voce Marks: 5+10**

**Books:**

1. A Text Book of Macro and Semi-micro Quantitative Analysis, A. I. Vogel, Orient Longman.
2. A Vogel’s Text Book of Quantitative Inorganic Analysis, J. Bassett, R. C. Denney, G. B. Jaffery and J. Menaham, Longman, London.

**M.Sc. Chemistry Semester I**

**Physical Chemistry Practical-I (CHEM 106)**

**Credits-3**

**Time: 6 Hrs (Two sessions)**

**Max Marks: 45+15(IA)**

**Experiments**

**Viscosity**

1. Study the variation of viscosity with concentration for a glycerol solution using Ostwald viscometer and thereafter determine the concentration of unknown solution of glycerol.
2. Determination of molar mass of a polymer.

**Conductometry**

1. Determine the strength of strong acid by conductometric titration with strong base.
2. Determine the strength of weak acid by conductometric titration with strong base.
3. Determine the strength of strong acid and weak acid in a mixture by conductometric titration with strong base.
4. Study precipitation titration between KCl and AgNO3 conductometrically. Determine the strength of given solution of AgNO3.
5. Determine solubility and solubility product of sparingly soluble salts like PbSO4, BaSO4.
6. Determine the relative strength of chloroacetic acid and acetic acid by

conductivity measurements.

**Potentiometry**

1. Determine the standard electrode potential of Cu and Zn.
2. Determine the strength of a given solution of ferrous ammonium sulphate by potentiometric titration with K2Cr2O7 solution.
3. Study the precipitation titration between KCl and AgNO3 potentiometrically.
4. Determine the standard free energy change and equilibrium constant for the reaction Cu + 2Ag+ ⇌ Cu2+ + 2Ag

**Chemical Kinetics**

1. Study the hydrolysis of methyl acetate in presence of hydrochloric acid.
2. Study saponification of ethyl acetate by sodium hydroxide solution using same initial concentration of both the reactants.
3. Study saponification of ethyl acetate by sodium hydroxide solution taking the initial concentration of ester and base to be different.

**Adsorption**

1. Verify the Freundlich and Langmuir adsorption isotherms for adsorption of acetic acid/oxalic acid on activated charcoal.

**Note:** Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

**Experiment Marks: 30**

**Lab record & Viva-voce Marks: 5+10**

**Books:**

1. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
2. Findley’s Practical Physical Chemistry, B.P. Lavitt, Longman.
3. Practical Physical Chemistry, S.R. Palit and S.K. De, Science.
4. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.

**M.Sc. Chemistry Semester I**

**Organic Chemistry Practical-I (CHEM 107)**

**Credits-3**

**Time: 6 Hrs (Two sessions)**

**Max Marks: 45+15(IA)**

**Demonstrations of Laboratory & Purification techniques**

Refluxing, Solvent extraction, Purification of solvents and reagents using various techniques like crystallization, distillation, steam distillation, vacuum distillation. Drying and storage of solvents, sublimation etc.

**Two-step Preparation of some important organic compounds involving the reactions out of the followings representative reactions)**

1. Esterification and saponification

2. Oxidation

3. Reduction or Hydrogenation

4. Partial Reduction

5. Nucleophilic substitution

6. Aromatic electrophilic substitution reaction

7. Condensation reactions

8. Hoffman’s Bromamide reaction

9. Heterocyclic synthesis

10. Any other reaction as per requirement

**All the students must submit the recrystallised product along with m.p. for all the stages of preparation.**

**Experiment Marks: 30**

**Lab record & Viva-voce Marks: 5+10**

**Books Suggested:**

1. A Hand book of Organic Analysis-Qualitative and Quantitative by H.T. Clarke, and revised by B.Haynee, Edward Arnold, London 1975.
2. Vogel's Text Book of Practical Organic Chemistry by B.S. Furhen et. al., Longman-Group Ltd.
3. Systematic Qualitative Organic Analysis by H. Middleton, Edward Arnold (Publishers) Limited, London 1959.
4. Elementary Practical Organic Chemistry by Arthur I. Vogel, EX CBS Publishers and Distributors.
5. Experiments in Organic Chemistry by Louis, F.Fieser, D.C. Heath and Company Boston, 1955.

**M.Sc. Chemistry Semester II**

**Inorganic Chemistry-II (CHEM 201)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION – A**

**Electronic Spectra and Magnetic Properties of Transition Metal Complexes-I**

Electronic arrangements of microstates, calculation of the number of microstates in various electronic arrangements, spectroscopic term symbols, vector diagrams to indicates coupling of orbital angular momenta in p2, p3, d2 configurations and spin orbit coupling for p2 arrangement, spectroscopic terms, spectral terms of d2 to d8 metal ions, determining the ground state terms-Hund's rules, derivation of the term symbols for a closed subshell.

**SECTION – B**

**Electronic Spectra and Magnetic Properties of Transition Metal Complexes-II**

Interpretation of electronic spectra, Orgel diagrams, Tanabe-Sugano diagrams for transition metal complexes (d1-d9 states), calculations of Dq, B and β parameters, charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

**Circular Dichroism and Optical Rotatory Dispersion**

Polarized light, fundamental symmetry requirements, for optical activity, interaction of polarized light with optically active matter, optical rotation, Cotton effect, configuration of Tris-chelated complexes.

**SECTION - C**

**Metal л-Complexes**

Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal carbonyls; preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes; tertiary phosphine as ligand.

**SECTION - D**

**MetalClusters**

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

**Books Suggested:**

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harper & Row.
3. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
4. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
5. Introduction to Ligand fields; B.N. Figgis, Wiley, New York.
6. Modern Aspects of Inorganic Chemistry; H.J. Emeleus and Sharpe.
7. Introduction to Ligand Field Theory; C.J.Ballahyen, McGraw Hill, New York.
8. Organometallic Chemistry; R.C.Mehrotra and A.Singh, New Age International.
9. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H.McDaniel and J.J.Alexander; John Wiley.
10. The Organometallic Chemistry of the Transition Metals; R.H. Crabtree, John Wiley.

**M.Sc. Chemistry Semester II**

**Physical Chemistry-II (CHEM 202)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**Section-A**

**Quantum Mechanics-I**

The postulates of quantum mechanics, Linear and Hermitian operators. Commutation of operators and Uncertainty Principle. Schrödinger equation, eigen function and eigen values, free particle, Schrödinger equation for a particle in a box, the degeneracy, particle in a box with a finite barrier, Schrödinger equation for linear harmonic oscillator and its solution, zero point energy, Tunneling Problem: Tunneling through a rectangular barrier.

**Section – B**

**Quantum Mechanics-II**

Energy levels and wave-functions of Rigid rotator. Hydrogen atom: Complete solution (separation of variables in spherical polar coordinates and its solution). Radial distributions. Angular momentum and its directional quantization, Angular momentum operators, commutation relation, Ladder operators, shape of atomic orbitals upto d-level and their discussion.

**SECTION – C**

**Polymers**

Basic concepts, Kinetics of Polymerization:Mechanism and Kinetics of chain growth polymerization: free-radical, cationic, anionic and coordination polymerization. Mechanism and Kinetics of step-growth polymerization. Comparison between step-growth and chain polymerization. Molecular mass of polymers:Significance of average molecular mass.Poly-dispersity, Molecular mass distribution curves. Determination of molecular mass by viscosity method. Electrically conducting polymers, Flame retardant polymers, Liquid crystal polymers.

**Section-D**

**Nuclear and Radiochemistry**

Nuclear stability and binding energy. Mass and binding energy, Nuclear fission and nuclear fusion, fission cross section, chain fission, fission product and fission yield. Interaction of nuclear radiation with matter, Detectors (Proportional, Geiger-Muller and Scintillation counters) and their principles. Units for measuring radiation absorbed, radiation dosimetry.  
 Radiotracer technique, Activation analysis, isotope dilution technique, Radiochromatography, radiometric titrations, Neutron absorptiometry. Some applications

**Books Suggested:**

1. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
2. Quantum Chemistry, I.M. Levine, Prentice Hall.
3. Essentials of Nuclear Chemistry, 4th Edition (1995), H.J. Arnikar, Wiley Eastern, New Delhi.
4. Nuclear & Radiochemistry, 3rd Edition (1981), G. Fridlander, J.W. Kennedy, E. S. Macias, and J. M. Miller, John Wiley, New York.
5. Introduction to Nuclear Chemistry, B. C. Harvey Prentice-Hall (1969).
6. Polymer Chemistry, Billmayer
7. Polymer Chemistry, Gowarikar
8. Principles of Polymerization, Geroge Odian.
9. Quantum Chemistry, B. K. Sen, Kalyani Publishers
10. Quantum Chemistry, R. Prasad, New Age International.

**M.Sc. Chemistry Semester II**

**Organic Chemistry-II (CHEM 203)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two questions from each of the sections A, B, C & D. The candidates are required to attempt five questions in all, selecting at least one question from each section. All questions carry equal marks.

**SECTION – A**

**Aromatic Electrophilic Substitution** Theoretical treatment of aromatic substitution reactions, structure-reactivity relationship in mono substituted benzene ring, orientation in other ring system, energy profile diagram, Vilsmeir-Haak reaction, Reimer-Tiemann reaction, Bischler-Napieralski reaction, Pechmann reaction, Houben-Hoesch reaction, Fries rearrangement

**Nucleophilic Aromatic Substitution**

Mechanism of Nucleophilic substitution in aromatic systems via diazonium ions, by addition-elimination and elimination-addition machanism (involving arynes); von-Richter rearrangement, Sommelet-Hauser and Stevens rearrangements.

General aspects of generation, structure, stability and reactivity of arynes

**SECTION-B**

**Aliphatic Electrophilic Substitution** Bimolecular mechanisms - SE2 and SEi. The SE1 mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

**Neighbouring Group Participation and Carbocation Rearrangements**

Anchimeric assistance, neighbouring group participation by non-bonding electrons, sigma and π-bonds, classical and non-classical carbocations. Carbocations rearrangements: migratory aptitudes, Wagner Meerwein rearrangement, pincol pinacolone rearrangement, Demjanove rearrangement, Tiffeneau-Demjanov ring expansion, aldehyde-ketone rearrangement, dienone-phenol rearrangement and trans-annular rearrangements.

**SECTION – C**

**Free Radicals**

General aspects of generation, structure, stability and reactivity of free radicals, types of free radical reactions, halogenation including allylic halogenation (NBS), auto-oxidation, decomposition of azo compounds and peroxides, coupling of alkynes, homolytic aromatic substitution, Sandmeyer reaction and Hunsdiecker reaction.

**Addition to C-C Multiple Bond** General mechanistic considerations,Mechanism of addition of hydrogen halide, H2O, halogens, HOX and mercuric salt to alkenes and alkynes. Hydroboration, formation of C-C bonds via organoboranes, hydroboration of acetylenes, nucleophilic addition to alkenes.

**SECTION-D**

**Addition to Carbon-Hetero Atoms Multiple Bonds**

General mechanistic considerations and reactivity,Hydration and Addition of Alcohols to Aldehydes, Ketones and Acids. Addition -Elimination Reactions of Ketones and Aldehydes, Reactivity of carbonyl compounds towards Addition.

Lithium aluminium hydride reduction- carbonyl compounds, acids, esters, nitriles. Additions of Grignard reagents. Reformatsky reaction, Wittig reaction, Claisen condensation, Dieckman reaction, Aldol condensation, Knoevenagal condensation, Perkin reaction, Cannizzaro reaction, Benzoin condensation, Mannich Reaction, Robinson-Mannich reaction, Ester hydrolysis, aminolysis of esters, amide hydrolysis.

**Books Suggested**

1. Advanced Organic Chemistry Reactions, 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. Boyd, 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 & Professional.
8. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.

**M.Sc. Chemistry Semester II**

**Inorganic Chemistry Practical-II (CHEM 204)**

**Credits-3**

**Time: 6 Hrs (Two sessions)**

**Max Marks: 45+15(IA)**

1. **Quantitative analysis:**

Separation of the metal ions and determination of any one of them using volumetric/gravimetric methods.

Cu-Ni, Cu-Zn, Cu-Al, Ca-Ba, Fe-Mg, Fe-Ni etc.

1. **Preparations:**

Preparation of the following inorganic compounds and their spectroscopic studies.

1. Hg[Co(SCN)4]
2. [Cu(NH3)4]SO4.H2O
3. Prussian Blue and Turnbull’s Blue
4. Na[Cr(NH3)2(SCN)4]
5. Mn(acac)3
6. [Ni(NH3)6]Cl2
7. VO(acac)2

**Experiment Marks: 30**

**Lab record & Viva-voce Marks: 5+10**

**Books Suggested:**

1. A Text Book of Macro and Semi-micro Quantitative Analysis, A. I. Vogel, Orient Longman.
2. A Vogel’s Text Book of Quantitative Inorganic Analysis, J. Bassett, R. C. Denney, G. B. Jaffery and J. Menaham, Longman, London.

**M.Sc. Chemistry Semester II**

**Physical Chemistry Practical-II (CHEM 205)**

**Credits-3**

**Time: 6 Hrs (Two sessions)**

**Max Marks: 45+15(IA)**

**Surface Tension**

1. Determine the surface tension of given organic solvents.
2. Study the effect of soap concentration on the lowering of surface tension of water.
3. Compare the cleansing powers of two detergents provided to you.

**pH-metry**

1. Determine the strength of strong acid by pH-metric titration with strong base.
2. Determine the strength of weak acid by pH-metric titration with strong base.
3. Determine the dissociation constant of acetic acid using pH-meter.

**Distribution Law**

1. Determine the partition coefficient of iodine for distribution between chloroform and water.
2. Determine distribution coefficient of ammonia between chloroform and water.
3. Determine the formula of the complex formed between copper (II) ion and ammonia using distribution method.

**Polarimetry**

1. Study the variation of angle of optical rotation with the concentration of any optically active substance (sucrose or glucose) and thereafter   
   determine the unknown concentration of the same substance in given   
   solution.
2. Determine the specific and molecular rotation of sucrose or glucose at   
   a number of concentrations.
3. Study the kinetics of inversion of cane-sugar (sucrose) in presence of an acid.

**Refractometry**

1. Determine the refractive index of simple organic liquids like methyl acetate, ethyl acetate, methanol, ethanol, n-hexane, chloroform.
2. Determine the refractivity and molar refractivity of some organic liquids like methyl acetate, ethyl acetate, methanol, ethanol, n-hexane, chloroform.
3. Determine the molar refractivities for CH2, C, H and Cl.
4. Study the variation of refractive index with concentration for KCl solution and thereafter determine the unknown concentration of given KCl solution.

**Note:** Any experiment can be introduced in the practical class on the basis of availability of instruments/chemicals.

**Experiment Marks: 30**

**Lab record & Viva-voce Marks: 5+10**

**Books Suggested:**

1. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
2. Findley’s Practical Physical Chemistry, B.P. Lavitt, Longman.
3. Practical Physical Chemistry, S.R. Palit and S.K. De, Science.
4. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.

**M.Sc. Chemistry Semester II**

**Organic Chemistry Practical-II (CHEM 206)**

**Credits-3**

**Time: 6 Hrs (Two sessions)**

**Max Marks: 45+15(IA)**

**Organic Mixture Analysis**

**Demonstrations of separation of binary mixtures:** usingH2O, HCl, NaOH, NaHCO3, Ether or other reagent as may be necessary along with required conditions for their use.

**Systematic identification** of mixtures of pure organic compounds: separation and identification of simple binary mixtures having acidic, basic and neutral components. Preparation of their derivatives, determination of b.p./m.p. for components and their derivatives.

**Any other experiment be added as per requirement**

**Experiment Marks: 30**

**Lab record & Viva-voce Marks: 5+10**

**Books Suggested:**

1. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.)., Ltd. London, 1975).
2. "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.
3. "A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis" by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966.
4. "Elementary Practical Organic Chemistry" by Arthur I. Vogel, CBS Publishers & Distributors.
5. "A Guide to spectroscopy in Organic Chemistry' by PAVY
6. "Organic Spectroscopy', 3rd Ed., by William Kamp. John Wiley & Sons.
7. "Spectroscopic" Methods in Organic Chemistry, D.H. William & Ian Fleming.
8. Vogel's Text Book of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd.

**M.Sc. Chemistry Semester III**

**Inorganic Chemistry General (CHEM-301)**

**Credits-3**

**Time: 3 Hrs**

**Max. Marks: 45+15(IA)**

**Note:** Seven questions will be set; Question 1 will be compulsory covering all the sections. Two questions will be set from each section. The candidates are required to attempt five questions selecting at least one question from each section and compulsory question. All questions carry equal marks.

**SECTION A**

**Transport and Storage of Dioxygen 8 Hrs**

Heme proteins and oxygen uptake, structure and function of hemoglobin, myoglobin, hemocyanins and hemerythin, model synthetic complexes of iron and cobalt.

**Electron Transfer in Biological Systems 7 Hrs**

Structure and function of metalloproteins in electron transport processes-cytochromes and iron-sulphur proteins, synthetic models.

**SECTION B**

**Polarography 8 Hrs**

General principles, diffusion controlled current, Dropping mercury electrode, IIkovic equation (without proof), Half-wave potentials, over potential, Evaluation of Polarographic waves, Conditions for performing Polarographic determinations and applications of Polarography, theories of hydrogen overvoltage (Tafel’s theory, Recombination theory and Volmer, Erdy and Gruss theory/theory of slow discharge of ions).

**Vibrational Spectroscopy 7 Hrs**

Symmetry, shapes and number of IR modes AB2, AB3, AB4, AB5 and AB6 (Group theoretical treatment) mode of bonding of ambidentate ligands and diketonato or complexes, application of resonance Raman spectroscopy particularly for the study of active- sites of metalloproteins.

**SECTION C**

**Mossbauer Spectroscopy 8 Hrs**

Basic principles, spectral parameters and spectrum display. Application of the technique to the studies of (1) bonding and structures of Fe2+ and Fe3+ compounds including those of intermediate spin, (2) Sn2+ and Sn4+ compounds – nature of M-L bond, coordination number, structure and (3) detection of oxidation state.

**Photoelectron Spectroscopy 7 Hrs**

Basic principles; photo-electric effect, ionization process, Koopman’s theorem. Photoelectron spectra of simple molecules, ESCA, chemical information from ESCA.

**Books Suggested:**

1. Principles of Bioinorganic Chemistry: S. J. Lippard and J. M. Berg, University Science Books.
2. The Inorganic Chemistry of Biological Process; M. N. Huges; John Wiley & Sons.
3. Physical methods in Chemistry; R. S. Drago; Saunders, Philadelphia.
4. Fundamentals of Molecular Spectroscopy; C. N. Banwell; McGraw Hill.

**M.Sc. Chemistry Semester III**

**Physical Chemistry General (CHEM-302)**

**Credits-3**

**Time: 3 Hrs**

**Max. Marks: 45+15(IA)**

**Note:** Seven questions will be set; Question 1 will be compulsory covering all the sections. Two questions will be set from each section. The candidates are required to attempt five questions selecting at least one question from each section and compulsory question. All questions carry equal marks.

**Section – A**

**Microwave Spectroscopy** Basics of spectroscopy. The rotation of molecules, rotational spectra of rigid diatomic molecules, intensities of rotational spectral lines, isotopic effect, non-rigid rotator, spectra of polyatomic linear molecules and symmetric top molecules.

**Infrared Spectroscopy**

The vibrating diatomic molecule, force constant, zero point energy, simple harmonic vibrator, anharmonicity, Morse potential, overtones, hot bands, diatomic vibrating rotators, P,Q,R branches, vibration of polyatomic molecules, normal mode of vibrations.

**Raman Spectroscopy**

Classical and quantum theories, pure rotational Raman spectra of linear molecules, vibrational Raman spectra, mutual exclusion principle, polarization of the light and Raman effect, depolarization of Raman lines.

**Section – B**

**Nuclear Magnetic Resonance Spectroscopy**

Basic principles of NMR, theory of nuclear magnetic resonance, spin lattice relaxation, spin-spin relaxation, experimental techniques chemical shift, the δ-scale of chemical shift, the origin of shielding constant, pattern of coupling, origin of spin-spin coupling, the nuclear overhauser effect.

**Nuclear Quadrupole Resonance Spectroscopy**

Introduction, energies of quadroupole transitions, effect of magneticfield on the spectra, relationship between electric field gradient and molecular structure, applications, interpretations of structural information from NQR spectra

**Electron Spin Resonance Spectroscopy**

Basic principles of ESR, experimental technique, the g-value hyperfine structure, Instrumentation of ESR and its applications to the study of free radicals and fast reactions, spin densities and Mc Connell relationship.

**Section – C**

**X-ray Crystallography**

Symmetry elements in crystals, stereographic projections, point groups (illustration of R, R-bar, Rm, R/m, R-bar/m point groups only), miller indices for planes and directions, criteria for determining unit cell of lattice, space lattices, space groups P1, Pbar1, P2, P21, Pm, Pc, C2, Cm, Cc

X-ray emission spectra, absorption edges, X-ray filters, Reciprocal lattice concept and its importance, Definition of Reciprocal lattice vector (derivation excluded). Interplanar spacing using reciprocal lattice concept for cubic, tetragonal, orthorhombic and hexagonal crystal systems, Equivalence of Bragg’s and Laue condition, Structure factor calculations for primitive, base-centered, body-centered and face centered unit cells. Relation of structure factor to electron density and intensities (derivation excluded), Interpretation of powder photographs for cubic crystals, Data reduction, Phase problem – Patterson method and Heavy-atom method, refinement of structure by successive and difference fourier synthesis. Correctness of a structure (Discrepancy index)

Characteristic difference between X-ray, electron and neutron diffraction techniques.

**Books Suggested:**

1. Fundamentals of Molecular Spectroscopy, C.N. Banwell, Tata McGraw Hill.
2. Modern Spectroscopy, J.M. Hollas, John Wiley.
3. Basic Principles of Spectroscopy, R.Chang, McGraw Hill.
4. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
5. Physical Method in Chemistry, R.S. Drago, Saunders College.
6. Elementary Crystallography, L. Azaroff.

### [Structure Determination by X-ray Crystallography](http://www.amazon.com/Structure-Determination-X-ray-Crystallography-Analysis/dp/1461439566/ref=sr_1_1?s=books&ie=UTF8&qid=1365747515&sr=1-1&keywords=Ladd+and+Palmer), M. Ladd and R. Palmer

### [X-Ray Structure Determination: A Practical Guide, 2nd Edition](http://www.amazon.com/X-Ray-Structure-Determination-Practical-Guide/dp/0471607118/ref=sr_1_1?s=books&ie=UTF8&qid=1365747589&sr=1-1&keywords=Stout+and+Jensen) by [George H. Stout](http://www.amazon.com/George-H.-Stout/e/B001HMLOY6/ref=sr_ntt_srch_lnk_1?qid=1365747589&sr=1-1) and Lyle H. Jensen.

### Essentials of Crystallography, McKie & McKie, Blackwell Scientific Publications, 1986

1. Handbook of X-rays, Emmett and F. Kaelbse, McGraw Hill.

**M.Sc. Chemistry Semester III**

**Organic Chemistry General (CHEM-303)**

**Credits-3**

**Time: 3 Hrs**

**Max. Marks: 45+15(IA)**

**Note:** Seven questions will be set; Question 1 will be compulsory covering all the sections. Two questions will be set from each section. The candidates are required to attempt five questions selecting at least one question from each section and compulsory question. All questions carry equal marks.

**SECTION - A**

**Ultraviolet and Visible Spectroscopy: 05** Introduction and understanding of UV phenomenon, 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 polyenes. Fieser-Woodward rules for conjugated dienes and carbonyl compounds.

**Mass Spectrometry 10**Introduction, ion production - EI, CI, FD and FAB, Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, Nitrogen rule, molecular weight determination molecular formula from isotopic ratio data, isotope profile of halogen compounds, fragmentation pattern - simple cleavage, retro-Diels Alder, Hydrogen transfer rearrangement like scrambling, ortho effect, McLafferty rearrangement, fragmentation patterns of hydrocarbons, alcohols, phenols, ethers, aldehydes, ketones, esters, carboxylic acids, amines, nitro, amides, nitriles.

**SECTION – B**

**Nuclear Magnetic Resonance Spectroscopy 15** General introduction and definition, chemical shift, spin-spin interaction, shielding mechanism, mechanism of measurement, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & mercapto), complex spin-spin interaction between two, three, four and five nuclei (first order spectra), spin system-Pople notation, virtual coupling. Stereochemistry, concept of topicity, effect of enantiomeric and diastereomeric protons, hindered rotation, Karplus curve - variation of coupling constant with dihedral angle. Fourier transform technique and its advantages. Resonance of other nuclei-F, P.

Tools for simplification of complex NMR spectrum (chemical and instrumental)**:**-Deuteration, changing solvent, trifluoroacetylation, basification and acidification, lanthanide shift reagents, increased magnetic field strength, double resonance and nuclear overhauser effect (NOE), variable temperature probe. Concept of 2D-NMR spectroscopy.

**SECTION – C**

**Carbon-13 NMR Spectroscopy 05**

General considerations, Comparison of 1H-NMR and 13C-NMR, Proton coupled and proton decoupled 13C-NMR, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants. Nuclear Overhauser effect.

**Infrared Spectroscopy 05**

Principle and Theory, 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 conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance. FT-IR.

**Composite Problems 05**

Problems involving the application of the above spectroscopic techniques (UV/Visible, IR, NMR and Mass) for structural elucidation of organic molecules.

**Books Suggested**

1. Introduction to Spectroscopy- A Guide for Students of Organic Chemistry, 2nd Edn. By Donald L. Pavia, Gary M. Lampman and George S. Kriz. Saunders Golden Sunburst Series. Harcourt Brace College Publishers, New York.
2. Spectrometric Identification of Organic Compounds, R. M. Silverstein, G. C. Bassler and T. C. Morrill, John Wiley.
3. Application of Spectroscopy of Organic Compounds, J. R. Dyer, Prentice Hall.
4. Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming, Tata McGraw-Hill.
5. Spectroscopy of Organic Compounds by P.S. Kalsi, Wiley Estern, New Delhi.
6. Organic Spectgroscopy by William Kemp, John Wiley.
7. Organic Mass Spectrometry by K.G. Das & E.P. James, Oxford & IBH Publishing Co.
8. Organic Spectroscopy (Principles & Applications) by Jagmohan.

**M.Sc. Chemistry Semester III**

**Inorganic Chemistry Special-I (CHEM-304)**

**Credits-4**

**Time:3 Hrs**

**Max.Marks:60+20 IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION – A**

## Reaction Mechanism of Transition Metal Complexes

Energy profile of a reaction, reactivity of metal complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, anation reactions, reactions without metal ligand bond cleavage. Substitution reactions in square planar complexes, the Trans effect, mechanism of the substitution reactions.

**SECTION - B**

**Electron Transfer Reactions**

Redox reactions, electron transfer reactions, general discussion and kinetic rate laws., mechanism of one electron transfer reactions, outer-sphere type reactions, cross reactions and Marcus-Hush theory, inner sphere type reactions, two electron transfer reactions, metal ion catalysed reactions, mixed valence complexes and their electron transfer.

**SECTION - C**

**Reactions of metal complexes**

Reactions of metal complexes having ligands as nitrile, phosphate and azide. Reactivity of coordinated hydrocarbons: a) Nucleophilic addition and substitution b) Rearrangement reactions, Redistribution reactions, Fluxional isomerism of organometallics.

**SECTION – D**

**Inorganic Polymers**Classification, types of inorganic polymerization, comparison with organic polymers, boron-nitrogen polymers, silicones, coordination polymers, phosphorus-nitrogen compounds.

**Non-aqueous Solvents** Reaction in non-aqueous media with respect to H2SO4, BrF3, N2O4 and phosphoryl chloride; Kinetics and mechanism of coordination reactions in non-aqueous media.

**Books Suggested:**

1. Mechanism of Inorganic Reactions; F.Basolo and R.G. Pearson, John Wiley and Sons, New York.
2. Inorganic Reaction Mechanism; M.L. Tobe; Nelson, Wlaton and Thames
3. Inorganic Chemistry; K.F. Purcell, J.C. Kotz; Holt-Sanders International Editions; Philadelphia.
4. The Chemistry of Molten Salts; H. Bloom Benjamin, New York.
5. Principles and Application of Organotransition Metal Chemistry, J.P. Collman, L.S. Hegsdus, J.R. Norton and R.G. Finke, University Science Books.
6. The Organometallic Chemistry of the Transition Metals; R.H. Crabtree, John Wiley.
7. Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International
8. Coordination Chemistry; Banerjea; Tata McGraw Hill.
9. Inorganic Chemistry, A Modern Introduction; T. Moeller; John Wiley and Sons.
10. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. McDaniel and J.J. Alexander; John Wiley and Sons Inc.

**M.Sc. Chemistry Semester III**

**Inorganic Chemistry Special-II (CHEM-305)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION – A**

**Alkyls and Aryls of Transition Metals**

Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis

**Fluxional Organometallic compounds** Fluxionality and dynamic equilibria in compound such as η2-olefin, η3-allyl and dienyl complexes, Carbonyl scrambling.

**SECTION – B**

**Compounds of Transition Metal-Carbon Multiple Bonds**

Alkylidenes, alkylidynes, low valent carbenes and carbynes- synthesis, nature of bond, structural characteristics, nucleophilic and electrophilic reactions on the ligands, role in organic synthesis

**Transition Metal Compounds with Bonds to Hydrogen**

**SECTION – C**

**Transition Metal π-Complexes**

Transition metal π-complexes with unsaturated organic molecules, alkenes, alkynes, allyl, diene, dienyl, arene and trienyl complexes, preparations, properties, nature of bonding and structural features. Important reactions relating to nucleophilic and electrophilic attack on ligands and to organic synthesis.

**SECTION - D**

**Homogeneous Catalysis**

Stoichiometric reactions for catalysis, homogeneous catalytic hydrogenation, Zeigler-Natta polymerization of olefins, catalytic reactions involving carbon monoxide such as hydrocarbonylation of olefins (oxo reaction), oxopalladation reactions, activation of C-H bond.

**Books Suggested**

1. Mechanism of Inorganic Reactions; F.Basolo and R.G. Pearson, John Wiley and Sons, New York.
2. Inorganic Chemistry; K.F. Purcell, J.C. Kotz; Holt-Sanders International Editions; Philadelphia. .
3. Principles and Application of Organotransition Metal Chemistry, J.P. Collman, L.S. Hegsdus, J.R. Norton and R.G. Finke, University Science Books.
4. The Organometallic Chemistry of the Transition Metals; R.H. Crabtree, John Wiley.
5. Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International.
6. Coordination Chemistry; Banerjea; Tata McGraw Hill.
7. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. McDaniel and J.J. Alexander; John Wiley and Sons Inc.

**Or**

**M.Sc. Chemistry Semester III**

**Physical Chemistry Special-I (CHEM-304)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20 (IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION - A**

**Quantum Mechanics-I**

Problem of two electrons, exchange interactions. Approximate methods: First order time-independent perturbation theory for non-degenerate states. Variation theorem and variational methods. Ground and excited state of helium atom. Coupling of angular momentum for many electron system, spin-orbit coupling, Molecular Term symbols. Born-Oppenheimer approximation, the hydrogen molecule ion, the hydrogen molecule, their symmetric and antisymmetric solution (without actual evaluation of various integrals).

**SECTION - B**

**Quantum Mechanics-II**

Valence bond and MO (LCAO) treatment of hydrogen molecule. Comparison of the MO and VB treatments and their equivalence limit. Configuration Interaction. Extension of MO theory to other systems- Homonuclear and heteronuclear diatomics, simple polyatomic molecules.

The pi-electron approximation, Huckel theory of conjugated systems. Applications to ethylene, butadiene, cyclobutadiene and cyclopropenyl molecules. Calculation of properties- Delocalization energy, electron density, bond order.

**Section-C**

**Quantum Mechanics - III**

Time-dependent Schrödinger equation, Time-dependent perturbation theory for photochemical systems. Radiative transitions. Einstein coefficients. Quantum mechanical theory of absorption of light by molecules. Transition moment integral. Oscillator strength, rules governing the transition between two energy states. Self-consistent field method. Ab initio and Semi-empirical Methods for Closed Shell Systems.

**SECTION-D**

**Micelles**

Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization-phase separation and mass action models, solubilization, emulsions, micro emulsion, reverse micelles.

**General Properties of Liquids**

Liquids as dense gases, liquids as disordered solids, some thermodynamics relations, internal pressure and its significance in liquids, equation of state, critical constants, Different types of intermolecular forces in liquids.

**Books suggested:**

1. Theoretical Chemistry, S. Glasstone, Affiliated East-West Press.
2. Quantum Mechanics, H.L. Strauss, Prentice Hall.
3. Quantum Chemistry, B. K. Sen, Kalyani Publishers
4. Quantum Chemistry, R. Prasad, New Age International.
5. A textbook of Physical Chemistry, Vol. 4, K.L. Kapoor, MacMillan India Ltd.
6. Quantum Chemistry, C.R. Gatz, E.M. Co.
7. Friedman, Molecular Quantum Mechanics, 3 rd edition (1997), P.W. Atkins and R.S. Oxford University Press. Oxford.
8. , Quantum Chemistry, H. Eyring, J.Walter and G.E. Kimball (1944) John Wiley, New York.
9. Quantum Chemistry, 5th edition (2000), Pearson Educ., Inc., I.N. Levine New Delhi.
10. Micelles, Theoretical and Applied Aspects, V. Moroi, Plenum.
11. Significance of liquid structures, H. Eyring

**M.Sc. Chemistry Semester III**

**Physical Chemistry Special-II (CHEM-305)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION – A**

### Statistical Mechanics

Ensemble averaging, postulates of ensemble averaging. Micro canonical, canonical and grand canonical ensembles, corresponding distribution laws (using Lagrange’s method of undetermind multipliers). Maxwell- Boltzmann statistics, Boltzmann distribution, derivation of the Boltzmann distribution expression, determination of the Boltzmann constant, Maxwell distribution law of velocities from Boltzmann distribution expression

**SECTION – B**

**Quantum Statistics**

The Bose-Einstein statistics, statistics of a photon gas, the Fermi-Dirac statistics, Fermi-Dirac systems, extreme gas degeneration, slight gas degeneration, electron gas in metals, thermionic emission and comparison of two statistics, non degenerate and degenerate systems.

#### SECTION – C

## Statistical Thermodynamics

Partition function and thermodynamic properties, partition function and factorization of partition function, translational partition function, translational thermodynamic function, atoms and monoatomic molecules, Sackur-Tetrode equation, diatomic molecules, separation of internal partition function. Rotational and vibrational energies, entropy due to internal degrees of freedom. Rotational partition function, rotational partition function for polyatomic molecules, vibrational partition function

**SECTION-D**

Determination and calculation of thermodynamic properties i.e. internal energy, entropy, Helmholtz and Gibbs free energy, ortho and para hydrogen states, free energy functions. Partition function and equilibrium constant, effect of nuclear spin, isomolecular reaction, isotopic exchange reactions.Einstein theory and Debye theory of heat capacities of monatomic solids.

## Non-equilibrium Thermodynamics

## Meaning and scope of irreversible thermodynamics. Thermodynamic criteria for non-equilibrium states, Phenomenological laws-linear laws, Gibb’s equation, Onsager’s reciprocal relation, Entropy production-specific laws of entropy production, Non-equilibrium stationary states, Prigogine’s principle of entropy production, Coupled phemomena. Some important applications.

**Books Suggested:**

1. Introduction to Statistical Thermodynamics, H.Dole.
2. Theoretical Chemistry, S.Glasstone, Affiliated East-West Press.
3. Thermodynamics, Lewis and Randall.
4. Chemical Physics, J.C. Slater.
5. Non-equilibrium Thermodynamics, C. Kalidas

**Or**

**M.Sc. Chemistry Semester III**

**Organic Chemistry Special-I (CHEM-304)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION – A**

**Organometallic Reagents I** Principle, preparations, properties and applications of the reagents of the following metals/non-metals in organic synthesis with mechanistic details

Li, Mg, Cd, Zn, Cu, S, Si, B and I

**SECTION - B**

**Organometallic Reagents II** Principle, preparations, properties and applications of the reagents of the following metals in organic synthesis with mechanistic details Pd, Ni, Fe, Co, Rh, Cr and Ti compounds.

**SECTION –C**

**Oxidation** Introduction, Different oxidative processes, Hydrocarbons- alkenes, aromatic rings, saturated C-H groups (activated and unactivated). Alcohols, diols, aldehydes, ketones, ketals and carboxylic acids.Amines, hydrazines, and sulphides.Oxidations with ruthenium tetraoxide, and thallium (III) nitrate.

**SECTION –D**

**Reduction** Introduction. Different reductive processes. Hydrocarbons– alkanes, alkenes, alkynes and aromatic rings.Carbonyl compounds – aldehydes, ketones, acids and their derivatives. Epoxides.Nitro, nitroso, azo and oxime groups.Hydrogenolysis,

**Books Suggested:**

1. Modern Synthetic Reactions, H.O. House, W.A. Benzamin.
2. Some Modern Method of Organic Synthesis, W. Carruther, Cambridge Univ. Press.
3. Advanced Organic Chemistry, Reactions Mechanism and Structure, J. March, John Wiley.

4. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional

**M.Sc. Chemistry Semester III**

**Organic Chemistry Special-II (CHEM-305)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D.        The candidates are required to attempt five questions in all selecting        at least one question from each section. All questions carry equal        marks.

**SECTION - A**

**Pericyclic Reactions**

Molecular orbital symmetry, frontier orbital of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system classification of pericyclic reactions, Woodward - Hoffmann correlation diagram. FMO & PMO approach, Electrocylic reaction - conrotatory and disrotatory motions. 4n, 4n+2, allyl systems, Ring opening of cyclopropyl halides and tosylates, cycloadditions-antarafacial and suparafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3-dipolar cycloadditions and cheleotropic Reactions.

**SECTION – B**

**Pericyclic Reactions**

Sigmatropic Rearrangements-suprafacial and entarafacial shifts of H, sigmatropic shifts involving carbon moieties, retention and inversion of configuration, [3,3] and [5,5] sigmatropic rearrangements, detailed treatment of Sommelet-Hauser, Claisen and Cope rearrangements introduction to ene reactions. Simple problems on Pericyclic reactions, Group transfers and eliminations.

**SECTION – C**

**Photochemistry**

Excitation and excited states, Franck-Condon Principle, Jablonski diagram, energy transfer photsensitization, quenching, quantum efficiency and quantum yield.

Photochemistry of carbonyl compounds (Norrish type I and type II changes, photoreaction of cyclic ketones, Paterno-Buchi reaction and Photoreducation. Photochemistry of olefins and 1,3-Butadiene (cis-trans isomerisation, dimerisation and cycloadditions).

**SECTION – D**

**Photochemistry**

Di-π-methane rearrangement, enone and dienone rearrangements, photochemistry of aromatic compounds (substitution, isomerization, cyclization and cycloaddition reactions), Photo-Fries rearrangement, photolysis of nitrile esters and Barton reaction, Hoffman-Loefller-Freytag reaction. Synthesis of vitamin D.

**Books Suggested:**

1. Pericyclic Reactions, S.M. Mukherji Macmilan India.
2. Organic Photochemistry, J Coxan & B. Halton, Cambridge University Press.
3. Introductory Photochemistry,.A. Cox and T. Camp McGraw Hill.
4. The Conservation of Orbital Symmetry, R.B. Woodward and R. Hoffmann" Verlag Chemie Academic Press.
5. Problem Solving approach to Orbital Symmetry, R.E. Lehr and A.P. Merchand
6. Organic Reactions and Orbital Symmetry, T.L. Gilchrist and R.C. Storr, Cambridge University Press, Cambridge, 2nd Edn. 1979.

**Or**

**M.Sc. Chemistry Semester III**

**Pharmaceutical Chemistry Special-I (CHEM-304)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION – A**

**Synthon approach-I**

Definition of terms- Disconnection, synthons, functional group interconversions (FGI), synthetic equivalents. General principles of the disconnection approach, the importance of order of events in organic synthesis, one group C-X and two group C-X, One group C-C disconnections-alcohols and carbonyl compounds, chemoselectivity, reversal of polarity, amine synthesis.

**SECTION - B**

**Synthon approach-II**

Two group C-C disconnections-1,3 & 1,5-difunctionalized compounds, Stereochemistry in organic synthesis-stereoselectivity, stereospecificity, regioselectivity and regiospecificity

Synthon approach in the synthesis of the following drugs: Salbutamol, Propanolol, moxnidazole, nafimidone, drildone, belfosih. Ocfentanil, afornine

Principle of protection of alcoholic, amino, carbonyl and carboxylic groups

**SECTION – C**

Systematic (Hantzsch-Widman) nomenclature for monocylic and fused ring systems.

Methods of synthesis and Reactions including mechanism of the following five-membered 1,2- and 1,3-heterocycles: pyrazole, imidazole, oxazole, isooxazole, thiazole, isothiazole; their basic character.

**SECTION – D**

Methods of synthesis and Reactions including mechanism of the following six-membered heterocycles: purines and pyrimidines. Caffeine, xanthine, theobromine, theophylline

Methods of synthesis and Reactions including mechanism of-Indoles, quinolines and isoquinolines

Flavanoids: Occurrence, nomenclature and general methods of structure determination, isolation, importance and synthesis of Cyanin, Quercetin, Diadzein and Chrysin.

**Books Suggested:**

1. Designing Organic Synthesis, S.Warren, Wiley.
2. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press.
3. Modern Synthetic Reactions, H.O.House, W.A. Benzamin.
4. Advanced Organic Chemistry Reactions, Mechanisms a Structures, J. March, Wiley.
5. Advanced Organic Chemistry Part B. F.A. Carey and R.J. Sundberg, Plenum Press.
6. Organic Chemistry, Vol. 2, I.L. Finar, ELBS.

**M.Sc. Chemistry Semester III**

**Pharmaceutical Chemistry Special-II (CHEM-305)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION – A**

**General mode of action, Medicinal Uses and Synthesis of Important Drugs in the Following Categories.** Antineoplastic Agents: Metastasis, classification, mode of action of alkylating agents ( synthesis of mephalan, thiotepa, busulfan, lomustine) and antimetabolites ( synthesis of methotrexate, 5-fluorouracil, 6-mercaptopurine), hormone based therapies, plant products, radiotherapeutic agents. Taxol realated compounds.

Antiviral agents: RNA and DNA viruses, An introduction to AIDS, how HIV infects the system, mode of action of nucleoside reverse transcriptase inhibitors- AZT, ddI, ddC, d4T & 3TC and HIV-protease inhibitors-Ritonavir. Synthesis of AZT

An overview of HIV entry inhibitors, Integrase inhibitors, Chemokine receptor binders, Inhibitors of gp41 fusion activity

Antimalarials: Cinchona alkaloids, 4-aminoquinolines, 8-aminoquinolines, Mefloquine, 9-aminoacridines. Synthesis of Metaquine, chloroquine, primaquine

**SECTION – B**

**Antibiotics**

Penicillins: Discovery, mode of action, SAR, Penicillins and semi-synthetic penicillins, problems of sensitivity to acids, β-lactamases and narrow spectrum of activity; solving these problems leading to the development of penicillin V,oxacillin,cloxacillin, ampicillin, amoxycillin, carbenicillin and carfecillin; β-lactamase inhibitors-Clavulanic acid, Olivanic acids

Cephalosporins: Classification, SAR, synthesis of cephalosporin-C, recent advances of fourth generation cephalosporins

Sulfonamides-SAR, mode of action. Sulfanilamide analogs- synthesis of Sulfathiazole, sulfadiazine, sulfacetamide

Tetracyclins and aminoglycosides- Structure, mode of action, SAR, streptomycin, neomycin, gentamycin; Macrolides- mode of action, erythromycin, azithromycin; Synthesis of chloramphenicol

Quinolones, fluoroquinolones- Structure, mode of action, synthesis of nalidixic acid and ciprofloxacin

Lincomycins

**SECTION – C**

Prostaglandins: General Introduction, nomenclature of prostaglandins and eicosanoid biosynthesis

Non-Steroidal anti-inflammatory agents: Classification, mode of action, COX-2 inhibitors, salol principle

Synthesis of celecoxib, valdecoxib, aspirin, phenbutazone, mefanamic acid, indomethacin, piroxicam, diclofenac, Naproxen

Antipyretic-Analgesics: opoid antagonists and agonists-codeine and heroin), synthesis of meperidine, methadone, dextropropoxyphen

**SECTION – D**

Antifertility agents: Ovulation inhibitors and related hormonal contraceptives- norethindrone, norethynodrel, estradiol and mestranol.Recent Advances

Antihypertensive agents: Classification, Hypertension, Renin-Angiotensin system, mode of action, Calcium channel blockers, ACE inhibitors and β-blockers, centrally acting adrenergic drugs, Peripherally acting sympatholytics- Synthesis of atenolol, clonidine, methyldopa, guanabenz, diltiazem, captopril, enalapril.

**Books Suggested:**

1. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, Ed. Robert F. Dorge.
2. Burger's Medicinal Chemistry and Drug Discovery Vol-I Ed. M.E. Wolf, John Wiley.
3. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.
4. Organic Chemistry Vol.-2 I.L. Finar, ELBS

**M.Sc. Chemistry Semester III**

**Inorganic Special Practical I & II**

**(CHEM 306 & CHEM 307)**

**Credits- 4+4**

**Time:12Hrs**

**(Four sessions, spread over 2 days to all papers)**

**Max. Marks: 60+20(IA) & 60+20(IA)**

**Inorganic Special Practical I (CHEM-306)**

1. **Preparations:**

Preparation of selected Inorganic Compounds and their Characterization by elemental analysis and spectroscopic methods (IR, NMR, EPR, Magnetic moment etc.).

**I** Choloropentaamminecobalt (III) Chloride

**II** Nitro/Nitritopentaamminecobalt (III) Chloride (Distinction between nitro and nitrito by IR)

**III** Potassium trioxalatoferrate (III)

**IV** Chromous acetate

**V** Cis and trans [Co(en)2Cl2]

**Experiment Marks: 40**

**Lab record & Viva-voce Marks: 10+10**

**Inorganic Special Practicals II (CHEM-307)**

1. **Instrumentation:**

**I** Spectrophotometric Determinations

**II** Conductometric Titrations

**III** Flame Photometry

**IV** Potentiometric/pH-analysis

**V** Electrogravimetric analysis

**VI** Polarographic analysis

**VII** Any other techniques introduced

**Experiment Marks: 40**

**Lab record & Viva-voce Marks: 10+10**

**Books Suggested:**

1. Synthesis and Characterization of Inorganic compounds. W. L. Jolly, Prentice Hall, Englowood.
2. A Text Book of Quantitative Analysis: A. I. Vogel, ELBS, London.
3. Inorganic Preparations: W. G. Palmer.

**Or**

**M.Sc. Chemistry Semester III**

**Physical Special Practical I & II**

**(CHEM 306 & CHEM 307)**

**Credits- 4+4**

**Time: 12 Hrs**

**(Four sessions, spread over 2 days to all papers)**

**Max. Marks: 60+20(IA) & 60+20(IA)**

**Physical Special Practical I (CHEM-306)**

### Potentiometry

1. Determination of activity coefficient of Ag+ in a solution of silver nitrate and to study the effect of potassium nitrate on the activity coefficient of silver nitrate.
2. Determination of the cell Pt, H2⎪HCl AgCl⎪Ag with various concentrations of HCl and to obtain the activity coefficient of HCl.
3. Determination of solubility of silver halides in water.
4. Determination of first and second ionization constant of phosphoric acid.
5. Study of silver-ammonia complex and determination of the stability constant.
6. Determination of strength of ferrous ammonium sulphate using potassium dichromate or ceric sulphate and determination of redox potential.
7. Determination of strength of HCl and CH3COOH in a mixture using NaOH.
8. Titration of weak/strong acid with strong base using quinhydrone and determination of dissociation constant of the acid.
9. Study of equilibrium constant of the reaction Fe+++ + Ag → Fe++ + Ag+.
10. To determine the degree of hydrolysis of aniline hydrochloride.
11. Titration of halides with AgNO3 individually and in the mixture of two halides.

**Polarimetry**

1. Determine the percentage of two optically active substances in a mixture polarimetrically.
2. Determination of relative strength of acids by the study of inversion of sucrose.
3. Investigate the effect of substitution of chloride ions on rate constant of inversion of cane sugar by using mono-, di- and tri-chloroacetic acids as catalysts.

**Experiment Marks: 40**

**Lab record & Viva-voce Marks: 10+10**

**Physical Special Practical II (CHEM-307)**

**Conductometry**

1. Determination of the equivalent conductance of weak acid (benzoic and acetic acid) at several concentrations and the dissociation constant of the acid.
2. Determination of the equivalent conductance of strong electrolytes such as HCl, KCl, KNO3 and NaCl and the validity of Onsagar equation.
3. Determination of solubility of silver halides.
4. Study of degree of hydrolysis of aniline hydrochloride.
5. Conductometric titration of: (i) Strong acid vs. strong base,   
   (ii) Strong acid vs. weak base, (iii) Weak acid vs. strong base, (iv) Weak acid vs. weak base, (v) CH3COOH + HCl vs. NaOH, (vi) CuSO4 vs. NaOH.
6. Determine the critical micelle concentration (CMC) of a surfactant (sodium lauryl sulphate) by conductivity method.

**Colorimetry/Spectrophotometry**

1. Verification of the Lambert-Beer’s law using solutions such as K2Cr2O7, CuSO4, KMnO4 in water and I2 in CCl4.
2. Study of iron-tiron and iron-salicylic acid complexes.
3. Determination of the composition of various mixtures spectrophotometrically:
4. Potassium dichromate and potassium permanganate
5. Crystal violet and aurine
6. Determine the dissociation constant of an indicator spectrophotometrically.

**Note:** Any experiment may be introduced/deleted in the practical class based on the availability/non-availability of the instruments/chemicals.

**Experiment Marks: 40**

**Lab record & Viva-voce Marks: 10+10**

**Books Suggested**

1. Practical Physical Chemistry, S.R. Palit and S.K. De, Science.
2. Experimental Physical Chemistry, R.C. Das and B. Behera,McGraw Hill.
3. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
4. Findley’s Practical Physical Chemistry, B.P. Lavitt, Longman.

**Or**

**M.Sc. Chemistry Semester III**

**Organic Special Practical I & II**

**(CHEM 306 & CHEM 307)**

**Credits- 4+4**

**Time: 12Hrs**

**(Four sessions, spread over 2 days to all papers)**

**Max. Marks: 60+20(IA) & 60+20(IA)**

**Organic Special Practical I (CHEM-306)**

**1**. **Preparations of Organic compounds involving two and three stages**:

Typical preparations from which the two and three stage preparations can be chosen are:

1. Toluene — p-nitrotoluene — p-nitrobenzoic acid — p-amino benzoic acid

2. Hydroquinone — Benzoquinone — 5- Hydroxy benzoxathiole-2-one —5-Acetoxy     benzoxathiol-2-one

3. Benzene — Acetopheneone — Acetophenone oxime — Acetanilide

4. Benzaldehyde — Benzoin — Benzil — Benzillic acid

5.Acetylacetone — 4,6-dimethylpyridine-2-mercaptopyrimidine — 4,6-dimethyl-2-

hydrazinpyrimidine — 1-(4'-6'-dimethylpyridine-2'yl) 3,5-dimethylpyrazole

6. Nitrobenzene — m-dinitrobenzene — m-nitroaniline — m-nitrophenol

7. Phthalic acid — phthalic anhydride – phthalimide — Anthranilic acid

8. Acetophenone — Benzalacetophenone — epoxide

9. Cyclohexanone —Cyclohexanone oxime—caprolactam

10. Phthalic anhydride—o-benzolylbenzoic acid—anthraquinone.

11. O-Cholobenzoinc acid —N-phenylanthranilic acid —acridone.

12. Cholrobenzene—2,4-dinitrochlorobenzene —2,4-dinitrophenol

13. Bromobenzene—triphenylcarbinol-tritylchloride

14. Resorcinol—resacetophenone — 4-ethyl resorcinol

15. Resorcinol — 4-methyl-7-hydroxycoumarin — 6 and 8- nitro-4-methyl-7-

hydroxycoumarin

16. Phenol — salicylaldehyde —coumarin

17. Aniline — 2,4,6-tribromaniline — 1,3,5-tribromobenzene

18. Resorcinol—resacetophenone — Chalcone

19. Any other multi step reaction as per requirement

**All the students must check the progress of reaction and purity of Final products for**

**all the stages of preparation by Thin layer Chromatography.**

**2. Demonstration of use of Chemistry software for drawing the structures of Organic compounds**:

Draw the Scheme used for a multi step preparation (two or three) using any structural drawing tool & get the IUPAC name and predicted 1H-NMR spectrum for each compound involved in multi step preparation.

**Experiment Marks: 40**

**Lab record & Viva-voce Marks: 10+10**

**Organic Special Practical II (CHEM-307)**

1. **Quantitative estimation of the followings:** Amino group, hydroxyl           group, acetoxy group, carbonyl group, unsaturation, reducing and           non-reducing sugars,

2. Saponification value and iodine value of fats and oils, formalin and glycine, Determination of the molecular weight of an acid by titration and by the silver salt method.

**Experiment Marks: 40**

**Lab record & Viva-voce Marks: 10+10**

**Books Suggested:**

1. "Elementary Practical Organic Chemistry by Arthur I.Vogel Longmans, Green and Co. 1958.
2. "An Introduction to Practical Biochemistry", by David T. Plummr, Tata McGraw Hill Publishing Company, Ltd., N. Delhi, 1988.
3. Practical Organic Chemistry' by Mann and Saunders.

4. Text Book of Vogel's Practical Organic Chemistry by Longman Group,          B.S. Furness et al., Ltd.

5. "Experiments in Organic Chemistry" Louis F. Fieser O.C. Heath and          Company Boston, 1955.

6. "Organic Synthesis" Collective Vol. I.

7. “Laboratory Manual in Organic Chemistry' by R.K. Bansal, Wiley Eastern Ltd., New Delhi-1980.

**Or**

**M.Sc. Chemistry Semester III**

**Pharmaceutical Special Practical I & II**

**(CHEM 306 & CHEM 307)**

**Credits- 4+4**

**Time: 12Hrs**

**(Four sessions, spread over 2 days to all papers)**

**Max. Marks: 60+20(IA) & 60+20(IA)**

**Pharmaceutical Special Practical I (CHEM-306)**

**Paper: CHEM306**

1. Preparations of organic compounds of medicinal interest.
2. Techniques in isolation and extraction of crude drugs, purification of various active principles having medicinal, industrial and chemical importance.
3. Quantitative estimation of drugs in biological samples.
4. Identification of microbes on the basis of Gram staining, sterility testing, microbial assays.

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**Experiment Marks: 40**

**Lab record & Viva-voce Marks: 10+10**

**Pharmaceutical Special Practical I (CHEM-307)**

Preparation and evaluation of the following : Emulsion, simple syrup, aqueous idodine solution, strong iodine solution, calamine lotion, boroglycerine, tannic acid glycerine, phenol glycerine, pipermint water, rose water, camphor water, formulation of simple and medicated ointments, magnesium hydroxide mixture (milk of magnesium), simple and complex powders, cough mixture, cold cream, vanishing cream and lotions.

**Experiment Marks: 40**

**Lab record & Viva-voce Marks: 10+10**

**Books suggested**

1. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.)., Ltd. London, 1975).
2. "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.
3. "A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis" by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966.
4. "Elementary Practical Organic Chemistry" by Arthur I. Vogel, CBS Publishers & Distributors.
5. "A Guide to spectroscopy in Organic Chemistry' by PAVY
6. "Spectrometric Identification of Organic Compounds", Fifth Ed., R.M. Silverstein, G.S. Bassler and T.C.Morrile, John Wiley and Sons, New York.
7. "Organic Spectroscopy', 3rd Ed., by William Kamp. John Wiley & Sons.
8. "Spectroscopic" Methods in Organic Chemistry, D.H. William & Ian Fleming.
9. Vogel's Text Book of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd

**M.Sc. Chemistry Semester IV**

**Inorganic Chemistry Special-III (CHEM-401)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION – A**

**Errors and Evaluation**

Definition of terms in mean and median. Precision-standard deviation, relative standard deviation. Accuracy-absolute error, relative error. Types of error in experimental data-determinate (systematic), indeterminate (or random) and gross. Sources of errors and the effects upon the analytical results. Methods for reporting analytical data. Statistical evaluation of data-indeterminate errors. Significance of the F test, the student ‘t’ test and the Chi-test.

**Nephelometry and Turbidimetry**

Theory - light scattering, choice and comparison between nephelometry and turbidimetry, factors affecting measurement, instrumentation, applications

**SECTION – B**

**Sewage and fertilizers**

Sewage treatment, Biochemistry of sewage, fertilizers - Nitrogen; ammonification, nitrification, denitrification, fixation of nitrogen, biochemistry and ecology of nitrogen fixation, nitrogen and phosphorus fertilizers in agriculture, eutrophication, surfactants - cationic, anionic and non ionic, specific properties, degradation.

Analysis of air pollutants

Biochemical effect of As and Heavy metals such as Cd, Pb and Hg.

**Molecular luminescence** Fluorimetry and Phosphorimetry: Introduction, principles of fluorescence and phosphorescence, interpretation of fluorescence spectra, factors, fluorescence intensity and concentration, instrumentation for fluorimetry, applications of fluorimetry.

Phosphorimetry, instrumentation, applications, comparison between fluorimetry and phosphorimetry

**SECTION – C**

**Chromatography**

General principles, types of chromatography, absorption chromatography, partition chromatography, vapour phase chromatography, paper and thin layer chromatography, retardation factor, retention volume, mechanism and efficiency of separations.

**Ion-Exchange**

General principles, ion exchangers-natural and synthetic, ion-exchange capacity, purification of water and other applications.

**Solvent Extraction**

General Principles, extraction coefficients, Batch, continuous, and counter current extractions, applications.

**SECTION -D**

**Ion selective electrodes**

Fundamental types of electrodes, gas sensors, ion sensors and enzyme electrodes, principle involved in measurements with ion selective electrodes with special reference to halide, sulphide and oxygen electrodes.

**Thermal Techniques**

Thermogravimetry, differential thermal analysis (DTA) and differential scanning calorimetry (DSC) principles and applications.

**Books Suggested**

1. A Textbook of Quantitative Inorganic Analysis, A.I. Vogel; ELBS, London.
2. Environmental Solution Analysis; S.M. Khopkar, Wiley Eastern.
3. Fundamentals of Analytical Chemistry; D.A. Skoog, O.M. West and F.J. Holler; W.B. Saunders.
4. Instrumental methods of Analysis; L.L. Merits, R.H. Willard and J.A. Dean; Van Nostrand-Reinhold.
5. Physical methods in Chemistry; R.S. Drago; Saunders.
6. Dynamics of Chromatography Part I.; J.C. Gidding; Dekker, New York.
7. Environmental Chemistry; S.K. Banerji, Prentice - Hall.

**M.Sc. Chemistry Semester IV**

**Inorganic Chemistry Special-IV (CHEM-402)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION -A**

**Electro analytical methods of Analysis**

Electrogravimetry:Current-voltage relationship during an electrolysis, decomposition potential, constant current electrolysis, constant cathode potential electrolysis, apparatus, electrodes, mercury cathode, applications physical properties of electrolytic precipitates, chemical factors of importance in electrodeposition.

Electrolytical methods without cathode potential control

Coulometric analysis: Coulometric methods of constant electrode potential and coulometric titrations. Apparatus and applications.

Amperometric titrations, anodic stripping voltammetry, and cyclic voltammetry

**SECTION –B**

**Atomic Absorption Spectroscopy**

General principles, resonance line, its natural width, Doppler effect, broadening due to pressure, Hollow cathode lamp. Application to alkali and alkaline earth metals.

**Flame photometry**  Theory of flame photometry, flame temperature, Emission Flame photometry - intensity of spectral lines, selection of optimum working conditions, application of flame photometry in trace metal analysis.

**SECTION –C**

**Spectrophotometry and Colorimetry**

Fundamental concepts, instrumentation for absorption measurements, interferences, application of absorption spectroscopy and Colorimetry to analysis of inogganic substance.

**Nuclear magnetic Resonance**

Basic Principle of NMR, Nuclear relaxation, Factors affecting nuclear relaxation, effect of chemical exchange on spectrum and evaluation of reaction rate of fast reactions, Double resonance, Lanthanide shift reagents, an overview of NMR of other nuclides with emphasis on 31P, 19F, 195Pt and 119Sn NMR. Application in inorganic chemistry

**SECTION –D**

**Electron Spin Resonance Spectroscopy**  Hyperfine coupling, spin polarization for atoms and transition metal ions, spin-orbit coupling and significance of g-tensor, application to transition metal complexes (having one unpaired electron) and inorganic free radicals such as PH4, F2- and [BH3]-. Double resonance in EPR.

**Circular Dichroism and Optical Rotatory Dispersion**

Polarized light, fundamental symmetry requirements, for optical activity, interaction of polarized light with optically active matter, optical rotation, Cotton effect, configuration of Tris-chelated complexes.

**Books Suggested:**

1. A Textbook of Quantitative Inorganic Analysis, A.I. Vogel; ELBS, London.
2. Fundamentals of Analytical Chemistry; D.A. Skoog, O.M. West and F.J. Holler; W.B. Saunders.
3. Instrumental methods of Analysis; L.L. Merrit, R.H. Willard and J.A. Dean; Van Nostrand-Reinhold.
4. Physical methods in Chemistry; R.S. Drago; Saunders.
5. Dynamics of Chromatography Part I.; J.C. Gidding; Dekker, New York.
6. NMR, NQR, EPR and MB Spectroscopy in inorganic Chemistry, R.V. Parish, Ellis Horwood.
7. Modern Optical Methods of Analysis; E.D. Olgen; McGraw Hill.
8. Introduction to Magnetic Resonance; McLachan and Carrington; Chapman and Hall.

**M.Sc. Chemistry Semester IV**

**Inorganic Chemistry Special-V (CHEM-403)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION – A**

**Metal Storage Transport and Biomineralization**

Ferritin, transferrin, and siderophores

**Calcium in Biology**

Calcium in living cells, transport and regulation, molecular aspects of intramolecular processes, extra cellular binding proteins

Coenzyme vitamin B12, vitamin B6.

**SECTION - B**

**Metalloenzymes**

Zinc enzymes – carboxypeptidase and carbonic anhydrase, alkaline phosphatase and alcohol dehydrogenase, Copper enzymes – superoxide dismutase. Molybdenum oxatransferase enzymes – xanthine oxidase

**SECTION - C**

**Supramolecular Chemistry**

Concepts and language.

1. Molecular recognition: Molecular receptors for different types of molecules including anionic substrates, design and synthesis of co-receptor molecules and multiple recognition.
2. Supramolecular reactivity and catalysis.
3. Transport processes and carrier design.
4. Supramolecular devices. Some example of self-assembly in supramolecular chemistry

**SECTION-D**

**Principles of Bio-Inorganic Medicine**

Evaluation of modern therapeutical, means of administering chemicals to humans, concentration effects, and dose-response relationship, future developments and trends in bio-inorganic therapy

**Metals in Medicine**

Metal deficiency and disease, toxic effects of metals, metals used for diagnosis and chemotherapy with particular reference to anticancer drugs

**Books Suggested**

1. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
2. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books.
3. Supramolecular chemistry, J.M. Lehn, VCH.

**M.Sc. Chemistry Semester IV**

**Inorganic Chemistry Special-VI (CHEM-404)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION - A**

**Photochemistry**

Absorption, excitation, photochemical laws, quantum yield, electronically excited states- life times-measurements of the times. Energy dissipation by radiative and non radiative processes, bimolecular quenching, absorption spectra, Franck condon principle, photochemical kinetics, photochemical stages-primary and secondary.

**SECTION-B**

**Excited States of Metal Complexes**

Electronically excited states of metal complexes: charge-transfer spectra, charge transfer transition, photosubstitution reactions, photorearrangements, photoisomerisation, photoredox processes conditions of excited states to be useful redox reactant Illustration of some reducing and oxidising character of Ru(2+) tris-bipyramidal complex. Transformation of chemical energy into light energy

**Metal Complex Sensitizers**

Metal complex sensitizer, photosensitised reactions in metal complexes, water photolysis, nitrogen fixation and carbon dioxide reduction

**SECTION - C**

**Solid State-I**

Crystalline and non-crystalline materials, glass transition temperature Tg and melting temperature Tm, classes of compounds of the type A2 B3 and AB3 Glass-ceramics, structures of polymers, glass and ceramics inorganic chains and rings.

Alloys-interstitial, substitutional and superconducting, Meissner effect, Hume-Rothery rules.

**SECTION - D**

**Solid State-II**

Perfect and imperfect crystals, intrinsic and extrinsic defects, point defects, line and plane defects, vacancies- schottky defects and Frankel defects, colour centers, non-stiochiometry and defects.

Metals, insulators and semiconductors, electronic structure of solids- band theory, band structure of metals, insulators and semiconductors. Intrinsic and extrinsic semiconductors, doping semiconductors, p-n junctions, superconductors, Optical and Magnetic properties.

**Books Suggested**

1. Concepts of Inorganic Photochemistry, A.W. Adamson and P.D. Fleischauer, Wiley.
2. Photochemistry of coordination compounds, K.Balzani and V.Carassti, Academic press.
3. Elements of Inorganic Photochemistry; G.J. Ferraudi, Wiley.
4. An Introduction to Crystal Chemistry; R.C. Evans, Cambridge University Press.
5. Introduction to solid state Physics; C.Kittel, Wiley New York.
6. Solid State Chemistry; N.B. Hannay; Prentic

**Or**

**M.Sc. Chemistry Semester IV**

**Physical Chemistry Special-III (CHEM-401)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**Section – A**

**Polymers**

Recapitulation and basics of polymers and polymerization. Biodegradable polymers: Types of degradable polymers, Chemical and biodegradation. Applications of biodegradable polymers, Hyperbranched–star polymers, Dendrimers, Plasticizers, Polymer composites. Properties of commercial polymers: Polyethylene, polyvinylchloride, polyamides, polyesters, phenolic resins, epoxy resins and silicon polymers.

Glass transition temperature (Tg), factors influencing the glass transition temperature, effect of molecular weight and melting point on glass transition temperature, importance of glass transition temperature.

**Section – B**

**Thermodynamics of Polymer Solutions**

Average end-to-end distance, average radius of gyration of polymer chains, statistical distribution of end-to-end dimensions, freely jointed chain in three dimensions, influence of bond angle restrictions.

Entropy of mixing and enthalpy of mixing by lattice model, Flory Huggins lattice theory, limitations of lattice model, entropy of mixing by free volume theory, heat and free energy of mixing, partial molar quantities i.e., chemical potential, heat of dilution and partial molar entropy of mixing, excluded volume, thermodynamic relations for dilute polymer solutions.

**Section – C**

**Determination of Molecular Weight of Polymers**

Molecular weight determination of polymers. Osmotic pressure: Membrane osmometer, high speed osmometer and vapour pressuree osmometer. Sedimentation or ultracentrifugation: Sedimentation velocity method, sedimentation equilibrium method. Light scattering: Scattering of light by small molecules and polymer solutions, asymmetric scattering, Debye method, Zimm plot method, comparison of Zimm and Debye methods, Determination of molecular weight by Gel Permeation Chromatography.

**Section – D**

**Advanced Statistical Mechanics**

Real gases, intermolecular potential and virial coefficients.

Structure of liquids-definition of distribution and correlation functions, Thermodynamic functions of a fluid and radial distribution function, Spectroscopic techniques for liquid dynamic structure studies.

Random walk problem in 1D. Theory of Brownian motion, Langevin theory, Fokker-Planck equation.

**Books Suggested:**

1. Polymer Chemistry, P.J. Flory,Cornell University Press
2. Physical Chemistry of Polymers, A.Tager,Mir Publishers
3. Physical Chemistry of Macromolecules, C.Tanford,Wiley Publisher.
4. Polymer Chemistry by Gowarikar,New Age International
5. Scaling Concepts in Polymer Physics, [Pierre-Gilles Gennes](http://www.amazon.com/s/ref=ntt_athr_dp_sr_1?_encoding=UTF8&field-author=Pierre-Gilles%20Gennes&search-alias=books&sort=relevancerank), Cornell University Press
6. Introduction to Polymers, Third Edition, [Robert J. Young](http://www.amazon.com/Robert-J.-Young/e/B001HN149U/ref=ntt_athr_dp_pel_1) and  [Peter A. Lovell](http://www.amazon.com/s/ref=ntt_athr_dp_sr_2?_encoding=UTF8&field-author=Peter%20A.%20Lovell&search-alias=books&sort=relevancerank),CRC Press
7. Polymer Physics (Chemistry), [M. Rubinstein](http://www.amazon.com/s/ref=ntt_athr_dp_sr_1?_encoding=UTF8&field-author=M.%20Rubinstein&search-alias=books&sort=relevancerank), [Ralph H. Colby](http://www.amazon.com/s/ref=ntt_athr_dp_sr_2?_encoding=UTF8&field-author=Ralph%20H.%20Colby&search-alias=books&sort=relevancerank),OUP Oxford
8. Statistical Mechanics by Donald A McQuarrie,University Science Books.

**M.Sc. Chemistry Semester IV**

**Physical Chemistry Special-IV (CHEM-402)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION-A**

**Solid State Chemistry**

Free electron theory of metals, Quantum mechanical treatment explaining the origin of band gaps, density of states, Band theory, Bloch theorem, Brillouin zones, effective mass of charge carriers, Semiconductors: Direct and indirect band gap semiconductors, hole concept, temperature dependence of mobility and electrical conductivity, free carrier concentration in intrinsic and extrinsic semiconductors, mass active law, Generation of carriers and their recombination in semiconductors. Types of junctions (metal-semiconductor, semiconductor-semiconductor, junctions in organic materials), Analysis of p-n junction including I-V characteristics.

**SECTION-B**

**Renewable energy sources**

Renewable energy resources: Biomass-Biofuels, Hydrogen, Solar energy. Related environmental and economical issues.

Introduction to Photovoltaics. Basic PV system design. Design and physics of solar cells, I-V characteristics, external and internal quantum efficiency. Thermodynamics of light conversion. Solar radiation and conversion efficiency. Factors influencing solar cell efficiency. Future trends in PV energy conversion. Silicon solar cells, alternatives to silicon, III-V materials for solar cells, thin film solar cells and third generation solar cells. Concentrator photovoltaics. Thermodynamic limit of light concentrators, Photovoltaics storage system.

**SECTION –C**

**Advanced Electrochemistry**

Advanced concepts: Overpotential concept, Exchange current density, Butler-Volmer equation, Polarizable and non-polarizable interfaces. Tafel equations. Electrochemical Processes: Difference between kinetically and mass transport controlled electrochemical processes. Difference between single step and multiple step electrode reactions. Brief introduction and applications of various electrochemical methods: Principle of electrochemical methods such as chronoamperometry, cyclic voltammetry, chronopotentiometry, coulometry, ac-impedance, spectroelectrochemistry and hydrodynamic methods. Electrocatalysis: Introduction to electrocatalysis. Homogeneous and heterogeneous electrocatalysis.

**SECTION-D**

**Applied Electrochemistry**

Corrosion: Forms of corrosion, Corrosion monitoring and prevention methods. Batteries and Fuel cells: Introduction. Nanostructured and surface modified electrodes: Introduction and their applications. Environmentally oriented electrochemistry: Electrochemistry of water splitting, electrolysis of sea water, electrochemical reduction of CO2, Electrochemical sewage disposal, electrochemical decontamination of soil.

**Ion Selective Electrodes**

Electrical Properties of membrane, glass electrode with special reference to H+, Na+, K+ ions, operation of solid membrane electrode, operation of liquid membrane electrode, coated type ion electrode, Applications of ion selective electrode in determination of some toxic metals and some anions (F-, Cl-, Br-, I- and NO3-).

**Books Suggested**

1. Principles of the Solid State, H.V. Keer, Wiley Eastern.
2. Solid State Physics, C.Kittel, John Wiley
3. [Solid State Physics](http://www.amazon.com/Solid-State-Physics-Neil-Ashcroft/dp/0030839939/ref=sr_1_1?s=books&ie=UTF8&qid=1365753701&sr=1-1&keywords=solid+state+physics) by [Neil W. Ashcroft](http://www.amazon.com/Neil-W.-Ashcroft/e/B001H6NBFM/ref=sr_ntt_srch_lnk_1?qid=1365753701&sr=1-1) and [N. David Mermin](http://www.amazon.com/N.-David-Mermin/e/B0028B0VQC/ref=sr_ntt_srch_lnk_1?qid=1365753701&sr=1-1)
4. [The Physics of Solar Cells (Properties of Semiconductor Materials)](http://www.amazon.com/Physics-Solar-Properties-Semiconductor-Materials/dp/1860943497/ref=sr_1_2?s=books&ie=UTF8&qid=1365753744&sr=1-2&keywords=Solar+cells) by [Jenny Nelson](http://www.amazon.com/Jenny-Nelson/e/B001K87KRW/ref=sr_ntt_srch_lnk_2?qid=1365753744&sr=1-2)
5. [Physics of Solar Cells: From Basic Principles to Advanced Concepts (Physics Textbook)](http://www.amazon.com/Physics-Solar-Cells-Principles-Advanced/dp/3527408576/ref=sr_1_5?s=books&ie=UTF8&qid=1365753744&sr=1-5&keywords=Solar+cells) by Peter Würfel
6. Optoelectronics of Solar Cells (SPIE Press Monograph Vol. PM115), [Greg P. Smestad](http://www.amazon.com/Greg-P.-Smestad/e/B001KI4G6U/ref=ntt_athr_dp_pel_1)
7. Electrochemical Methods: Fundamentals and Applications, 2nd Ed., A. J. Bard and L. R. Faulkner John Wiley & Sons: New York, 2002.
8. Modern Electrochemistry 1: Ionics 2nd Ed., Springer (1998), J. O’ M. Bockris & A. K. N. Reddy.
9. Modern Electrochemistry 2B: Electrodics in Chemistry, Engineering, Biology and Environmental Science 2nd Ed., Springer (2001), J. O’ M. Bockris & A. K. N. Reddy.
10. Modern Electrochemistry 2A: Fundamentals of Electrodics 2nd Ed., Springer (2001), J. O’ M. Bockris, A. K. N. Reddy and M. E. Gamboa-Aldeco.
11. Instrumental methods of analysis:Willard, Merritt & Dean
12. Advanced Analytical Chemistry: Meiter and Thomas
13. Instrumental methods of chemical analysis: Braun.
14. Principles of Instrumental analysis, 5th edition, D. A. Skoog, F. J. Holler, T. A. Nieman, Brooks Cole.

**M.Sc. Chemistry Semester IV**

**Physical Chemistry Special-V (CHEM-403)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

##### **Section - A**

**Thermal Methods of Analysis-I**Introduction to thermal analysis, TG and DTG, static, quasistatic and dynamic thermogravimetry, Instumentation, thermogram, factors affecting thermograms, application of thermogravimetry. Reaction Kinetics–kinetics by single and multiple heating rates. Differential thermal analysis, DTA theories, DTA curves, factors affecting DTA curves, Instrumentation, applications of DTA, simultaneous determination in thermal analysis. **Differential Scanning Calorimetry (DSC)**

Introduction, Instrumentation, Power compensated DSC, Heat Flux DSC, DSC-curves, factors affecting DSC curves, applications.

##### **Section – B**

##### **Material Chemistry**

Definition of nanomaterials, various techniques for the preparation of nanomaterials,Thermodynamics and Kinetics of Nucleation, Thin Films and Langmuir-Blodgett films - Preparation techniques, evaporation/sputtering, chemical processes, MOCVD, sol-gel. Langmuir-Blodgett (LB) film, growth techniques, photolithography, properties and applications of thin and LB films.

##### Electronic structure and properties of nanomaterials, optical, electrical and magnetic properties, diffusion and chemical behaviour, applications of nanomaterials.

##### **Section – C**

**Photochemistry** Revision of basic concepts of photochemistry, Life times of excited electronic states of atoms and molecules. Charge transfer transitions

The Frank-Condon principle, emission spectra, environment effect on absorption and emission spectra, Wigner’s spin conservation rule.Modes of decay of excited states, quenching of fluorescence, delayed fluorescence, collisional quenching, Stern–Volmer equation. Excimer and exciplex formation and decay.

Techniques for the study of transient species in photochemical reactions. Applications of Lasers in photochemical kinetics.

##### **Section – D**

**Biophysical Chemistry**

Chemical bonds in biological systems; Properties of water; Thermodynamic principles in biological systems; Osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mechanochemical system. Introduction to protein folding problem.Cell Membrane and Transport of Ions: Structure and functions of cell membrane. Active transport across cell membrane, irreversible thermodynamics treatment of membrane transport.

Optical methods and applications: Optical techniques in biological systems: Absorption spectroscopy, Fluorescence spectroscopy, Linear and Circular Dichroism.

## Books Suggested:

1. Fundamentals of Photochemistry, K.K. Rohtagi & Mukherjee, Wiley Eastern.
2. Photochemistry, J.G. Calvert and J.N. Pitts, Wiley.
3. Photochemistry and Spectroscopy, J.P. Simons, Wiley Interscience.
4. Principles and Applications of Photochemistry by Brian Wardle
5. Instrumental methods of analysis:Willard, Merritt & dean
6. Advanced Analytical Chemistry: Meiter and Thomas
7. Instrumental methods of chemical analysis: Braun
8. Principles of Biochemistry, A.L.Lehninger, Worth Publishers.
9. Biochemistry, L.Stryer, W.H.Freeman.
10. Biochemistry, J.David Rawn, Neil Patterson.
11. Biochemistry, Voet and Voet, John Wiley.
12. Outlines of Biochemistry, E.E.Conn and P.K.Stumpf, John Wiley.
13. Bioorganic Chemistry: A Chemical Approach to Enzyme Action, H.Dugas and C. Penny, Springer-Verlag.
14. Macromolecules: Structure and Function, F.Wold, Prentice Hall.
15. Biophysical Chemistry, Vol. 1-3, C. R. Cantor & Schimmel

### [Physical Biochemistry: Applications to Biochemistry and Molecular Biology](http://www.amazon.com/Physical-Biochemistry-Applications-Molecular-Biology/dp/0716714442/ref=sr_1_1?s=books&ie=UTF8&qid=1366976341&sr=1-1&keywords=Biophysical+chemistry+Friefelder) by D. M. Freifelder

### Biophysical Chemistry: Principles and Techniques by A. Upadhyay, Himalaya Publishing House

**M.Sc. Chemistry Semester IV**

**Physical Chemistry Special-VI (CHEM-404)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**Section-A**

**Advanced Chemical Kinetics**

London-Eyring-Polanyi method of calculation of energy of activation. Application of activated complex theory of reaction rates. Temperature dependence of pre-exponential factor. Thermodynamic aspects of reaction rates. Kassel’s theory (RRK), Rice-Ramsperger-Kassel-Marcus (RRKM) theory, unimolecular reactions and its validity.

**SECTION-B**

**Reaction Dynamics** Molecular beams, principle of crossed-molecular beams. Molecular encounters and principal parameters, e.g. Impact parameter, Collision cross-section, Reaction cross-section and relation between reaction cross-section and reaction rate (single velocity). Dependence of collisional cross-section on translational energy.

**Solution Kinetics** Ion-ion reaction, ion-dipole reaction and enzyme kinetics (effect of pH and temperature). Lineweaner-Burk plot for the analysis of enzymolysis. Reactions between polar molecules, kinetic salt, salt effect.

**SECTION-C**

**Kinetics of Fast Reactions**

General treatment of chain reaction, apparent activation energy of chain reactions, chain lengths, theories of branching chain and explosion (hydrogen-oxygen reaction). Modern techniques in gas phase and in solution, flash photolysis, flow methods, relaxation techniques (temperature jump, pressure jump) and shock tube technique.

**SECTION-D**

**Liquid Crystals**

Mesmorphic behaviour, thermotropic liquid crystals, positional order, bond orientational order, nematic and smectic mesophases; smectic – nematic transition and clearing temperature – homeotropic, planar and schlieren textures, twisted nematics, chirals nematics, molecular arrangement in smectic A and smectic C phases, optical properties of liquid crystals. Dielectric susceptibility and dielectric constants. Lyotropic phases and their description of ordering in liquid crystals.

## Books Suggested:

1. Theoretical Chemistry, S. Glasstone, Affiliated East-West Press.
2. Micelles, Theoretical and Applied Aspects, V. Moroi, Plenum.
3. Material Science Engineering, W.D. Callisler, Jr.
4. Chemical Kinetics, K.J. Laidler, McGraw Hill
5. Theories of Chemical Reaction Rates, K.J. Laidler, McGraw Hill.
6. Theory of Rate Processes, S. Glasstone, K.J. Laidler and H. Eyring, McGraw Hill.
7. Reaction Kinetics Oxford Press (1997), M. J. Pilling and P. W. Seakins.
8. Thermotropic Liquid Crystals, G.W. Gray, John Wiley.
9. Handbook of Liquid Crystals, Kelkar and Hatz, Chemie Verlag.
10. Significance of liquid structures, H. Eyring.

**Or**

**M.Sc. Chemistry Semester IV**

**Organic Chemistry Special-III (CHEM-401)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all,selecting at least one question from each section. All questions carry equal marks.

**SECTION - A**

# Disconnection Approach-I

An introduction of synthons and synthetic equivalents, general principles of the disconnection approach, functional group interconversions, the importance of order of events in organic synthesis, one group C-X and two group C-X disconnections, one group C-C disconnection, chemoselectivity, regioselectivity, regiospecificity, stereoselectivity and stereospecificity.

**SECTION - B**

# Disconnection Approach-II

Reversal of polarity, amine synthesis,Synthesis of alkenes-use of wittig reagents,use of acetylene and aliphatic nitro compounds in organic synthesis, synthesis of three membered rings, photochemistry in organic synthesis-synthesis of four membered rings , uses of ketones in organic synthesis, synthesis of five and six membered rings

**SECTION - C**

**Disconnection Approach-III**

Principle of protection of alcoholic, amino, carbonyl and carboxylic groups, Two group C-C disconnection- Diels Alder reactions, 1,3-difunctionalized compounds and α,β unsaturated carbonyl compounds, control in carbonyl condensations, 1,5-difunctionalized compounds-Michael addition and Robinson Annelation.

**SECTION – D**

**Application of Disconnection-** Sarette's stereospecific synthesis of Cortesone, a brief survey of various approaches used towards the synthesis of Juvabione and their relative merits and demerits **05**

**Concept of aromaticity**, non-aromaticity, antiaromaticity, homoaromaticity, and psuedo-aromaticity. Aromaticity in charged rings, HMO and PMO for determining aromatic, non-aromatic and anti-aromatic character of annulenes having various π-electron systems, application of 1H-NMR in determining aromatic character of annulenes. **05**

**Principle of Green chemistry and its applications**

Basic Principle and need of green chemistry, Different tools for green synthesis (Elementary idea of green reagent, green solvent, green catalyst, solid phase, mw and ultrasound assisted) atom economy, synthesis involving basic principle of green chemistry-synthesis of adipic acid and BHC synthesis of Ibuprofen. **05**

**Book Suggested:**

1. Designing Organic Synthesis, S.Warren, Wiley.
2. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press.
3. Handbook of Green Chemistry- Green Catalysis- Paul T. Anastas, Robert H. Crabtree, Wiley-VCH
4. Methods and Reagents for green synthesis: An introduction, Pietro Tundo, Alvise Perosa, F. Zecchin, Wiley

**M.Sc. Chemistry Semester IV**

**Organic Chemistry Special-IV (CHEM-402)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION - A**

# Reactions

A detailed study including mechanism or Arndt-Eistert synthesis Beckmann, Hofmann, Curtius, Lossen, Schmidt, Favorskii, Neber, Fritsch-Butenberg-Wiechell, Baeyer-Villiger, Benzilbenzillic acid rearrangements.

**SECTION - B**

# Reactions

A detailed study including mechanism of Darzens synthesis, stroke enamine synthesis, Shapiro reaction, Sharplcss asymmetric epoxidation, Prevost and Woodward hydroxylation

# Flavonoids

Occurrence, nomenclature, general methods (chemical and spectroscopic) of structure determination of flavonoids. Isolation, structure elucidation and synthesis of Cyanin, Quercetin, Diadzein and Chrysin. Biosynthesis of Flavonoids: Acetate and Shikimic acid pathway, biosynthesis of catechin.

**SECTION - C**

# Heterocyclic compounds

Systematic (Hantzsch-Widman) nomenclature for monocylic and fused ring systems.

General synthesis and reactions (including mechanism) of the followings:

Three-membered heterocycles: oxirane, azirane, oxazirane, diaziridines

Four-memebered heterocycles: Oxetane and azetidine

**SECTION – D**

**Heterocyclic compounds**

General synthesis and reactions (including mechanism) of the followings:

Five-membered heterocycles: pyrazole, imidazole, oxazole, isooxazole, thiazole, isothiazole; Comparison of their basic character.General synthesis and reactivity of purines and pyrimidines.

**Book Suggeted:**

1. Designing Organic Synthesis, S.Warren, Wiley.
2. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press.
3. Modern Synthetic Reactions, H.O.House, W.A. Benzamin.
4. Advanced Organic Chemistry Reactions, Mechanisms a Structures, J. March, Wiley.
5. Advanced Organic Chemistry Part B. F.A. Carey and R.J. Sundberg, Plenum Press.
6. Organic Chemistry, Vol. 2, I.L. Finar, ELBS.
7. Heterocylic Chemistry, T.L. Gilchrist, Longman Scientific Technical.
8. Comprehensive Heterocyclic Chemistry, A.R. Katritzky and C.W. Rees, eds. Pergaman Press.
9. Polycyclic Aromatic Hydrocarbons, E. Clar, Academic Press.

**M.Sc. Chemistry Semester IV**

**Organic Chemistry Special-V (CHEM-403)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION - A**

**Enzymes**

Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labeling. Enzyme kinetics, Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible inhibition.

**Mechanism of Enzyme Action**

Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion

**SECTION – B**

Mechanism of action of chymotrypsin, papain and carboxypeptidase A.

**Co-Enzyme Chemistry**

Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological functions of coenzyme A, thiamine pyrophosphate (TPP), pyridoxal phosphate (PLP), NAD+, NADP+, FMN, FAD. Mechanisms of reactions catalyzed by the above cofactors

**Prostaglandins**: General Introduction, nomenclature and biological roles of prostaglandins. Synthesis of PGE2 and PGF2α.

**SECTION - C**

**Terpenoids**

General aspects of structure determination of terpenoids. Structure elucidation and synthesis of Geraniol, α-terpineol, α-pinene, camphor, farnesol and squalene. Biogenetic isoprene rule and biogenesis of terpenoids.

**SECTION – D**

**Steroids**

Isolation and nomenclature of steroids. Structure elucidation, synthesis (Woodward) and stereochemistry of cholesterol.

Methods for the following conversions.

1. Cholesterol → Testosterone
2. Cholesterol → Progesterone
3. Cholesterol → 5-α and 5-β cholanic acids.

Johnson's hydrochrysene approach towards the synthesis of Androsterone.

**Books Suggested:**

1. Organic Chemistry, Vol 2, I. L. Finar, ELBS.
2. Natural Products: Chemistry and Biology Significance, J.Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Longman, Essex.
3. Biochemistry, A.L. Lehninger.
4. Outlines of Biochemistry, Cohn & Stumpf.

**M.Sc. Chemistry Semester IV**

**Organic Chemistry Special-VI (CHEM-404)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION A**

**Drug Design**

Classification and discovery of new drugs, history and development of chemotherapeutic agents, therapeutic index, LD50 and ED50, naming of (new) drugs.

Elementary idea about drug action: the receptor role, neurotransmitters and receptors, ion channels and their control. Membrane bound enzymes-activation/deactivation. Chemical basis of messenger induced change of shape by the receptor. Design of agonists, antagonists and partial agonists

Drug development: screening of natural products, isolation and purification, structure determination, structure-activity relationships (SAR), synthetic analogues, isosteres and bioisosteres, concept of lead compounds.

Brief overview of pharmacokinetics and pharmacodynamics, concept of prodrug and synergism.

**SECTION B**

**Synthesis, General Mode of Action and Medicinal Uses of Important Drugs in the Following Categories**.

Antineoplastic Agents: Mechlorethamine, Chlorambucil, cyclophosphamide, carmustine, aminopterin, 6-mercaptopurine, paclitaxel (synthesis of paclitaxel excluded)

Antimalarials:Chloroquine, primaquine, chloroguanide, pyrimethamine

Analgesics, Antipyrics and Antiinflammatory agents: Morphine and related compounds (codeine and heroin), meperidine, methadone, aspirin, acetaminophen, indomethacin, phenylbutazone, mefenamic acid, ibuprofen, diclofenac, naproxen, celecoxib.

Antifertility agents: Ovulation inhibitors and related hormonal contraceptives - norethindrone, norethynodrel, estradiol, mestranol, non hormonal contraceptive- centchroman (synthesis of all the drugs excluded).

Cardiovascular Drugs: Calcium channel blockers and β-blockers: sorbitrate, diltiazem, atenolol and verapamil.

AIDS and drugs against HIV: HIV infection to the system, structure and mode of action of important drugs against HIV (nucleoside reverse transcriptase inhibitors) - AZT, ddI, ddC, d4T and 3TC (synthesis only of AZT).

**SECTION -C**

**Antibiotics**

Cell wall biosysnthesis and protein synthesis inhibitors: Penicillins and semi-synthetic penicillins. synthesis, structure elucidation and medicinal uses of penicillin G, problems of sensitivity to acids, β-lactamases and narrow spectrum of activity, solving these problems leading to the development of penicillin V, oxacillin, cloxacillin, ampicillin, amoxycillin, carbenicillin and carfecillin.

Cephalosporins - Discovery, structure elucidation and synthesis of cephalosporin-C.

**SECTION -D**

**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, stereochemistry, synthesis and biosynthesis of the followings: Ephedrine, (+)-Coniine, Nicotine, Quinine and Reserpine.

**Books Suggested:**

1. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, Ed. Robert F. Dorge.
2. Burger's Medicinal Chemistry and Drug Discovery Vol-I Ed. M.E. Wolf, John Wiley.
3. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.
4. Organic Chemistry Vol.-2 I.L. Finar, ELBS.
5. Natural Products: Chemistry and Biology Significance, J.Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Longman, Essex.

**Or**

**M.Sc. Chemistry Semester IV**

**Pharmaceutical Chemistry Special-III (CHEM-401)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION-A**

**Mechanistic and biosynthetic approach to plant secondary metabolites:**

Acetate-malonate pathway: Biosynthesis of plant fatty acids, biosynthesis and oxidation of ricinoleic acid). Polyketides: Biosynthesis of 6-methylsalicyclic acid, pencillic acid, griseofulvin

Acetate- mevalonate pathway: Biosynthesis of psoralen, gibberellic acid, cholesterol, conessine

Shikimic-acid pathway: Biosynthesis of chlorogenic acid and cichoriin, Cyanin, Quercetin,

Biosynthesis of Porphyrins

**SECTION-B**

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, biosynthesis and biological importance of the following: Ephedrine, (+)-Coniine, Nicotine, Quinine and Reserpine.

Carotenoids; Structure, synthesis and biogenesis of β-carotene and Vitamin-A

**SECTION – C**

Carbohydrates: Introduction, stereoisomerism, mutarotation of monosaccharides, ring structure of glucose, structure elucidation, of disaccharides, sucrose, maltose, lactose, polysaccharides, starch, glycosides, general structure elucidation

Terpenes

General introduction, isoprene rule, isolation of terpenes, General methods of structure determination of terpenes, structure elucidation of citral, menthol and camphor

**SECTION – D**

Steroids: Isolation, nomenclature, structural elucidation with special reference to Cholesterol, ergosterol and cardiac glycosides

Methods for the following conversions:

1. Cholesterol → Testosterone
2. Cholesterol → Progesterone

Porphyrins

Structures elucidation of chlorophyll, General structural features of haemoglobin (not structure elucidation).

**Books Suggested:**

1. Organic Chemistry, Vol 2, I. L. Finar, ELBS.
2. Natural Products: Chemistry and Biology Significance, J.Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Longman, Essex.

**M.Sc. Chemistry Semester IV**

**Pharmaceutical Chemistry Special-IV (CHEM-402)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION – A**

**Drug Design**

Introduction, Procedure followed in drug design-Screening of natural compounds, isolation, purification, structure determination, Search for lead Compounds, Molecular Modification of Lead Compound, prodrugs- utility, drug latentiation, carrier linked and bioprecursor prodrugs, Prodrugs of compounds containing alcohols, carboxylic acids, amines and carbonyl groups, drug synergism, hard and soft drugs. Structure-Activity Relationship (SAR), isosterism, Bioisosterism, Factors affecting Bioactivity, Theories of Drug Activity; Occupancy theory, Rate theory, Induced Fit theory

**SECTION – B**

Quantitative structure-activity relationships (QSAR)- Development of QSAR, Physicochemical parameters- Lipophilicity parameter, Polarizability, Electronic parameter, Ionization Constants, steric Parameters- Taft’s steric factor, molar refractivity, Verloop steric parameter, chelation parameters, Surface activity parameter, redox potential, hansch analysis, Craig plot, Topliss Scheme, Free-Wilson Approach

Co-Enzyme Chemistry

Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD+, NADP+, FMN, FAD, Mechanisms of reactions catalyzed by the above cofactors

**SECTION – C**

**Combinatorial Chemistry**

Introduction to Combinatorial chemistry, Combinatorial approaches, solid phase techniques, liquid phase synthesis, Chemical Peptide and small molecular libraries, split synthesis and parallel synthesis- applications and methodology, deconvolution, Combinatorial Organic Synthesis, High throughtput screening (HTS), Planning and designing a combinatorial synthesis-scaffolds, X-ray crystallography, docking procedures.

**SECTION – D**

**Enzymes**

Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labeling. Enzyme kinetics, Michaelis-Menten and Lineweaver-Burk plots. Enzyme inhibitors- reversible, irreversible, suicide substrates.

Mechanism of Enzyme Action

Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion

**Books Suggested:**

1. An Introduction to Medicinal Chemistry, G. L. Patrick, Oxford University Press.
2. Medicinal Chemistry, An Introduction, G. Thomas, John Wiley
3. Principles of Biochemistry, A. L. Lehninger, Worth Publishers.
4. Outlines of Biochemistry, E. E. Conn and P. K. Stumpf, John Wiley.
5. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, T. Palmer, Woodhead Publishers.

**M.Sc. Chemistry Semester IV**

**Pharmaceutical Chemistry Special-V (CHEM-403)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

# SECTION-A 15 Hrs

**Intellectual Property Rights**

Intellectual Property Rights- A brief introduction

GATT, WTO, TRIPs – Its scope and options, the changing R & D processes and IPR, The IPR tool kit

Patents- Definition, types, the patenting process, patent cooperation treaty, conditions to be satisfied by an invention to be patentable, features

Intellectual Property Protections of Living Species- Compatibility between conventions, protecting inventions in biotechnology, protections of traditional knowledge, biopiracy and documenting traditional knowledge, some case studies.

# SECTION-B 15 Hrs

Exercising and Enforcing of Intellectual Property Rights- Rights of an IPR owner, licensing agreements, criteria for patent infringement, case studies of patent infringement, IPR – a contract, unfair competitions and control, provisions in TRIPs, some case studies.

Patent Laws- Introduction, Salient features of “The Patents Act 1970” , “The Patent Rules 2003” and “The Patent Rules 2005”

Role of Patents in the Pharmaceutical Industry-Recent changes in IPR laws impacting pharmaceutical industry, intellectual cooperation in the pharmaceutical industry, some case studies

# SECTION-C

Drug & Cosmetic Act with special reference to schedule Y and M.

Clinical trials & Good clinical practices (GCP), guidelines and related management- GCP guidelines, principles of ICH GCP, ethical principles related to GCP, clinical trials, SOPs, regulation: obtaining clinical trial permission, application for permission, report: clinical trial report, trial management: data monitoring committee (DMC).

**SECTION-D**

Quality control and Quality Assurance: Requirements of GMP, cGMP, GLP, ISO-9000, regulatory requirements of drugs and pharmaceutical (USFD-NDA/ANDA), total quality management (TQM) Concept.

Stability testing of new drug substances and products: Drug substance – criteria, storage conditions, long term testing, accelerated testing, frequency, evaluation, labelling; Drug product – Selection of batches criteria, specification, conditions of storage and testing, Calculation of shelf life and expiry date of products

**Books Suggested:**

1. P.B. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, Tata            Mc Graw Hill (2001)
2. Steve Smith, The Quality Revolution, 1st ed., Jaico Publishing House (2002).
3. Lippincott Williams & Wilkins, The Science and Practice of Pharmacy, vol. I & II,        21st edition, Remington, Wolters Kluwer Health (India) Pvt. Ltd., New Delhi        (2005).
4. Arun Bhatt, Clinical Trials and Good Clinical Practice in India, 1st edition, D.K.         Publications, Mumbai (2006).

**M.Sc. Chemistry Semester IV**

**Pharmaceutical Chemistry Special-VI (CHEM-404)**

**Credits-4**

**Time: 3 Hrs**

**Max. Marks: 60+20(IA)**

**Note:** Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt five questions in all selecting at least one question from each section. All questions carry equal marks.

**SECTION-A**

Heat Transfer: Introduction, modes of heat transfer, Fourier's law of heat flow, thermal conductivity, steady state conduction. Equipments: Finned tube (extended surface) heat exchanger, plate heat exchanger, spiral heat exchanger, scraped heat exchanger and air cooled heat exchanger.

Distillation: Introduction, vapour – liquid equilibrium, partial vaporization, partial condensation, volatility, relative volatility, methods of distillation for two component systems–fractional distillation, azeotropic distillation, steam distillation, extractive distillation.

Filtration: Introduction, classification of filters, plate & frame filter presses, candle filter, filter media, filter aids, washing of filter cakes, filtration theory – constant pressure filtration, constant rate filtration, filtration cycle, centrifuges, batch top driven centrifuge, batch under driven centrifuge, disk type centrifuge.

**SECTION-B**

Drying: Introduction, rate of drying, constant rate period, critical moisture content, falling rate period, equilibrium moisture, free moisture, bound and unbound moisture, drying equipments – tray dryers, drum dryers, rotary dryers, spray dryers, flash dryers.

Crystallization: Introduction, supersaturation, modes of generation of supersaturation, nucleation, primary nucleation, secondary nucleation, crystal growth, L law of cyrstal growth, growth rate and grouth coefficients, crystallisation equipments – Tank crystallizers, circulating magma – vaccum crystallizers, circulating liquid evaporator crystallizers.

Fluid Flow: Introduction, Newtonian and non-Newtonian fluids, viscosity, effect of temeprature on viscosity, kinematic viscosity, laminar and turbulent flows, Reynolds number, Bernoullis equation without friction, orificemeter, venturimeter, pumps, types of pumps

**SECTION-C**

Reactors: Introduction to reactor design, ideal batch reactor, space time, space velocity, steady state mixed flow reactor, steady state plug flow reactor Chemical process development: Process design development, types of design process development, plant location, plant layout, plant operation and control, material handling.

Safety and loss preventation : Health and safety hazards, source of exposure, exposure evaluation, exposure hazard control, fire and explosion hazard, safety regulation, loss preventation.

**SECTION-D**

Chromatographic techniques: Principles of separation, applications and recent trends in chromatography:

Column, Paper, Thin layer and gas chromatography, HPLC, HPTLC, Size exclusion chromatography, Affinity chromatography, Ion-exchange chromatography

Biological Standardization: Bioassay and Radioimmunoassay: ELISA, radioimmunoassay of drugs like Digitalis & insulin

**Books Suggested:**

1. Cooper and Gunn’s Dispensing for Pharmaceutical Students, Ed.S.J. Carter, CBS publishers & Ddistributors.
2. Cooper and Gunn’s, Tutorial Pharmacy.
3. “Theory and Practice of Industrial Pharmacy” L.Lachman, Lea & Fabiger.
4. “A textbook of Pharmaceutical Chemistry” Bentley and Drivers, Oxford Press.
5. ISO Reports.
6. Indian Pharmacopoeia, Govt. of India, Ministry of Health and Family Welfare.
7. British Pharmacopoeia.
8. Indian Patent Act.
9. Sharma P.P., GMP, Vallabh prakashan.
10. “Remington’s Pharmaceutical science”. A.Osol Mack Publishing company.
11. Introduction to Chemical Engineering, Bedger et al., McGraw Hill.
12. Unit Operations of Chemical Engineering, Mc. Cable & Smith
13. Handbook of Chemical Engineering by parry.
14. Principles and methods of Pharmacy management, Harrg, A.; smith Loa & Febiger, Philadelphia.
15. Materials management by Gopalkrishna, Prentice Hall, India.
16. Unit Operations of chemical Reactor Design and Operation. W.d. Mc Cabe. J.C. Smith & P. Harriott,”
17. “Chemical Reactor Design and Operatiof” K.R. Westreterp, W.P. M. Swaaij, AACM, Beanackers.
18. Introduction to chemical Engineering, Mc Graw Hill W.L.Badger and J.T. Benchard,.
19. Max peters, “Elementary chemical Engineering”.
20. “Chemical Process Development”-Pt.l. D.G. Joreden,
21. “ Plant Design and Economics for chemical Engineers” M.S. Peters & K.D. Timmerhans,.

**M.Sc. Chemistry Semester IV**

**Inorganic Special Practical III & IV**

**(CHEM 405 & CHEM 406)**

**Credits- 4+4**

**Time: 12Hrs**

**(Four sessions, spread over 2 days to all papers)**

**Max. Marks: 60+20(IA) & 60+20(IA)**

**Inorganic Special Practical III (CHEM-405)**

1. **Quantitative analysis:**

Determination of triple elements in the mixtures, ores, alloys etc. by available analytical techniques.

**I** Volumetrically

**II** Gravimetrically

**III** Instrumentation methods

**Experiment Marks: 40**

**Lab record & Viva-voce Marks: 10+10**

**Inorganic Special Practical IV (CHEM-406)**

**1**  Determination of any one metal ion by volumetric method (Complexometric titration).

Ca2+, Mg2+, Zn2+ , Cu2+ etc.

**2** Preparation of some inorganic compounds and their spectral studies.

Tris(acetyl-acetonato) manganese (III)

Tris(acetyl-acetonato) cobaltate (III)

Preparation of Ferrocene

Tris thioureacopper(I) sulfate

Tris(acetylacetonato)chromium(III)

**Experiment Marks: 40**

**Lab record & Viva-voce Marks: 10+10**

**Books Suggested:**

1. A Text Book of Quantitative Analysis: A. I. Vogel, ELBS, London.
2. Inorganic Preparations: W. G. Palmer.

**Or**

**M.Sc. Chemistry Semester IV**

**Physical Special Practical III & IV**

**(CHEM 405 & CHEM 406)**

**Credits- 4+4**

**Time: 12 Hrs**

**(Four sessions, spread over 2 days to all papers)**

**Max. Marks: 60+20(IA) & 60+20(IA)**

### Physical Special Practical – III (CHEM 405)

**pH-metry**

1. Preparation of buffer solution of various pH and the determination of their pH values.
2. pH-titratioins of: (i) Acetic acid vs. NaOH, (ii) hydrochloric acid vs. NaOH, (iii) acetic acid vs. ammonium hydroxide and (iv) HCl vs. NH4OH.
3. Determination of the degree of hydrolysis of aniline hydrochloride.
4. To find dissociation constants of weak acids.
5. Determine the Hammett constant of a given substituted benzoic acid by pH measurements.

# Chemical Kinetics

1. Determination of velocity constant of the reaction of ethyl acetate with NaOH and activation energy and temperature coefficient of the reaction.
2. Determination of the velocity constant and energy of activation of the reactions between H2O2 and HI.
3. Investigation of the reaction between acetone and iodine (with respect to H+, I2 and acetone).
4. Determination of the order and velocity of the reaction between potassium persulphate and potassium iodide.
5. Study the rate of reaction between ethyl bromoacetate and sodium thiosulphate kinetically.

**Experiment Marks: 40**

**Lab record & Viva-voce Marks: 10+10**

### Physical Special Practical – IV (CHEM 406)

**Polarography**

1. To determine dissolved oxygen in aqueous solution of organic solvent.
2. Determination of half wave potentials of some cations in aqueous and in non-aqueous solutions.
3. Determination of half wave potentials of ions in mixtures.
4. Amperometirc titrations involving: (i) Pb(NO3)2 vs. K2Cr2O7 and   
   (ii) Pb(NO3)2 vs. K2SO4.

## Interferrometry

1. Determination of speed of sound of pure liquids/mixtures using interferrometer.

**Flame Photometry**

1. Determination of Na+, K+ Ca2+ and Mg2+ in tap water, juice, electrical etc.

**Dielectric Constant and Dipole Moment**

1. Determination of dielectric constants of some organic liquids and composition of unknown mixtures.
2. Determination of dipole moments of some organic liquids.

**Data-Handling/Representation**

1. Using origin-Lab draw data in different styles of graphs.
2. Linear Curve fitting and calculation of regression coefficient using EXCEL worksheet.
3. Calculate activation energy using /thermal analysis data by single/multiple heating rate methods using EXCEL worksheet.

**Note:** Any experiment may be introduced/deleted in the practical class based on the availability/non-availability of the instruments/chemicals.

**Experiment Marks: 40**

**Lab record & Viva-voce Marks: 10+10**

## Books Suggested

1. Practical Chemistry, A.M. James and F.E. Pricherd, Longman.
2. Practical Physical Chemistry, B.P. Levitt and Zindley’s, Longman.
3. Practical Physical Chemistry, S.R. Palit and S.K. De, Science Book Agency.
4. Experimental Physical Chemistry, R.C. Das and B. Behra, McGraw Hill.

5. Experiments in Physical Chemistry, Shoemaker and Gailand McGraw Hill.

6. Systematic experimental Physical Chemistry, T.K. Chandershekhar & S.K. Rajbhoj

7.   Experimental Physical Chemistry, V.D.Athawale and Parul Mathur,       New Age International.

**Or**

**M.Sc. Chemistry Semester IV**

**Organic Special Practical III & IV**

**(CHEM 405 & CHEM 406)**

**Credits- 4+4**

**Time: 12 Hrs**

**(Four sessions, spread over 2 days to all papers)**

**Max. Marks: 60+20(IA) & 60+20(IA)**

### Organic Special Practical – III (CHEM 405)

1. **Qualitative Analysis**: Separation of components of a binary (liquid-liquid, liquid-solid or solid-solid) organic mixture using physical and chemical methods and characterization of the components with the help of chemical analysis
2. Spectroscopic confirmation of the binary mixtures using IR and NMR (IR & NMR spectra will be provided).

**Experiment Marks: 40**

**Lab record & Viva-voce Marks: 10+10**

### Organic Special Practical – IV (CHEM 406)

**1.**  **Colorimetric determination of the followings**: Carbohydrates, ascorbic acid, amino acids, proteins, cholesterol, urea.

2. **Extraction of organic compound from natural products**: Any one of the followings:–

Caffeine from tea leaves

Isolation of β-carotene from carrot

Isolation of limonene from citrus rind

Isolation of nicotine from tobacco

Isolation of lactose from milk

Isolation of Casein from milk

**Experiment Marks: 40**

**Lab record & Viva-voce Marks: 10+10**

**Books Suggested:**

1. "Elementary Practical Organic Chemistry by Arthur I.Vogel Longmans, Green and Co. 1958.
2. "An Introduction to Practical Biochemistry", by David T. Plummr, Tata McGraw Hill Publishing Company, Ltd., N. Delhi, 1988.
3. Practical Organic Chemistry' by Mann and Saunders.
4. Text Book of Vogel's Practical Organic Chemistry by Longman Group, B.S. Furness et al., Ltd.
5. "Experiments in Organic Chemistry" Louis F. Fieser O.C. Heath and Company Boston, 1955.
6. "Organic Synthesis" Collective Vol. I.
7. Laboratory Manual in Organic Chemistry' by R.K. Bansal, Wiley Eastern Ltd., New Delhi-1980.
8. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.)., Ltd. London, 1975).
9. "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.
10. "A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis" by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966.
11. "Elementary Practical Organic Chemistry" by Arthur I. Vogel, CBS Publishers & Distributors.
12. "A Guide to spectroscopy in Organic Chemistry' by PAVY
13. "Spectrometric Identification of Organic Compounds", Fifth Ed., R.M. Silverstein, G.S. Bassler and T.C.Morrile, John Wiley and Sons, New York.
14. "Organic Spectroscopy', 3rd Ed., by William Kamp. John Wiley & Sons.
15. "Spectroscopic" Methods in Organic Chemistry, D.H. William & Ian Fleming.
16. Vogel's Text Book of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.)., Ltd. London, 1975).
17. "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.

**Or**

**M.Sc. Chemistry Semester IV**

**Pharmaceutical Special Practical III & IV**

**(CHEM 405 & CHEM 406)**

**Credits- 4+4**

**Time: 12Hrs**

**(Four sessions, spread over 2 days to all papers)**

**Max. Marks: 60+20(IA) & 60+20(IA)**

**Pharmaceutical Special Practical III (CHEM 405)**

1. Separations and identification of components of binary organic mixture using chemical methods and spectral data.
2. Applications of IR, UV, 1HNMR, 13C NMR, Mass spectroscopy in drug analysis.
3. Chromatographic separations: TLC, paper and column.

**Experiment Marks: 40**

**Lab record & Viva-voce Marks: 10+10**

**Pharmaceutical Special Practical IV (CHEM 406)**

1. Determination of specific rotation of ibuprofen and determination of its percentage in the unknown sample.
2. Volumetric determination of ibuprofen in the given tablet.
3. Spectrophotometer determination of aspirin content in the soluble aspirin table.
4. Spectrophotometer determination of Paracetamol in the tablet.
5. Determination of Vitamin C in given formulation.
6. Determination of phenobarbilone in the given cough syrup.
7. To perform I.P. monograph of tablet
8. To perform I.P. monograph of hard gelatine capsule.
9. Determination of Chloramphenicol in given capsule.

**Experiment Marks: 40**

**Lab record & Viva-voce Marks: 10+10**

**Books Suggested:**

1. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.)., Ltd. London, 1975).
2. "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.
3. "A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis" by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966.
4. "Elementary Practical Organic Chemistry" by Arthur I. Vogel, CBS Publishers & Distributors.
5. "A Guide to spectroscopy in Organic Chemistry' by PAVY
6. "Spectrometric Identification of Organic Compounds", Fifth Ed., R.M. Silverstein, G.S. Bassler and T.C.Morrile, John Wiley and Sons, New York.
7. "Organic Spectroscopy', 3rd Ed., by William Kamp. John Wiley & Sons.
8. "Spectroscopic" Methods in Organic Chemistry, D.H. William & Ian Fleming.
9. Vogel's Text Book of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd.

**OPEN ELECTIVE PAPERS OFFERED BY CHEMISTRY DEPARTMENT FOR M.Sc. STUDENTS OF DEPARTMENT OF PHYSICAL SCIENCES OTHER THAN CHEMISTRY DEPARTEMNT**

**M.Sc. Physical Sciences.**

**Open elective paper-01 (OE-201, 2nd Semester)**

**Environmental and Analytical chemistry**

**Credits-2**

**Time: 2 Hrs**

**Max. Marks: 35+15(IA)**

**Note:** Eight questions will be set, four from each of the sections. The candidates are required to attempt five questions in all selecting two question from each section. All questions carry equal marks.

**SECTION A**

**Hydrosphere**

Hydrological cycle of water, Water 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.

**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 and their effect, air pollution controls and their chemistry.

**SECTION B**

**Thermoanalytical methods:**

Introduction, Thermogravimetric analysis (TGA), Derivative Thermogravimetric analysis (DTGA), factors affecting TGA and applications, Differential thermal analysis (DTA): theory, factors affecting DTA and applications.

**Chromatography**

Introduction, Classification of chromatographic methods; Adsorption and Partition Chromatography (Column, Paper and Thin Layer Chromatography), ion exchange chromatography: Principles and Applications.

**Analysis of Food**

Importance of Food analysis, Determination of approximate composition: Moisture, Fat, Protein, Fiber, Carbohydrate etc.

**Books Suggested:**

1. Environmental Chemistry; A. K. De, Wiley Eastern.
2. Environmental Pollution Analysis; S. M. Khopkar, Wiley Eastern.
3. Environmental Chemistry; S. K. Banerji: Prentice – Hall.
4. Dynamics of Chromatography Part I; J. C. Gidding; Dekker, New York.
5. Instrumental methods of Analysis; L. L. Merits, R. H. Willard and J. A. Dean; Van Nostrand-Reinhold.

**M.Sc. Physical Sciences.**

**Open elective paper-02 (OE-301, 3rd Semester)**

**Credits-2**

**Time: 2 Hrs**

**Max. Marks: 35+15(IA)**

**Note:** Eight questions will be set, four from each of the sections. The candidates are required to attempt five questions in all selecting two question from each section. All questions carry equal marks.

**SECTION A**

**Polymer Chemistry 15 Hrs.**

Polymer basic concepts: monomers, degree of polymerization, classification of polymers, types of polymerization, Concept of no. average molecular weight and mass average molecular weight, Methods of determining molecular weights, concept of kinetic chain length Polydispersity index, kinetics of polymerization (addition and chain polymerization) Thermal properties of polymers, Flame retardant polymers, Flame retarding Thermoplastics and Thermosets, physical properties of polymers (glass transition temperature, crystalline melting point), factors affecting Tg  and Tm Polymer composites, its classification, polymer composites using filler reinforcement, Biocomposites, application of biocomposites in automobiles and in construction materials. Polymer nanocomposites, Properties of polymer nanocomposites, application of polymer nanocomposites

**SECTION B**

**Medicinal Chemistry 15 Hrs.**

Concept of drug and drug development, lead compound and lead modification, prodrugs and soft drugs, an elementary idea of structure reactivity relationship (SAR), Elementary idea about drug action: the receptor role, neurotransmitters and receptors, ion channels and their control, membrane bound enzymes-activation/deactivation, chemical basis of messenger induced change of shape by the receptor,

Definition, uses and side effects of the following categories of drugs:

Antipyretics, analgesics & anti-inflammatory agents (paracetamol, asprin, mefenamic acid, ibuprofen and diclofenac), antimalarial (Chloroquine, chloroguanide), Anticancer (Chlorambucil, cyclophosphamide), Cardiovascular drugs (sorbitrate, diltiazem), Antifertility agents (introduction to hormonal and nonhormonal contraception only).

**Books Suggested:**

1. Polymer Chemistry, Billmayer

2. Polymer Chemistry, Gowarikar

3. Principles of Polymerization, Geroge Odian

4. Wilson and Gisvold's Text book of Organic Medicinal and            Pharmaceutical Chemistry, Ed. Robert F. Dorge.

5. Burger's Medicinal Chemistry and Drug Discovery, Vol-I, Ed. M.E.        Wolf, John Wiley.

6. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.