NEP and Learning Outcome-based Curriculum Framework (LOCF)

For

Post Graduate
.....Programme.....
(To be effective from the Academic Session 2022-23)

Department of Chemistry
Gurugram University, Gurugram
(A State Govt. University Established Under Haryana Act 17of 2017)

Table of Contents

1. Background

- The Chemistry Department of Gurugram University, Gurugram, Haryana - India was established in 2020.
- Department has started P.G. Program M.Sc. - Chemistry w.e.f. 2020-2021.
- The vision of the Department of Chemistry is to promote excellence and innovation in teaching an research and to create an academically stimulating atmosphere in to well-integrated system.
- To encourage critical thinking and develop research skill.
- Specialization in Organic chemistry and proposed to be start specialization in Inorganic and Physical Chemistry.
- Intake in First session 2020-22 was 20 Students.
- In Session 2021-23 Intake Increased up-to 40 Students.

2. Programme Outcomes

On completing M.Sc. (Chemistry) Programme, the students shall be able to realize following programme outcomes:

PO	Description
PO-1	Understand the advance concepts of organic, physical, and inorganic, and their application.
PO-2	Execute innovative and critical thinking in chemical sciences, which they have developed from theory classrooms and practical labs.
PO-3	Identify the given chemical problems and analyse them using scientific tools.
PO-4	Interpret the data collected from an experiment.
PO-5	Communicate well with others, make effective presentations, and write scientific reports and documents.
PO-6	Handle analytical techniques such as UV-Vis spectrophotometer, FTIR, Polarimeter, Potentiometer, Colorimeter, Chromatography etc.
PO-7	Understand the major thrust areas in chemical sciences to do their future doctorate and jobs in industries or academia.

3. Programme Specific Outcomes

On completing M.Sc. Chemistry Programme, the students shall be able to realize following outcomes:

PSO	Description
PSO-1	The detailed functional knowledge of theoretical concepts and experimental aspects of chemistry.
PSO-2	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like analytical, synthetic, pharmaceutical etc.
PSO-3	To understand, analyse, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon based- problem in chemical sciences.
PSO-4	Provide opportunity to excel in academics, research or industry.

4. Postgraduate Attributes

- Disciplinary Knowledge
- Creative and Critical Thinking
- Reflective Thinking
- Problem Solving
- Communication Skills
- Research Skills
- Life Skills
- Multicultural Competence
- Moral and Ethical Values
- Life-long Learning
- Global Competence

5. Qualification Descriptors

M.Sc. Chemistry eligibility needs candidates to have minimum 50% marks in their Bachelor degree from a recognized university like B.Sc. (Hons.) in Chemistry/B.Sc.(Pass)/B.Sc.(Life Sciences) with Chemistry as the main subject.

6. Scheme of Programme

Semester – I

Course opted	Course Code	Course title	Course ID	Teaching Scheme			Examination Scheme			Duration of Exam (Hours)	Credit
				L	T	P	Sessional Marks	External Marks	Total		
Core Course	CC101	Inorganic Chemistry-I	CHEM 101	4	0	0	30	70	100	03	4
	CC103	Physical Chemistry-I	CHEM 103	4	0	0	30	70	100	03	4
	CC105	Organic Chemistry-I	CHEM 105	4	0	0	30	70	100	03	4
Core Lab	CC107	Inorganic Chemistry Lab-I	CHEM 107	0	0	6	30	70	100	06	3
	CC109	Physical Chemistry Lab-I	CHEM 109	0	0	6	30	70	100	06	3
	CC111	Organic Chemistry Lab-I	CHEM 111	0	0	6	30	70	100	06	3
General Elective Course	GEC113/ GEC115	Chemistry of Life Sciences/ Mathematics for Chemist	CHEM 113 /CHEM 115	3			25	50	75	03	3
	Total			15	0	18	205	470	675		24

Skill Enhancement	SEC117	*Chemistry of Environmental Science	CHEM 117	3	0	0	25	50	75	03	3

Note:

*Subject offered to other department

Credit requirement for completion of this semester: 24. Credit requirement for completion of programme: 100

Semester – II

Course opted	Course Code	Course title	Course ID	Teaching Scheme			Examination Scheme			Duration of Exam (Hours)	Credit
				L	T	P	Sessional Marks	External Marks	Total		
Core Course	CC102	Inorganic Chemistry-II	CHEM 102	4	0	0	30	70	100	03	4
	CC104	Physical Chemistry-II	CHEM 104	4	0	0	30	70	100	03	4
	CC106	Organic Chemistry-II	CHEM 106	4	0	0	30	70	100	03	4
Core Lab	CC108	Inorganic Chemistry Lab-II	CHEM 108	0	0	6	30	70	100	06	3
	CC110	Physical Chemistry Lab-II	CHEM 110	0	0	6	30	70	100	06	3
	CC112	Organic Chemistry Lab-II	CHEM 112	0	0	6	30	70	100	06	3
General Elective Course	GEC114	*Nanoscience/Skill Development	GEC/114a GEC/114b	3	0	0	25	50	75	03	3
	Total			15	0	18	205	470	675		24

Ability Enhancement Course											
	AEC/116	**Instrumental Analysis	AEC/116	2	0	0	15	35	50	03	2
Lab	AEC/ 118	**Instrumental Analysis Lab	AEC/118	0	0	2	15	35	50	06	2

Note:

*Open elective subject opted from other Department

**Subject offered to other Department

Credit requirement for completion of this semester: 24. Credit requirement for completion of programme: 100

Semester – III

Course opted	Course Code	Course title	Course ID	Teaching Scheme			Examination Scheme			Duration of Exam (Hours)	Credi
				L	T	P	Sessional Marks	External Marks	Total		
Core Course	CC201	Spectroscopic Methods in Chemistry	CHEM 201	4	0	0	30	70	100	03	4
	CC203/209/215	Inorganic/Physical/Organic Chemistry Special-I	CHEM 203/209/215	4	0	0	30	70	100	03	4
	CC205/211/217	Inorganic/Physical/Organic Chemistry Special-II	CHEM 205/211/217	4	0	0	30	70	100	03	4
	CC207/213/219	Inorganic/Physical/Organic Chemistry Special-III	CHEM 207/213/219	4	0	0	30	70	100	03	4
Core Lab	CC221/225/229	Inorganic/Physical/Organic Chemistry Lab Special-I	CHEM 221/225/229	0	0	8	30	70	100	08	4
	CC223/227/231	Inorganic/Physical/Organic Chemistry Lab Special-II	CHEM 223/227/231	0	0	8	30	70	100	08	4
Skill Enhancement Course(s)											
	SEC233	Computer for Chemists	CHEM 233	1	0	1	15	35	50	02	2
	Total			17	0	17	195	455	650		26

Note:

1. Credit requirement for completion of this semester: 26. Credit requirement for completion of programme: 100

Semester – IV

Course opted	Course Code	Course title	Course ID	Teaching Scheme			Examination Scheme			Duration of Exam (Hours)	Credit
				L	T	P	Sessional Marks	External Marks	Total		
Core Course	CC/202/ 206/210	Inorganic/Physical/Organic Chemistry Special-IV	CHEM 202/206/210	4	0	0	30	70	100	03	4
	CC/204/ 208/212	Inorganic/Physical/Organic Chemistry Special-V	CHE 204/208/212	4	0	0	30	70	100	03	4
Core Lab	CC/214/ 218/222	Inorganic/Physical/Organic Chemistry Lab Special-III	CHEM 214/218/222	0	0	8	30	70	100	08	4
	CC/216/ 220/224	Inorganic/Physical/Organic Chemistry Lab Special-IV	CHEM 216/220/224	0	0	8	30	70	100	08	4
Seminar									50		2
Dissertation//Internship/Academic Project/Enterpreneurship											
DIE 226				2	0	6			150		8
	Total			10	0	22	120	280	600		26

Note:

Credit requirement for completion of this semester:26. Credit requirement for completion of programme:10

Syllabus

M.Sc. Chemistry (Four Semesters) Course

Under Choice Based Credit System

M.Sc. Chemistry Semester-I
Inorganic Chemistry-I (CHEM 101)
No. of Credits:4

L T P
4 0 0

Max. Marks: 70+30
Time: 3Hrs

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, relatio between orders of a finite groups and its subgroups. Conjugacy relation an classes.Symmetry elements and symmetry operations, Point symmetry group. Schönflie symbols, representations of groups by matrices (representation for the C_n, C_{nv}, C_{nh},D_{nh} etc groups to be worked out explicitly). Character of a representation, reducible and irreducibl representations. The great orthogonality theorem (without proof) and its importance Derivation of character tables of C_{2v}, C_{3v} and D_{2h} Character tables and their use. Molecula asymmetry, dissymmetry and optical activity.

SECTION – B

Metal-Ligand Equilibria in Solution-I: Stepwise and overall formation constants and thei interaction, trends in stepwise constants, factors affecting the stability of metal complexe with reference to the nature of metal ion and ligand, chelate effect and its thermodynami origin, determination of binary formation constants by pH-metry and spectrophotometry.

SECTION – C

Metal-Ligand Equilibria in Solution-II

Substitution reactions in octahedral complexes- Acid hydrolysis, Base hydrolysis, racemization of tris chelate complexes, theories of trans effect with respect to Pt(II) complexes. Brief account of electron transfer reactions, inert and labile complexes.

SECTION – D

Stereochemistry and Bonding in Main Group Compounds

VSEPR Theory, Walsh diagrams (tri-atomic molecules), d_π-p_π bonds, Bent rule an energetics of hybridization

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 π-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 103)
No. of Credits:4

L T P
4 0 0

Max. Marks: 70+30
Time: 3Hrs

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 , 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.

Thermodynamics
Recapitulation of thermodynamic laws. Thermodynamic functions of mixing (free energy, entropy, volume and enthalpy), concept of escaping tendency and chemical potential

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

Statistical Mechanics :

Ensemble averaging, postulates of ensemble averaging. Microcanonical, canonical and grand canonical ensembles, corresponding distribution laws (using Lagrange's method of undetermined multipliers). Distinguishable and Indistinguishable/ Identical Particles. 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. Quantum statistics: Bose-Einstein statistics and Fermi-Dirac statistics, Bose-Einstein condensation & distribution function. Derivation o Fermi-Dirac distribution.

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.

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 105)
No. of Credits:4

L T P
4 0 0

Max. Marks: 70+30
Time: 3Hrs

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 SN^1 and SN^2, 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. SN^i, $SN^{1'}$, $SN^{2'}$ and $SN^{i'}$ 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, biphenyl

(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 stereoselectivereaction.Elementary idea of principle categories of asymmetric synthesis. Cram's rule and its modification, Prelog rule and horeausrule.

Stereochemistry of sugars- C1 and 1C conformations of hexoses, c_2'-endo and c_3'-endo conformation of pentoses, homomorphous sugars, abnormal mutarotation and Δ-2 instability factor.Stereochemistry of decalins.

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
Inorganic Chemistry Practical-I (CHEM 107)
No. of Credits:3

L T P
0 0 6

Max. Marks: 70+30
Time: 6 Hrs

1. **Qualitative analysis:**
   Total five radicals to be given containing two less common metal ions, one insoluble and two aci radicals: $CH_3COO^-, BO_3^{3-}, PO_4^{3-}, CO_3^{2-}, HCO_3^-, NO_2^-, NO_3^-, Cl^-, Br^-, I^-, S^{2-}, SO_3^{2-}, SO_4^{2-}, S_2O_3^{2-}, F^-, C_2O_4^{2-}$
   .
   Less common metal ions – W, Tl, Mo, Se, Ti, Zr, Th, V, U, Ce, Be (two metal ions in cationic an anionic forms)
   Insoluble: Halides (AgCl, AgBr, AgI); Sulphates ($PbSO_4$, $BaSO_4$) and Oxides (Al_2O_3, Cr_2O_3, SnO_2 TiO_2, SiO_2)
2. Cerimetric/Iodometric/Oxidimetry titrations

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

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 an J. Menaham, Longman, London.

M.Sc. Chemistry Semester I
Physical Chemistry Practical-I (CHEM 109)
No. of Credits:3

L T P
0 0 6

Max. Marks: 70+30
Time: 6 Hrs

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

[3] Determine the strength of strong acid by conductometric titration with strong base.

[4] Determine the strength of weak acid by conductometric titration with strong base.

[5] Determine the strength of strong acid and weak acid in a mixture by conductometric titration with strong base.

[6] Study precipitation titration between KCl and $AgNO_3$conductometrically. Determine the strength of given solution of $AgNO_3$.

[7] Determine solubility and solubility product of sparingly soluble salts like $PbSO_4$, $BaSO_4$.

[8] Determine the relative strength of chloroacetic acid and acetic acid by conductivity measurements.

Chemical Kinetics

[9] Study the hydrolysis of methyl acetate in presence of hydrochloric acid.

[10] Study saponification of ethyl acetate by sodium hydroxide solution using same initial concentration of both the reactants.

[11] Study saponification of ethyl acetate by sodium hydroxide solution taking the initial concentration of ester and base to be different.

Adsorption

[12] 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.

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.
   Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill

M.Sc. Chemistry Semester I
Organic Chemistry Practical-I (CHEM 111)
No. of Credits:3

L T P
0 0 6

Max. Marks: 70+30
Time: 6 Hrs

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 ou of the following 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.

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

Books Suggested:

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

M.Sc. Chemistry Semester I
Chemistry of Life Science Paper (CHEM 113)
No. of Credits:3

L T P **Max. Marks: 50+25**
3 0 0 **Time: 3 Hrs**

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.Biologicalmembranes.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) ar 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 ar 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.
6. Corrosion Understanding the Basic, by Joseph R Davis, ASM International

M.Sc. Chemistry Semester I
Mathematics for Chemists (CHEM 115)
No. of Credits:3

L T P
3 0 0

Max. Marks: 50+25
Time: 3 Hrs

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. Data analysis, mean and standard deviation, Absolute and Relative errors

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, Algebrai simplification, Partial differentiation, Exact and inexact differential with their applicatio to thermodynamic principles.

Integral Calculus

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

Differential Equation

Simple differential equations, separable variables, homogeneous equations, exac differential equations, linear differential equations, partial differential equation: 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 Saunde Company.
3. Mathematical Methods for Science Students, G. Stephemen, ELBS.
4. Chemical Thermodynamics, R.C. Reid.

M.Sc. Chemistry Semester I
General Elective paper
Chemistry of Environmental Science (SEC 117)
No. of Credits: 3

L T P
3 0 0

Max. Marks: 50+25
Time: 3 Hrs

Note: Eight questions will be set, four from each of the sections. The candidates are required toattempt five questions in all selecting two questions 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, Chemicaland photochemical reactions in atmosphere, smog formation, oxides of N, C, S and their effect,air pollution controls and their chemistry.

SECTION B

Types of Pollution and their Management, Solid waste Management: Air Pollution; Harmful effects of Air Pollution, Control of Air Pollution. Noise Pollution Harmful effects of noise pollution, control of noise pollution. Global warming, Acid rain, Ozone depletion. Solid Waste Management; Classification of solid waste, Collection, transportation, treatment, and disposal of solid waste, Radioactive and e-waste Economic recovery of solid waste.Sanitary landfill, on site sanitation.

SECTION C

Water Pollution: Water pollution, Harmful effects of water pollution, control of water pollution. Waste Water Management: Treatment & disposal of wastewater. Reuse and saving in use of water, rain water harvesting.

Corrosion: Definition and its significance. Mechanisms of Chemical (Dry) and Electrochemical (Wet) corrosion.Protection from corrosion, Protective coatings cathodic protection, sacrificial anode and modification in designs.

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. Atmospheric pollution, by W Buch, Tata McGraw Hill(TMH)
5. Introduction to Environmental Science, by G Tyler Miller and Scott Spoolman, Cengage Learning.
6. Corrosion Understanding the Basic, by Joseph R Davis, ASM International.

M.Sc. Chemistry Semester II
Inorganic Chemistry-II (CHEM 102)
No. of Credits:4

L T P **Max. Marks: 70+30**
4 0 0 **Time: 3 Hrs**

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 p^2, p^3, d^2 configurations and spin orbit coupling for p^2 arrangement, spectroscopic terms, spectral terms of d^2 to d^8 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 (d^1-d^9 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, magnetic moment calculations spin only. orbital contribution quenching of magnetic moment, 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, structure types, nido, arachano, closoetc structure prediction of boranes using sty formulae, Wades rule, Wades Mingo rules, Isolobal analogy, carboranes, metalloboranes an metallocarboranes. Metal carbonyl and halide clusters, compounds with metal-meta 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 an 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 104)
No. of Credits:4

L T P
4 0 0

Max. Marks: 70+30
Time: 3 Hrs

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 Hermitianoperators.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, calculation of various average values, 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-growtl polymerization.Comparison between step-growth and chain polymerization. Molecular mass o polymers:Significance of average molecular mass.Poly-dispersity, Molecular mass distribution curves Determination of molecular mass by viscosity method. Electrically conducting polymers, Flame retardan polymers, Liquid crystal polymers.

SECTION-D

Nuclear and Radiochemistry

Nuclear stability and binding energy. Mass and binding energy, Nuclear fission anc nuclear fusion, fission cross section, chain fission, fission product and fission yield Interaction of nuclear radiation with matter, Detectors (Proportional, Geiger-Muller anc Scintillation counters) and their principles. Units for measuring radiatio 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 Easterr 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, GerogeOdian.
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 106)
No. of Credits:4

L T P
4 0 0

Max. Marks: 70+30
Time: 3 Hrs

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 - S_E2 and S_Ei. The S_E1 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, pincolpinacolone 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, type

of free radical reactions, halogenation including allylic halogenation (NBS), auto-oxidatior decomposition of azo compounds and peroxides, coupling of alkynes, homolytic aromati substitution, Sandmeyer reaction and Hunsdiecker reaction.

Addition to C-C Multiple Bond General mechanistic considerations,Mechanism of addition of hydrogen halide, H_2O, halogens, HO and mercuric salt to alkenes and alkynes. Hydroboration, formation of C-C bonds vi 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 t 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. Addition of Grignard reagents.Reformatsky reaction, Wittig reaction, Claisen condensatior Dieckman reaction, Aldol condensation, Knoevenagal condensation, Perkin reactior Cannizzaro reaction, Benzoin condensation, Mannich Reaction, Robinson-Mannich reactior Ester hydrolysis, aminolysis of esters, amide hydrolysis.

Books Suggested

1. Advanced Organic Chemistry Reactions, Mechanism and Structure, Jerry March, Joh 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 Universit 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 Academi & 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 108)
No. of Credits:3

L T P **Max. Marks: 70+30**
0 0 6 **Time: 6 Hrs**

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.

I. $Hg[Co(SCN)_4]$
II. $[Cu(NH_3)_4]SO_4.H_2O$
III. Prussian Blue and Turnbull's Blue
IV. $Na[Cr(NH_3)_2(SCN)_4]$
V. $Mn(acac)_3$
VI. $[Ni(NH_3)_6]Cl_2$
VII. $VO(acac)_2$

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

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 110)
No. of Credits:4

L T P
0 0 6

Max. Marks: 70+30
Time: 6 Hrs

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

4. Determine the strength of strong acid by pH-metric titration with strong base.
5. Determine the strength of weak acid by pH-metric titration with strong base.
6. Determine the dissociation constant of acetic acid using pH-meter.

Distribution Law

7. Determine the partition coefficient of iodine for distribution between chloroform an water.
8. Determine distribution coefficient of ammonia between chloroform and water.
9. Determine the formula of the complex formed between copper (II) ion and ammoni using distribution method.

Polarimetry

10. Study the variation of angle of optical rotation with the concentration of any optical active substance (sucrose or glucose) and thereafte determine the unknown concentration of the same substance in give solution.
11. Determine the specific and molecular rotation of sucrose or glucose a a number of concentrations.
12. Study the kinetics of inversion of cane-sugar (sucrose) in presence of an acid.

Refractometry

13. Determine the refractive index of simple organic liquids like methyl acetate, ethy acetate, methanol, ethanol, n-hexane, chloroform.
14. Determine the refractivity and molar refractivity of some organic liquids like methy acetate, ethyl acetate, methanol, ethanol, n-hexane, chloroform.
15. Determine the molar refractivities for CH_2, C, H and Cl.
16. Study the variation of refractive index with concentration for KCl solution an 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.

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 112)
No. of Credits:4

L T P
0 0 6

Max. Marks: 70+30
Time: 6 Hrs

Organic Mixture Analysis
Demonstrations of separation of binary mixtures: usingH_2O, HCl, NaOH, $NaHCO_3$, Ethe or other reagent as may be necessary along with required conditions for their use.
Systematic identification of organic mixtures: separation and identification of binar mixtures including derivatives, in the formation of individual components.
Any other experiment be added as per requirement

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

Books Suggested:

1. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke an revised by B.Maynes, Edward Arnold (Pub.)., Ltd. London, 1975).
2. "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnol (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. Furnerset. al., Longma Group Ltd.

Ability Enhancement Course (AEC-116, II Semester)
Instrumental Analysis
No. of Credits-2

L T P
2 0 0

Max. Marks: 35+15
Time: 3 Hrs

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

Ultraviolet and Visible Spectroscopy:
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.

Infrared Spectroscopy:
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.

SECTION B

Nano-particle/material Characterization: Principles of electron microscopy, Scanning Electron Microscopy (SEM), Strengths and limitations of Scanning electron microscopy, Transmission Electron Microscopy (TEM). Atomic Force Microscopy (AFM).
Thermal Methods of Analysis: Thermo gravimetric Analysis (TGA), principle of TGA, and Differentia Scanning Calorimetry (DSC).

Books Suggested:

1. Introduction to Spectroscopy- A Guide for Students of Organic Chemistry, 2 nd 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, Johı Wiley.
3. Principles of Instrumental Analysis, Skoog , Douglas A., F. James Holler and Timothy Nieman, Fiftl Edition. New York. 1998.
4. Thermal Analysis. W.W. Wandlandt, Wiley, New York, 1986.
5. Spectroscopy of Organic Compounds by P.S. Kalsi, Wiley Estern, NewDelhi.
6. Thermal Analysis, A. Blazek, Van Nostrand Reinhold, London, 1972.
7. "Nanomaterials Chemistry: Recent Developments and New Directions", ed. by C.N.R. Rao, A. Muller & A.K. Cheetham (Eds.), Wiley-VCH, 2007
8. Nanoscale Materials by Luis M., Liz-Marzan and Prashant V.Kamat, Kluwer Academic Publishers (Boston) 2003.

Ability Enhancement Course (AEC-118, II Semester)
Instrumental Analysis Lab
No. of Credits-2

L T P
0 0 2

Max. Marks: 35+15
Time: 6 Hrs

Hand-on Experiments of following Instruments-

1. UV-Visible Spectrometer.
2. IR Spectrophotometer.
3. TGA
4. DSC
5. SEM

Books Suggested:

1. A Text Book of Quantitative Analysis: A. I. Vogel, ELBS, London.
2. Thermal Analysis, A. Blazek, Van Nostrand Reinhold, London, 1972.
3. "Nanomaterials Chemistry: Recent Developments and New Directions", ed. by C.N.R. Rao, A. Mull & A.K. Cheetham (Eds.), Wiley-VCH, 2007
4. Concept of Modern Catalysis and Kinetics, I. Chorkendorff and J. W. Niemantsverdriet

M.Sc. Chemistry Semester III
Spectroscopic Methods in Chemistry (CHEM-201)
No. of Credits:4

L T P **Max. Marks: 70+30**
4 0 0 **Time: 3 Hrs**

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 attemp five questions selecting at least one question from each section and compulsor question. All questions carry

Section A

Ultraviolet and Visible Spectroscopy
Introduction and understanding of UV phenomenon, Various electronic transitions (185-80(nm), Beer-Lambert law, effect of solvent on electronic transitions, ultraviolet bands fo carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. Fieser Woodward rules for conjugated dienes and carbonyl compounds.

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

Principle and Theory, Characteristic vibrational frequencies of alkanes, alkenes, alkynes aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrationa frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides lactones, lactams and conjugated carbonyl compounds).Effect of hydrogen bonding an solvent effect on vibrational frequencies, overtones, combination bands and Ferm resonance.FT-IR.

SECTION B

Nuclear Magnetic Resonance Spectroscopy
^{1}H-NMR
Basic principles of NMR, theory of nuclear magnetic resonance, spin lattic relaxation, spin-spin relaxation, experimental techniques chemical shift, the δ-scale o chemical shift, the origin of shielding constant, pattern of coupling, origin of spin-spi coupling, Chemical shift values and correlation for protons bonded to carbon (aliphatic olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxyli acids, amines, amides &mercapto), complex spin-spin interaction between two, three, fou and five nuclei (first order spectra), spin system-Pople
Karplus curve - variation of coupling constant with dihedral angle. Fourier transforr technique .

Carbon-13 NMR Spectroscopy

General considerations, Comparison of ^{1}H-NMR and ^{13}C-NMR, Proton coupled and proton decoupled ^{13}C-NMR, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants. Introduction of ^{31}P-NMR and ^{19}F-NMR

SECTION C

Mossbauer Spectroscopy

Basic principles, spectral parameters and spectrum display. Application of the technique to the studie of (1) bonding and structures of Fe^{2+} and Fe^{3+} compounds including those of intermediate spin, (2) Sn^{2+} an Sn^{4+} compounds – nature of M-L bond, coordination number, structure and (3) detection of oxidation state.

Vibrational Spectroscopy

Symmetry, shapes and number of IR modes AB_2, AB_3, AB_4, AB_5 and AB_6 (Group theoretic treatment) mode of bonding of ambidentate ligands and diketonato or complexes, application of resonanc Raman spectroscopy particularly for the study of active- sites of metalloproteins.

SECTION D

Mass Spectrometry

Introduction, ion production - EI, CI, FD and FAB, Mass spectral fragmentation o 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-Diel Alder, Hydrogen transfer rearrangement like scrambling, ortho effect, McLaffert rearrangement, fragmentation patterns of hydrocarbons, alcohols, phenols, ether aldehydes, ketones, esters, carboxylic acids, amines, nitro, amides, nitriles.

Composite Problems

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

Books Suggested:

1. Physical methods in Chemistry; R. S. Drago; Saunders, Philadelphia.
2. Fundamentals of Molecular Spectroscopy; C. N. Banwell; McGraw Hill.
3. Introduction to Spectroscopy- A Guide for Students of Organic Chemistry, 2nd Edn By Donald L. Pavia, Gary M. Lampman and George S. Kriz. Saunders Golde Sunburst Series. Harcourt Brace College Publishers, New York.
4. Spectrometric Identification of Organic Compounds, R. M. Silverstein, G. C. Bassle and T. C. Morrill, John Wiley.
5. Application of Spectroscopy of Organic Compounds, J. R. Dyer, Prentice Hall.

6. Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming, Tata McGraw-Hill.
7. Spectroscopy of Organic Compounds by P.S. Kalsi, Wiley Estern, New Delhi.
8. Organic Spectgroscopy by William Kemp, John Wiley.
9. Organic Mass Spectrometry by K.G. Das & E.P. James, Oxford & IBH Publishing Co.
10. Organic Spectroscopy (Principles & Applications) by Jagmohan.

M.Sc. Chemistry Semester III
Inorganic Chemistry Special-I (CHEM 203)
No. of Credits:4

L T P
4 0 0

Max. Marks: 70+30
Time: 3Hrs

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. Subitution 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 o coordinated hydrocarbons: a) Nucleophilic addition and substitution b) Rearrangemen 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 H_2SO_4, BrF_3, N_2O_4 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 205)
No. of Credits:4

L T P
4 0 0

Max. Marks: 70+30
Time: 3 Hrs

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 i organic synthesis

Compounds of Transition Metal-Carbon Multiple Bonds

Alkylidenes, alkylidynes, low valentcarbenes and carbynes- synthesis, nature of bonc structural characteristics, nucleophilic and electrophilic reactions on the ligands, role i organic synthesis

SECTION – B

Transition Metal π-Complexes

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

Fluxional Organometallic compounds

Fluxionality and dynamic equilibria in compound such as η^2-olefin, η^3-allyl and dieny complexes, Carbonyl scrambling

SECTION – C

Homogeneous Catalysis

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

SECTION – D

Thermal Techniques

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

Polarography

General principles, diffusion controlled current, Dropping mercury electrode, Ilkovic 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).

Books Suggested:

11. Mechanism of Inorganic Reactions; F.Basolo and R.G. Pearson, John Wiley and Sons New York.
12. Inorganic Reaction Mechanism; M.L. Tobe; Nelson, Wlaton and Thames
13. Inorganic Chemistry; K.F. Purcell, J.C. Kotz; Holt-Sanders International Editions Philadelphia.
14. The Chemistry of Molten Salts; H. Bloom Benjamin, New York.
15. Principles and Application of Organotransition Metal Chemistry, J.P. Collman, L.S Hegsdus, J.R. Norton and R.G. Finke, University Science Books.
16. The Organometallic Chemistry of the Transition Metals; R.H. Crabtree, John Wiley.
17. Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International
18. Coordination Chemistry; Banerjea; Tata McGraw Hill.
19. Inorganic Chemistry, A Modern Introduction; T. Moeller; John Wiley and Sons.
20. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. McDaniel and J.J Alexander; John Wiley and Sons Inc.
21. Physical methods in Chemistry; R. S. Drago; Saunders, Philadelphia.

M.Sc. Chemistry Semester III
Inorganic Chemistry Special-III (CHEM 207)
No. of Credits:4

L T P
4 0 0

Max. Marks: 70+30
Time: 3 Hrs

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

Transport and Storage of Dioxygen

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

Electron Transfer in Biological Systems

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

Metal Storage Transport and Biomineralization

Ferritin, transferrin, and siderophores

SECTION – B

Metalloenzymes

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

Calcium in Biology

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

Coenzyme vitamin B_{12}, vitamin B_6.

Metals in Medicine

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

SECTION - C

Supramolecular Chemistry

Concepts and language.

a) Molecular recognition: Molecular receptors for different types of molecules includin anionic substrates, design and synthesis of co-receptor molecules and multipl recognition.
b) Supramolecular reactivity and catalysis.

c) Transport processes and carrier design.
d) Supramolecular devices. Some example of self-assembly in supramolecular chemistry

SECTION – D

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.

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. Fundamentals of Analytical Chemistry; D.A. Skoog, O.M. West and F.J. Holler; W.B. Saunders.
4. Instrumental methods of Analysis; L.L. Merrit, R.H. Willard and J.A. Dean; Van Nostrand-Reinhold.
5. Physical methods in Chemistry; R.S. Drago; Saunders
6. Mechanism of Inorganic Reactions; F.Basolo and R.G. Pearson, John Wiley and Sons. New York.
7. Inorganic Chemistry; K.F. Purcell, J.C. Kotz; Holt-Sanders International Editions; Philadelphia. .
8. Principles and Application of Organotransition Metal Chemistry, J.P. Collman, L.S. Hegsdus, J.R. Norton and R.G. Finke, University Science Books.
9. The Organometallic Chemistry of the Transition Metals; R.H. Crabtree, John Wiley.
10. Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International.
11. Coordination Chemistry; Banerjea; Tata McGraw Hill.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
Physical Chemistry Special-I (CHEM 209)
No. of Credits:4

L T P
4 0 0

Max. Marks: 70+30
Time: 3 Hrs

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 variationalmethods.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 hydroge 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 th MO and VB treatments and their equivalence limit.ConfigurationInteraction.Extension c MO theory to other systems- Homonuclear and heteronucleardiatomics, simple polyatomi molecules.

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

SECTION-C

Quantum Mechanics - III

Time-dependent Schrödinger equation, Time-dependent perturbation theory fc photochemical systems.Radiativetransitions.Einsteincoefficients.Quantum mechanical theor of absorption of light by molecules.Transition moment integral.Oscillator strength, rule governing the transition between two energy states.

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,Micellar structure and shape, Micellar aggregation, CMC in non-aqucous media, Thermodynamic parameters of micellization, thermodynamics of micellization-phase separation and mass action models, solubilization, emulsions, micro emulsion, reverse micelles.

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-211)
No. of Credits:4

L T P
4 0 0

Max. Marks: 70+30
Time: 3 Hrs

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, canonic and grand canonical ensembles, corresponding distribution laws (using Lagrange's metho of undetermind multipliers). Maxwell- Boltzmann statistics, Boltzmann distributio derivation of the Boltzmann distribution expression, determination of the Boltzman 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 statistic Fermi-Dirac systems, extreme gas degeneration, slight gas degeneration, electron gas i metals, thermionic emission and comparison of two statistics, non degenerate an degenerate systems.

SECTION – C

Statistical Thermodynamics-I

Partition function and thermodynamic properties, partition function and factorizatio of partition function, translational partition function, translational thermodynamic functio atoms and monoatomic molecules, diatomic molecules, separation of internal partitio function. Rotational and vibrational energies, entropy due to internal degrees of freedon Rotational partition function, rotational partition function for polyatomic molecule vibrational partition function

SECTION-D

Statistical Thermodynamics-II

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.

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

M.Sc. Chemistry Semester III
Physical Chemistry Special-III (CHEM-213)
No. of Credits:4

L T P
4 0 0

Max. Marks: 70+30
Time: 3 Hrs

Note: Eight questions will be set, two from each of the sections A, B, C & D. Th candidates are required to attempt five questions in all selecting at least one questio 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 biodegradabl 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 o glass transition temperature.

Section – B

Thermodynamics of Polymer Solutions

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

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

Section – C

Determination of Molecular Weight of Polymers

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

Section – D

Conducting polymers: Introduction, classification, conduction mechanism, doping of conducting polymers and its significance, factors affecting the conductivity, synthesis and characterization of conducting polymers
Applications in energy storage devices: solar cell, supercapacitors, sensor.

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, Cornell University Press
6. Introduction to Polymers, Third Edition, Robert J. Young and Peter A. Lovell,CR(Press
7. Polymer Physics (Chemistry), M. Rubinstein, Ralph H. Colby,OUP Oxford

M.Sc. Chemistry Semester III
Organic Chemistry Special-I (CHEM 215)
No. of Credits:4

L T P
4 0 0

Max. Marks: 70+30
Time: 3 Hrs

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

SECTION – A

Organometallic Reagents

Principle, preparations, properties and applications of the reagents of the followi metals/non-metals in organic synthesis with mechanistic details
Li, Mg, Cd, Zn, Cu, Ni, Fe, Co, Cr and Pd.

SECTION –B

Oxidation

Introduction, Different oxidative processes, Aldehydes, ketones, ketals and carboxyl acids.Amines, hydrazines, and sulphides.Oxidations with ruthenium tetraoxide, and thalliu (III) nitrate.

SECTION – C

Reduction

Introduction, Different reductive processes, Carbonyl compounds – aldehydes, ketone acids and their derivatives.Epoxides.Nitro, nitroso, azo and oximegroups.Hydrogenolysi.

SECTION – D

Reactions

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

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

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
5. Modern Synthetic Reactions, H.O.House, W.A. Benzamin.
6. Advanced Organic Chemistry Reactions, Mechanisms a Structures, J. March, Wiley.
7. Advanced Organic Chemistry Part B. F.A. Carey and R.J. Sundberg, Plenum Press.

M.Sc. Chemistry Semester III
Organic Chemistry Special-II (CHEM-217)
No. of Credits:4

L T P
4 0 0

Max. Marks: 70+30
Time: 3Hrs

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, 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 photosensitization, 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 rearrangements of ethers &anilides, Barton reaction, Hoffman-Loefller-Freytag reaction.

Books Suggested:

1. Pericyclic Reactions, S.M. MukherjiMacmilan 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" VerlagChemie 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.

M.Sc. Chemistry Semester III
Organic Chemistry Special-III (CHEM-219)
No. of Credits:4

L T P
4 0 0

Max. Marks: 70+30
Time: 3Hrs

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

SECTION - A

Enzymes
Introduction and historical perspective, chemical and biological catalysis, remarkabl properties of enzymes like catalytic power, specificity and regulation. Nomenclature an classification, extraction and purification. Fischer's lock and key and Koshland's induced fi hypothesis, concept and identification of active site by the use of inhibitors, affinit labeling. Enzyme kinetics, Michaelis-Menten and Lineweaver-Burk plots, reversible an 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 PGE_2 and $PGF_{2\alpha}$.

SECTION - C

Terpenoids
General aspects of structure determination of terpenoids.Structure elucidation and synthesis ofGeraniol, α-pinene,Biogenetic isoprene rule and biogenesis of terpenoids.

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

SECTION – D

Steroids

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

Methods for the following conversions.

i) Cholesterol → Testosterone

ii) Cholesterol → Progesterone

iii) Cholesterol → 5-α and 5-βcholanic acids.

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 III
Inorganic Special Practical I & II
(CHEM 221 & CHEM 223)

Credits: 4+
Time:8 Hr
Max. Marks: 70+30 & 70+3

Inorganic Special Practical I (CHEM 221)

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 $[Co(en)_2Cl_2]$

Inorganic Special Practicals II (CHEM 223)

1. Instrumentation:

I Spectrophotometric Determinations
II Conductometric Titrations
III Potentiometric/pH-analysis
IV Any other techniques introduced

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

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.

M.Sc. Chemistry Semester III

Physical Special Practical I & II

(CHEM 225 & CHEM 227)

Credits: 4+4
Time: 08Hrs
Max. Marks: 70+30 & 70+30

Physical Special Practical I (CHEM-225)

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, $H_2|HClAgCl|Ag$ with various concentrations of HCl and to obtain the activity coefficient of HCl.
3. Determination of solubility and solubility product 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 CH_3COOH 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 $Fe^{+++} + Ag \rightarrow Fe^{++} + Ag^+$.
10. To determine the degree of hydrolysis of aniline hydrochloride.
11. Titration of halides with $AgNO_3$ 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.

Physical Special Practical II (CHEM-227)

Conductometry

1. Determination of the equivalent conductance of weak acid (benzoic and acetic acid) a several concentrations and the dissociation constant of the acid.
2. Determination of the equivalent conductance of strong electrolytes such as HCl, KC KNO_3 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 bas (ii) Strong acid vs. weak base, (iii) Weak acid vs. strong base, (iv) Weak acid v weak base, (v) CH_3COOH + HCl vs. NaOH, (vi) $CuSO_4$ vs. NaOH.
6. Determine the critical micelle concentration (CMC) of a surfactant (sodium laur sulphate) by conductivity method.

Colorimetry/Spectrophotometry

7. Verification of the Lambert-Beer's law using solutions such as $K_2Cr_2O_7$, CuSO. $KMnO_4$ in water and I_2 in CCl_4.
8. Study of iron-tiron and iron-salicylic acid complexes.
9. Determination of the composition of various mixtures spectrophotometrically:
   (i) Potassium dichromate and potassium permanganate
   (ii) Crystal violet and aurine
10. Determine the dissociation constant of phenolphthalein spectrophotometrically.

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

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.

M.Sc. Chemistry Semester III
Organic Special Practical I & II
(CHEM 229 & CHEM 231)

Credits: 4+4
Time: 08Hrs
Max. Marks: 70+30 & 70+30

Organic Special Practical I (CHEM 229)

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 — Acetophenoneoxime — 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 —Cyclohexanoneoxime—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 ^{1}H-NMR spectrum for each compound involved in multi step preparation.

Organic Special Practical II (CHEM 231)

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 sal method.

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

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 Hil 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.

M.Sc. Chemistry Semester-III

SKIL ENHANCEMENT COURSE

Computer for Chemists CHEM 233

No. of Credits:2

L T P
1 0 3

Max. Marks: 35+15
Time:2 Hrs

Note: The question paper will comprise of nine questions, two from each unit. The candidates will be required to attempt five questions selecting at least one from each unit. All questions will carry equal marks.

UNIT-I

Computer Fundamentals: Functional components of a digital computer, concepts of hardwareand software binary, octal & hexadecimal number systems. Binary arithmetic, input/output andstorage devices, overview o functions of operating system, types of operating systems, featuresof windows operating system.
MS Office: Word, Excel, Power Point, Equation, Math type.
Chem Office: Structure of molecules like proteins, DNA, RNA, Sugar, amino acids,heterocyclic compounds chemical reactions (single step, two step & multistep) usingChem Draw/Chem Office(Free alternatives OpenOffice (www.openoffice.org, ISIS Draw (http://www.mdli.com; registration required).
Programming Fundamentals: Algorithms, flowcharts, linear and binary search algorithms,bubble sor algorithms. Matrix transpose, matrix addition and matrix multiplication algorithmsand their applications.

UNIT-II

Programming in C: Character set, constants and variables, reserved words, data types,expressions, scanf an print statements, operators and their hierarchy, conditional, unconditionaland loop control structures. One dimensional and two-dimensional arrays,Functions.

UNIT-III

Computer Application in Chemistry: Developing programs in C involving simple formulae inchemistry suc as van der Waals equation, pH titration, kinetics, radioactive decay, evaluationof lattice energy and ionic rad from experimental data. Linear simultaneous equation to solvesecular equations within the Huckel theor Elementary structural features such as bond lengths,bond angles, dihedral angles etc. of molecules extracte from a database such as Cambridgedatabase.

Books Suggested

1. Introduction to Computer Science, P.K. Sinha
2. Let Us C, YashwantKanetker
3. Computational Chemistry, A.C. Norris.

M.Sc. Chemistry Semester IV
Inorganic Chemistry Special-IV (CHEM-202)
No. of Credits:4

L T P
4 0 0

Max. Marks: 70+30
Time:3 Hrs

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

Nephelometry and Turbidimetry

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

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 – B

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 -C

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 coulometri titrations. Apparatus and applications.

Amperometric titrations, anodic stripping voltammetry, and cyclic voltammetry

SECTION -D

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 ^{31}P, ^{19}F, and ^{119}Sn NMR. Application in inorganic chemistry

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 V (CHEM-204)
No. of Credits:4

L T P
4 0 0

Max. Marks: 70+30
Time: 3 Hrs

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.

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

SECTION - B

Solid State-I

Crystalline and non-crystalline materials, glass transition temperature Tg and melting temperature Tm, classes of compounds of the type A_2 B_3 and AB_3 Glass-ceramics, structure of polymers, glass and ceramics inorganic chains and rings.

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

SECTION - C

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.

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 PH_4, F_2^- and $[BH_3]^-$. Double resonance in EPR.

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Books Suggested

8. A Textbook of Quantitative Inorganic Analysis, A.I. Vogel; ELBS, London.
9. Environmental Solution Analysis; S.M. Khopkar, Wiley Eastern.
10. Fundamentals of Analytical Chemistry; D.A. Skoog, O.M. West and F.J. Holler; W.B Saunders.
11. Instrumental methods of Analysis; L.L. Merits, R.H. Willard and J.A. Dean; Var Nostrand-Reinhold.
12. Physical methods in Chemistry; R.S. Drago; Saunders.
13. Dynamics of Chromatography Part I.; J.C. Gidding; Dekker, New York.
14. Environmental Chemistry; S.K. Banerji, Prentice - Hall.

M.Sc. Chemistry Semester IV
Physical Chemistry Special-IV (CHEM 206)
No. of Credits:4

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4 0 0

Max. Marks: 70+30
Time:3 Hrs

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

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 NO_3^-).

SECTION-B

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.

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

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. ElectrocatalysisIntroduction 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 CO_2, Electrochemical sewage disposal, electrochemical decontamination of soil.

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 by Neil W. Ashcroft and N. David Mermin
4. The Physics of Solar Cells (Properties of Semiconductor Materials) by Jenny Nelson
5. Physics of Solar Cells: From Basic Principles to Advanced Concepts (Physics Textbook) by Peter Würfel
6. Optoelectronics of Solar Cells (SPIE Press Monograph Vol. PM115), Greg P. Smestad
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.

Physical Chemistry Special-IV (CHEM 208)
No. of Credits:4

L T P
4 0 0

Max. Marks: 70+30
Time:3 Hrs

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 origi of band gaps, density of states, Band theory, Bloch theorem, Brillouin zones, effective mas of charge carriers, Semiconductors: Direct and indirect band gap semiconductors, hol concept, temperature dependence of mobility and electrical conductivity, free carrie concentration in intrinsic and extrinsic semiconductors, mass active law, Generation o carriers and their recombination in semiconductors. Types of junctions (metal semiconductor, semiconductor-semiconductor, junctions in organic materials), Analysis o p-n junction including I-V characteristic

SECTION- B

Material Chemistry

Definition of nanomaterials, various techniques for the preparation o 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 o 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 ir biological systems; Osmotic pressure, membrane equilibrium, muscular contraction anc energy generation in mechanochemical system. Introduction to protein folding problem.Cel 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.DavidRawn, 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
16. Physical Biochemistry: Applications to Biochemistry and Molecular Biology by D. M Freifelder
17. Biophysical Chemistry: Principles and Techniques by A. Upadhyay, Himalay Publishing House

M.Sc. Chemistry Semester IV
Organic Chemistry Special-IV (CHEM-210)
No. of Credits:4

L T P
4 0 0

Max. Marks: 70+30
Time:3 Hrs

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 wittigreagents,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- Synthesis of Juvabione as an indicative example.

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 ^{1}H-NMR in determining aromatic character of annulenes

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.

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

Methods and Reagents for green synthesis: An introduction, PietroTundo, AlvisePerosa, F Zecchin, Wiley

M.Sc. Chemistry Semester IV
Organic Chemistry Special-V (CHEM-212)
No. of Credits:4

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4 0 0

Max. Marks: 70+30
Time:3 Hrs

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, Drug development: screening of natural products, isolation and purification, structure determination, structure-activity relationships (SAR), synthetic analogues, isosteres and bioisosteres, concept of lead compounds therapeutic index, LD50 and ED50.

Elementary idea about drug action: the receptor role, neurotransmitters and receptors, ion channels and their control. Membrane bound enzymes-activation/deactivation. 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 prodrugs.

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 compound (codeine and heroin), meperidine, methadone, aspirin, acetaminophen, indomethacin phenylbutazone, mefenamic acid, ibuprofen, diclofenac, naproxen, celecoxib.

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 o important drugs against HIV (nucleoside reverse transcriptase inhibitors) - AZT, ddI, ddC d4T and 3TC (synthesis only of AZT).

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-memeberedheterocycles: 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.

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. Heterocylic Chemistry, T.L. Gilchrist, Longman Scientific Technical.
6. Comprehensive Heterocyclic Chemistry, A.R. Katritzky and C.W. Rees, eds. Pergaman Press.

M.Sc. Chemistry Semester IV
Inorganic Special Practical III & IV
(CHEM 214 & CHEM 216)

Credits: 4+4
Time: 8Hrs
Max. Marks: 70+30 & 70+30

Inorganic Special Practical III (CHEM 214)

1. **Quantitative analysis:**

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

I Volumetrically

II Gravimetrically

III Instrumentation methods

Inorganic Special Practical IV (CHEM 216)

1 Determination of any one metal ion by volumetric method (Complexometric titration).
Ca^{2+}, Mg^{2+}, Zn^{2+} , Cu^{2+} etc.

2 Preparation of some inorganic compounds and their spectral studies.

Tris(acetyl-acetonato) manganese (III)

Tris(acetyl-acetonato) cobaltate (III)

Preparation of Ferrocene

Tristhioureacopper(I) sulfate

Tris(acetylacetonato)chromium(III)

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

Books Suggested:

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

M.Sc. Chemistry Semester IV
Physical Special Practical III & IV
(CHEM 218 & CHEM 220)

Credits: 4+4
Time: 8Hrs
Max. Marks: 70+30 & 70+30

Physical Special Practical – III (CHEM 218)

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. NH_4OH.
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

6. Determination of velocity constant of the reaction of ethyl acetate with NaOH and activation energy and temperature coefficient of the reaction.
7. Determination of the velocity constant and energy of activation of the reaction between H_2O_2 and HI.
8. Investigation of the reaction between acetone and iodine (with respect to H^+, I_2 and acetone).
9. Determination of the order and velocity of the reaction between potassium persulphate and potassium iodide.
10. Study the rate of reaction between ethyl bromoacetate and sodium thiosulphate kinetically.

Physical Special Practical – IV (CHEM 220)

Flame Photometry

1. Determination of Na^+, K^+ Ca^{2+} and Mg^{2+} in tap water, juice, electrical etc.

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.

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 ParulMathur, New Age International.

M.Sc. Chemistry Semester IV
Organic Special Practical III & IV
(CHEM 222 & CHEM 224)

Credits: 4+4
Time: 8Hrs
Max. Marks: 70+30 & 70+30

Organic Special Practical – III (CHEM 222)

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).

Organic Special Practical – IV (CHEM 224)

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

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

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. Furnerset. 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.