M.Sc. Chemistry (Two years Course)
CHOICE BASED CREDIT SYSTEM
SCHEME OF EXAMINATION w.e.f. 2016-17

M.Sc. Ist Semester

Paper No.	Code	Nomenclature	Contact hours (L+T+P)	Credits	Max. Marks
Paper-I	CY(H)-101	Inorganic Chemistry-1	4+0+0 = 04	04	80+20
Paper-II	CY(H)-102	Physical Chemistry-1	4+0+0 = 04	04	80+20
Paper-III	CY(H)-103	Organic Chemistry-1	4+0+0 = 04	04	80+20
Paper-IV	CY(H)-104	Inorganic Chemistry Practical-1	0+0+8 = 08	04	50
Paper-V	CY(H)-105	Physical Chemistry Practical-1	0+0+8 = 08	04	50
Paper-VI	CY(H)-106	Organic Chemistry Practical-1	0+0+8 = 08	04	50
Paper-VII	CY(FC)-107 A CY(FC)-107 B	Mathematics for Chemists or Biology for Chemists	3+0+0= 03	03	40+10

Note:

- CY (H), CY (FC) represents Hard core, Foundation Course papers in Chemistry.
- All the papers in M.Sc. 1st semester are hard core and mandatory for M.Sc. 1st semester students.
- Each theory paper will include 20% marks as internal assessment as per University rules.
- Each practical examination will be of 08 hours and will be conducted in two sessions (Morning & Evening) of 04 hours each.
- Maximum marks of M.Sc. 1st semester will be 500. Theory 350 marks; Practical 150 marks)
- Practical marks will include 10% marks for viva-voce and 10% for record files.
- The payment to the internal as well as external examiners will be made on the basis of sessions.
- Total credits : 27
  Hard Core = 24; Foundation Course = 03

M.Sc. 2nd Semester

Paper No.	Code	Nomenclature	Contact hours (L+T+P)	Credits	Max. Marks
Paper-VIII	CY(H)-201	Inorganic Chemistry-II	4+0+0 =04	04	80+20
Paper-IX	CY(H)-202	Physical Chemistry-II	4+0+0 =04	04	80+20
Paper-X	CY(H)-203	Organic Chemistry-II	4+0+0 =04	04	80+20
Paper-XI	CY(H)-204	Inorganic Chemistry Practical-II	0+0+8 =08	04	50
Paper-XII	CY(H)-205	Physical Chemistry Practical-II	0+0+8 =08	04	50
Paper-XIII	CY(H)-206	Organic Chemistry Practical-II	0+0+8 =08	04	50
Paper-XIV	CY(S)-207	General Spectroscopy	3+0+0=03	03	60+15
Paper-XV	CY(S)-208	Characterization Techniques in Chemistry	3+0+0 =03	03	60+15
Paper-XVI	CY(OE)-209	Environmental Chemistry-I	3+0+0 =03	03	60+15

Note:

- CY (H), CY(S), CY (OE) represents Hard core, Soft core & open elective papers in Chemistry.

- Hard core papers are mandatory for M.Sc. 2nd semester students.
- Candidate has to opt one Soft core paper out of two, namely, CY(S)-207; CY(S)-208;
- CY (OE)-209 is to be opted by M.Sc. students from Chemistry Department/ other Departments.
- Maximum marks of M.Sc. 2nd semester will be 600 (Theory 450; Practical 150)
- Each theory paper will include 20% marks as internal assessment as per University rules.
- Each practical examination will be of 08 hours and will be conducted in two sessions (Morning & Evening) of 04 hours each.
- Practical marks will include 10% marks for viva-voce and 10% for record files.
- The payment to the internal as well as external examiners will be made on the basis of Sessions.
- Total Credits = 30
  Hard core = 24; Soft core = 03; Open Elective = 03

M.Sc. 3rd semester

Paper No.	Code	Nomenclature	Contact hours (L+T+P)	Credits	Max. Marks
Paper-XVII (a)	CY(H)-301(a)	Inorganic Special-I	4+0+0 = 04	04	80+20
Paper-XVII(b)	CY(H)-301(b)	Physical Special-I	4+0+0 = 04	04	80+20
Paper-XVII (c)	CY(H)-301(c)	Organic Special-I	4+0+0 = 04	04	80+20
Paper-XVIII (a)	CY(H)-302 (a)	Inorganic Special-II	4+0+0 = 04	04	80+20
Paper-XVIII(b)	CY(H)-302 (b)	Physical Special-II	4+0+0 = 04	04	80+20
Paper-XVIII(c)	CY(H)-302 (c)	Organic Special-II	4+0+0 = 04	04	80+20
Paper-XIX (a)	CY(H)-303 (a)	Inorganic Special-III	4+0+0 = 04	04	80+20
Paper-XIX(b)	CY(H)-303 (b)	Physical Special-III	4+0+0 = 04	04	80+20
Paper-XIX (c)	CY(H)-303 (c)	Organic Special-III	4+0+0 = 04	04	80+20
Paper-XX (a)	CY(S)-304 (a)	Inorganic Special Practical-I	0+0+8 = 08	04	50
Paper-XX (b)	CY(S)-304 (b)	Physical Special Practical-I	0+0+8 = 08	04	50
Paper-XX (c)	CY(S)-304 (c)	Organic Special Practical-I	0+0+8 = 08	04	50
Paper-XXI (a)	CY(S)-305 (a)	Inorganic Special Practical-II	0+0+8 = 08	04	50
Paper-XXI (b)	CY(S)-305 (b)	Physical Special Practical-II	0+0+8 = 08	04	50
Paper-XXI (c)	CY(S)-305 (c)	Organic Special Practical-II	0+0+8 = 08	04	50
Paper-XXII (a)	CY(S)-306 (a)	Inorganic Special Practical-III	0+0+8 = 08	04	50
Paper-XXII (b)	CY (S)-306 (b)	Physical Special Practical-III	0+0+8 = 08	04	50
Paper-XXII (c)	CY (S)-306 (c)	Organic Special Practical-III	0+0+8 = 08	04	50
Paper-XXIII	CY(OE)-307	Environmental Chemistry-II	3+0+0 =03	03	60+15

Note:

- CY (H) & CY(S), CY (OE) represents Hard core, Soft core & Open Elective papers respectively in Chemistry.

- Hard core papers are mandatory for M.Sc. 3rd semester students.
- Candidate has to opt three Hard core & three Soft core papers from the same series i.e. "a" or "b" or "c"
- CY (OE)-307 is to be opted by M.Sc. students from Chemistry Department/ other Departments.
- Maximum marks of M.Sc. 3rd semester will be 525(Theory 375; Practical 150)
- Each theory paper will include 20% marks as internal assessment as per University rules.
- Each practical examination will be of 08 hours and will be conducted in two sessions (Morning & Evening) of 04 hours each.
- Practical marks will include 10% marks for viva-voce and 10% for record files.
- The payment to the internal as well as external examiners will be made on the basis of sessions.
- Total Credits = 27
  Hard core = 12; Soft core = 12; Open Elective = 03

M.Sc. 4th semester

Paper No.	Code	Nomenclature	Contact hours (L+T+P)	Credits	Max. Marks
Paper-XXIII (a)	CY(H)-401(a)	Inorganic Special-IV	4+0+0 = 04	04	80+20
Paper-XXIII(b)	CY(H)-401(b)	Physical Special-IV	4+0+0 = 04	04	80+20
Paper-XXIII(c)	CY(H)-401(c)	Organic Special-IV	4+0+0 = 04	04	80+20
Paper-XXIV (a)	CY(H)-402 (a)	Inorganic Special-V	4+0+0 = 04	04	80+20
Paper-XXIV(b)	CY(H)-402 (b)	Physical Special-V	4+0+0 = 04	04	80+20
Paper-XXIV(c)	CY(H)-402 (c)	Organic Special-V	4+0+0 = 04	04	80+20
Paper-XXV (a)	CY(H)-403 (a)	Inorganic Special-VI	4+0+0 = 04	04	80+20
Paper-XXV (b)	CY(H)-403 (b)	Physical Special-VI	4+0+0 = 04	04	80+20
Paper-XXV (c)	CY(H)-403 (c)	Organic Special-VI	4+0+0 = 04	04	80+20
Paper-XXVI (a)	CY(S)-404 (a)	Inorganic Special Practical-IV	0+0+8 = 08	04	50
Paper-XXVI (b)	CY(S)-404 (b)	Physical Special Practical-IV	0+0+8 = 08	04	50
Paper-XXVI (c)	CY(S)-404 (c)	Organic Special Practical-IV	0+0+8 = 08	04	50
Paper-XXVII (a)	CY(S)-405 (a)	Inorganic Special Practical-V	0+0+8 = 08	04	50
Paper-XXVII (b)	CY(S)-405 (b)	Physical Special Practical-V	0+0+8 = 08	04	50
Paper-XXVII (c)	CY(S)-405 (c)	Organic Special Practical-V	0+0+8 = 08	04	50
Paper-XXVIII (a)	CY(S)-406 (a)	Inorganic Special Practical-VI	0+0+8 = 08	04	50
Paper-XXVIII (b)	CY (S)-406 (b)	Physical Special Practical-VI	0+0+8 = 08	04	50
Paper-XXVIII (c)	CY (S)-406 (c)	Organic Special Practical-VI	0+0+8 = 08	04	50

Note:

- CY (H) & CY(S), represents Hard core & Soft core papers respectively in Chemistry.

- Hard core papers are mandatory for M.Sc. 3rd semester students.
- Candidate has to opt three Hard core & three Soft core papers from the same series i.e. "a" or "b" or "c"
- Maximum marks of M.Sc. 4th semester will be 450(Theory 300; Practical 150)
- Each theory paper will include 20% marks as internal assessment as per University rules.
- Each practical examination will be of 08 hours and will be conducted in two sessions (Morning & Evening) of 04 hours each.
- Practical marks will include 10% marks for viva-voce and 10% for record files.
- The payment to the internal as well as external examiners will be made on the basis of sessions.
- Credits :
  Hard core = 12
  Soft core = 12
  Total credits = 24

M.Sc. Chemistry(Ist Semester)

Paper I CY (H)-101 Inorganic Chemistry-I **4 hrs. / Week**

Credits: 04

Max. Marks: 80 Time: 3Hrs.

Note:-*Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions one question will be compulsory containing 08 short answer type questions covering the entire syllabus. Further, examiner will set 02 questions from each section and the candidates will be required to attempt one question from each section. All questions will carry equal marks.*

Section-A

Stereochemistry and Bonding in Main Group compounds: VSEPR theory, dπ -pπ bonds, Bent rule and energetic of hybridization.

(7 Hrs.)

Metal-Ligand Equilibria in solution

Stepwise and overall formation constants and their interactions, trends in stepwise constants, factors affecting stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH-metry and spectrophotometry.

(8 Hrs.)

Section-B

Reaction Mechanism of Transition Metal Complexes-I

Energy profile of a reaction, Reactivity of metal complexes, Inert and labile complexes, Mechanisms for ligand replacement reactions, Formation of complexes from aquo ions, Ligand displacement reactions in octahedral complexes- acid hydrolysis, Base hydrolysis, racemization of tris chelate complexes, electrophilic attack on ligands, Anation reactions.

(15 Hrs.)

Section-C

Reaction Mechanism of Transition Metal Complexes-II

Mechanism of ligand, displacement reactions in square planar complexes, the trans effect, theories of trans effect, mechanism of electron transfer reactions – types; outer sphere electron transfer mechanism and inner sphere electron transfer mechanism, mechanism of one electron transfer reaction, electron exchange.

(15 Hrs.)

Section-D

Isopoly and Heteropoly Acids and Salts

Isopoly and Heteropoly acids and salts of Mo and W: Structures of isopoly and heteropoly anions.

(7 Hrs.)

Crystal Structures

Structures of some binary and ternary compounds such as fluorite, antifluorite, rutile, antirutile, crystobalite, layer lattices- Cd I_2, Bi I_3; Re O_3, Mn_2O_3, corundum, pervoskite, Ilmenite and Calcite.

(8 Hrs.)

Books Recommended:

1. Concise Inorganic Chemistry – J.D. Lee
2. Inorganic Chemistry – T. Moeller.
3. Modern Aspects of Inorganic Chemistry – H.J. Emeleus & A.G. Sharpe.
4. Introduction to ligand field – B.N. Figgis.
5. Chemical bonding – O.P. Agarwal.
6. Inorganic Reaction Mechanism – Edberg.
7. Inorganic Reactin Mechanism – Basolo Pearson.
8. Structural Principles in Inorganic Compounds – W. E. Addison.

M.Sc. Chemistry (1st Semester)

Paper II; CY (H)-102 Physical Chemistry-I 4 hrs. / Week
Credits: 04
Max. Marks: 80
Time: 3 Hrs.

Note:-*Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions one question will be compulsory containing 08 short answer type questions covering the entire syllabus. Further examiner will set 02 questions from each section and the candidates will be required to attempt one question from each section. All questions will carry equal marks.*

Section-A

Quantum Mechanics: Postulates of Quantum Mechanics; derivation of Schrodinger wave equation; Max-Born interpretation of wave functions ψand the Heisenberg's uncertainty principle; Quantum mechanical operators and their commutation relations, Hermition operators, (elementary ideas, quantum mechanical operator for linear momentum, angular momentum and energy as Hermition operator). The average value of the square of Hermition operators; commuting operators and uncertainty principle(x & p; E &t); Schrodinger wave equation for a particle in one dimensional box; evaluation of average position, average momentum and determination of uncertainty in position and momentum and hence Heisenberg's uncertainty principle, picorial representation of the wave equation of a particle in one dimensional box and its influence on the kinetic energy of the particle in each successive quantum level, lowest energy of the particle.

Section-B

Thermodynamics: Brief resume of first and second Law of thermodynamics. Entropy changes in reversible and irreversible processes, variation of entropy with temperature , pressure and volume, entropy concept as a measure of unavailable energy and criteria for the spontaneity of reaction; free energy, enthalpy functions and their significance, criteria for spontaneity of a process; partial molar quantities (free energy, volume ,heat concept), Gibb's-Duhem equation;

Section-C

Chemical Dynamics-I: Effect of temperature on reaction rates, Rate law for opposing reactions of Ist order and IInd order, Rate law for consecutive & parallel reactions of Ist order reactions, Collision theory of reaction rates and its limitations, steric factor, Activated complex theory, Ionic reactions: single and double sphere models, influence of solvent and ionic strength, the comparison of collision and activated complex theory.

Section-D

Electrochemistry:

Ion - Ion Interactions: The Debye -Huckel theory of ion- ion interactions; potential and excess charge density as a function of distance from the central ion, Debye Huckel reciprocal length, ionic cloud and its contribution to the total potential, Debye - Huckel limiting law of activity coefficients and its limitations, ion - size effect on potential, ion -size parameter and the theoretical mean - activity coefficient in the case of ionic clouds with finite - sized ions.

Debye - Huckel -Onsager treatment for aqueous solutions and its limitations. Debye-Huckel-Onsager theory for non-aqueous solutions, the solvent effect on the mobality at infinite dilution, equivalent conductivity ($\wedge$) vs. concentration $c^{1/2}$ as a function of the solvent, effect of ion association upon conductivity (Debye- Huckel - Bjerrum equation).

Books Recommended:

1. Thermodynamics for chemists by S.Glasstone.
2. Physical Chemistry by G.M. Barrow
3. Thermodymaics by R.C. Srivastava, S.K. Saha & A.K.Jain
4. Modern electrochemistry Vol.1 by J.O.M. Bockris and A.K.N. Reddy
5. Chemical Kinetics by K.J. Laidler
6. Kinetics & Mechanism of reaction rates by A.Frost & G.Pearson
7. Modern chemical kinetics by H.Eyring
8. Theories of reaction rates by K.J. laidler, H.Eyring & S. Glasstone.
9. Theoretical Chemistry by S. Glasstone.
10. Introduction to Quantum Mechanics by R. Chandra.

M.Sc. Chemistry (1st Semester)

Paper III; CY (H)-103 Organic Chemistry-I 4 hrs. / Week
Credits: 04
Max. Marks: 80
Time: 3 Hrs.

Note:-Examiner will set nine questions and the candidates will be required to attempt five questions in all. Out of nine questions one question will be compulsory containing eight short answer type questions covering the entire syllabus. Further examiner will set two questions from each section and the candidates will be required to attempt one question from each section. All questions will carry equal marks.

Nature of Bonding in Organic molecules: Delocalized chemical bonding –conjugation, cross conjugation, resonance, hyperconjugation , tautomerism. Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's rule, energy level of π-molecular orbitals, annulenes, antiaromaticity, homo-aromaticity, PMO approach. Bonds weaker than covalent, addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrins, catenanes and rotaxanes

Stereochemistry : Chirality, elements of symmetry, molecules with more than one chiral centre, diastereomerism. Determination of relative and absolute configuration (octant rule excluded) with special reference to lactic acid, alanine & mandelic acid. Methods of resolution, optical purity, prochirality, enantiotopic and diastereotopic atoms, groups and faces, asymmetric synthesis, cram's rule and its modifications, prelog's rule, conformational analysis of cycloalkanes (upto six membered rings), decalins, conformations of sugars, optical activity in absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape, geometrical isomerism in alkenes and oximes, methods of determining the configuration.

Reaction Mechanism: Structure and Reactivity: Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects. Hard and soft acids and bases. Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes. Effect of structure on reactivity. The Hammett equation and linear free energy relationship, substituent and reaction constants. Taft equation.

Section-D

Carbohydrates: Types of naturally occurring sugars, Deoxy sugars, amino sugars, branch chain sugars, general methods of determination of structure and ring size of sugars with particular reference to maltose, lactose, sucrose, starch and cellulose.

Natural and Synthetic Dyes: Various classes of synthetic dyes including heterocyclic dyes, interaction between dyes and fibers, Structure elucidation of indigo and Alizarin.

Books Recommended:

1. Advanced Organic Chemistry- Reactions Mechanism and Structure by Jerry March.
2. A guide Book to Mechanism in Organic Chemistry by Peter Sykes.
3. Organic Chemistry by R.T. Morrison and R.N.Boyd.
4. Reaction Mechanism in Organic Chemistry by S.M. Mukherji and S.P. Singh.
5. Stereochemistry of Organic Compounds by D. Nasipuri.
6. Stereochemistry of Organic Compounds by P.S. Kalsi.
7. Carbohydrate by S.P. Bhutani.
8. Organic Chemistry by I.L. Finar.
9. Color Chemistry by R.L.M. Allen.
10. Chemistry of Synthetic Dyes by K. Venkatraman.

M.Sc. Chemistry (1st Semester)

Inorganic Chemistry Practical-I

Paper –IV CY (H)- 104

120 Hrs./Week)
Credits: 04
Time : 8Hrs.
Max. Marks: 50

1. Volumetric Analysis (20 Marks)

(a) Potassium iodide titrations
Determination of iodide, hydrazine and antimony (III)

(b) Potassium bromate titrations
(i) Determination of antimony (III) (by Direct Method)
(ii) Determination of aluminium, Magnesium and zinc (by Oxine method)

(c) EDTA titrations
(i) Determination of calcium, copper, barium.
(ii) Back titration
(iii) Titration of mixtures using masking

2. Green methods of Preparation of the following (20 Marks)

(i) Bis(acetylacetonato) copper(II)
(ii) Tris(acetylacetonato) iron (III)
(iii) Tris(acetylacetonato)managanese(III)

3. Viva-Voce (05Marks)

4 Note Book (05 Marks)

Books Recommended

a. A text Book of Quantitative Inorganic Analysis: A.I. Vogel.
b. Applied Analytical Chemistry: O.P. Vermani.

M.Sc. Chemistry (1st Semester)
Physical Chemistry Practical - I
Paper V; CY (H) -105

8Hrs./Week
Credits: 04
Max. Marks 50
Time: 8 Hrs.

1. Condutometry

(i) To determine cell constant of conductivity cell.
(ii) NaOH vs. HCl titration.
(iii) NaOH vs. Oxalic acid titration.
(iv) NaOH vs CH_3 COOH titration
(v) Ba $(NO_3)_2$ vs. Na_2 SO_4 titration

2. Thermochemistry

Determination of heat of neutralization of the followings:-

(i) NaOH vs. Hcl
(ii) NaOH vs. CH_3 COOH
(iii) NaOH vs. Oxalic acid.

3. Refractometry

(i) To determine molar refractivity of the given liquid.
(ii) To determine percentage composition of liquids in the given binary mixture.
(iii) To determine concentration of sugar in a given solution.

4 Surface tension

To determine interfacial tension of two immiscible liquids.

5. Adsorption

To study the adsorption of Oxalic acid and Acetic acid on charcoal.

Viva Voce (5 Marks)
Practical Note Book (5Marks)

Book Recommended

1. Senior practical physical chemistry: B.D. Khosla, V.C. Garg and A. Khosla.
2. Experimental Physical Chemistry: A Thawale and P. Mathur.
3. Practical Physical Chemistry: B. Vishwanatha and P. S Raghav
4. Practical in Physical Chemistry: P.S. Sindhu.

M.Sc. Chemistry (1st Semester)
Organic Chemistry Practical-I
Paper-VI CY (H) -106

8Hrs/Week
Credits: 04
Max.Marks: 50
Time: 8 Hrs

1. Qualitative Analysis.

Separation, purification and identification of organic compounds in binary mixtures using water/$NaHCO_3$ and preparation of their suitable derivatives. 40 Marks

2. Viva-Voce 05 Marks

3. Note Book 05 Marks

Books Recommended

1. Experiments and Techniques in Organic Chemistry, by D. Pasto, C. Johnson and M. Miller.
2. Macroscale and Microscale Organic Experiments by K. L. Williamson, & D.C. Heath.
3. Systematic Qualitative Organic Analysis by H. Middleton .
4. Handbook of Organic Analysis-Qualitative and Quantitative by H. Clark.
5. Vogel's Textbook of Practical Organic Chemistry by A. R. Tatchell.

M.Sc. Chemistry (1st Semester)

Paper VII CY (FC)-107-A Mathematics for Chemists 2 hrs. / Week

Credits: 03

Max. Marks: 40

Time: 3 Hrs.

Note:-*Examiner will set eight questions and the candidates will be required to attempt five questions in all. All questions will carry equal marks.*

UNIT-I

Vector: 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, addition of vectors by components, multiplication and differentiation of vectors. Scalar and vector product. **(4Hrs)**

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. Definition of determinant, properties of determinants, evaluation of determinants. Illustration or applications to group theory, problems from chemistry. **(8 Hrs)**

Elements of Algebraic and Trigonometric Functions

The binomial expansion, some example from chemistry, sines, cosines and tangents, trigonometric identities. **(3 Hrs)**

UNIT-II

Differential and Integral Calculus: Theory, rules of differentiation, powers, added and subtracted functions, constants, products, quotients, functions of a function, logarithmic differentiation, parametric functions. Algebraic simplification, differentiation of implicit functions, graphical significance of differentiation, rate of change of slope, successive differentiation. Examples related to maximally populated rotational energy levels, Bohr's radius and most probable velocity from Maxwell's distribution. Exact and inexact differential with their application to thermodynamic principles. Integral theory, basic rules of integration, integration by parts, partial fraction, and substitution. **(15 Hrs)**

UNIT-III

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. **(3 Hrs)**

Partial Differentiation: The fundamental theorem, geometrical significance of partial differentiation, special cases of fundamental theorem, successive partial differentiation. Integral transforms (Fourier and Laplace). Reduction formulae, application to chemical problems. **(6 Hrs)**

Differential Equation: Simple differential equations, separable variables, homogeneous equations, exact equations, linear equations, equation of the first and second order, partial differential equation, application to physico-chemical problems. **(6 Hrs)**

Books Suggested

1. Mathematical Methods for Science Students, G. Stephemen, ELBS.
2. The Chemistry Mathematics Book, E. Stener, Oxford University Press.
3. Mathematics for Chemistry, Doggett and Sucliffe, Longman.
4. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill.
5. Chemical Mathematics, D.M. Hirst, Longman.
6. Applied Mathematics for Physical Chemistry, J.R. Barrante, Prentice Hall.
7. Basic Mathematics for Chemists, Tebbutt, Wiley.
8. Differential equation, Schaum series, Tata McGraw Hill.
9. Elements of Partial Differential Equation, I.N.Sneddom, Tata McGraw Hill..
10. Advanced Engg. Mathematics, E Kreyszig, John Wiely & sons.
11. Mathematical Techniques, Jordan &Smith, Oxford University Press.

M.Sc. Chemistry (1st Semester)

Paper VII CY (FC)-107-B Biology for Chemists 2 hrs. / Week
Credits: 03
Max. Marks: 40
Time: 3 Hrs.

Note:-*Examiner will set eight questions and the candidates will be required to attempt five questions in all. All questions will carry equal marks.*

UNIT - I

Cell structure and functions

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. **(4 Hrs)**

Carbohydrates

Conformation of monosaccharides, structure and functions of important derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, amino sugars. N-acetylmuramic acid, sialic acid, disaccharides and polysaccharides. Structural polysaccharides - cellulose and chitin. Storage polysaccharides - starch and glycogen.

Structure and biological functions of glucosaminoglycans or mucopolysaccharides. Carbohydrates of glycoproteins and glycolipids. Role of sugars in biological recognition. Blood group substances. Ascorbic acid.

Carbohydrate metabolism - Kreb's cycle, glycolysis, glycogenesis and glycogenolysis, gluconeogenesis, pentose phosphate pathway. **(11 Hrs)**

UNIT - II

Lipids

Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids, prostaglandins. Lipoproteins - composition and function.

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

Lipid metabolism - β-oxidation of fatty acids. **(8 Hrs)**

Proteins

Chemical and enzymatic hydrolysis of proteins to peptides, Secondary structure of proteins, forces responsible for holding of secondary structures. α-helix, β-sheets, super secondary structure, triple helix structure of collagen. Tertiary structure of protein- folding and domain structure. Quaternary structure. **(7 Hrs)**

UNIT - III

Nucleic Acids and Genetic Code

Structure of nucleotides, nucleosides, DNA (Watson-Crick model) RNA structure and conformation, Replication of DNA, transcription, translation of genetic material, genetic code, universality of the code, codon, anticodon pairing, RNA, protein biosynthesis (initiation, elongation, termination and processing of the peptide chain). **(15 Hrs)**

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.

M.Sc. Chemistry (2nd Semester)

Paper- VIII CY (H)-201 Inorganic Chemistry-II **4 hrs. / Week**

Credits: 04

Max. Marks: 80

Time: 3 Hrs.

Note:-*Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions one question will be compulsory containing 08 short answer type questions covering the entire syllabus. Further, examiner will set 02 questions from each section and the candidates will be required to attempt one question from each section. All questions will carry equal marks.*

Section-A

Theories of Bonding in co-ordination complexes

Valence bond theory and limitations, Crystal field theory, splitting of d-orbitals in cubic, octahedral, tetrahedral, tetragonal, and square planar ligand enviornment, structural consequences of splitting of d-orbitals, Limitation of crystal field theory, molecular orbital theory, octahedral, tetrahedral or square planar complexes, π-bonding and molecular orbital theory.

(15 Hrs.)

Section-B

Electronic Spectra of Transition Metal Complexes

Spectroscopic ground states, correlation and spin-orbit coupling in free ions for Ist series of transition metals, Orgel and Tanabe-Sugano diagrams for transition metal complexes ($d^1 - d^9$ states) calculation of Dq, B and β parameters, effect of distortion on the d-orbital energy levels. Structural evidence from electronic spectrum, John-Tellar effect, Spectrochemical and nephalauxetic series, charge transfer spectra, electronic spectra of molecular addition compounds.

(16 Hrs.)

Section-C

Magantic Properties of transition metal complexes

Elementary theory of magneto - chemistry, Guoy's method for determination of magnetic susceptibility, calculation of magnetic moments, magnetic properties of free ions, orbital contribution, effect of ligand-field, application of magneto-chemistry in structure determination, magnetic exchange coupling and spin state cross over.

(8 Hrs.)

Metal Clusters

Structure and bonding in higher boranes, Wade's rules, Carboranes, Metal Carbonyl clusters- Low Nuclearity Carbonyl clusters, total electron count (TEC)

(8 Hrs.)

Section-D

Metal -∏ Complexes

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

(15 Hrs.)

Books Recommended:

1. Advanced Inorganic Chemistry – F.A. Cotton & G. Wilkinson.
2. Inorganic Chemistry: Principles of Structure & reactivity – J.E. Huheey.
3. Chemistry of the Elements – N.N. Greenwood & A. Earnshaw.
4. Concise Co-ordination Chemistry – R. Gopalan & R. Ramalingam.
5. Magneto Chemistry – R.L. Carlin.
6. Concise Inorganic Chemistry – J.D. Lee.
7. Introduction to Magneto Chemistry – A. Earnshasw.

M.Sc. Chemistry (2nd Semester)

Paper IX CY(H)-202 Physical Chemistry-II **4 hrs. / Week**

Credits: 04

Max. Marks: 80

Time: 3 Hrs.

Note:-*Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions one question will be compulsory containing 08 short answer type questions covering the entire syllabus. Further examiner will set 02 questions from each section and the candidates will be required to attempt one question from each section. All questions will carry equal marks.*

Section-A

Quantum mechanics: Schrodinger wave equation for a particle in a three dimensional box. The concept of degeneracy among energy levels for a particle in three dimensional box. Schrodinger wave equation for a linear harmonic oscillator & its solution by polynomial method. Zero point energy of a particle possessing harmonic motion and its consequence. Schrodinger wave equation for three dimensional Rigid rotator, energy of rigid rotator, space quantization; Schrodinger wave equation for hydrogen atom, separation of variable in polar spherical coordinates and its solution, principle, azimuthal and magnetic quantum numbers and the magnitude of their values, probability distribution function, radial distribution function and shape of atomic orbitals (s,p & d).

Section-B

Thermodynamics: Classius – Clayperon equation; law of mass action and its thermodynamic derivation. Third law of thermodynamics (Nernest heat theorem, determination of absolute entropy, unattainability of absolute zero) and its limitation. Phase diagram for two completely miscible components systems. Eutectic systems, Calculation of eutectic point, systems forming solid compounds A_x B_y with congruent and incongruent melting points, phase diagram and thermodynamic treatment of solid solutions.

Section-C

Chemical dynamics-II: Chain reactions: hydrogen - bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane. Photochemical reactions (hydrogen - bromine & hydrogen -chlorine reactions). General treatment of chain reactions (ortho -para hydrogen conversion and hydrogen - bromine reactions), apparent activation energy of chain reactions, chain length, Rice- Herzfeld mechanism of organic molecules decomposition(acetaldehyde) Branching chain reactions and explosions (H_2 - O_2 reaction). Kinetics of (one intermediate) enzymatic reaction : Michaelis - Menton treatment, evaluation of Michaelis 's constant for enzyme - substrate binding by Lineweaver - Burk plot and Eadie- Hofstae methods. Competitive and non-competitive inhibition.

Section-D

Ion Transport in solutions: Ionic movement under the influence of an electric field , mobility of ions, ionic drift velocity and its relation with current density, Einstein relation between the absolute mobility and diffusion coefficient, the Stokes- Einstein relation , the Nernst -Einstein equation, Waldens rule, the Rate- Process approach to ionic migration , the Rate process equation for equivalent conductivity, total driving force for ionic transport, Nernst - Planck Flux equation, ionic drift and diffusion potential , the Onsager phenomenological equations. The basic equation for the diffusion, Planck- Henderson equation for the diffusion potential.

Books Recommended:

1. Thermodynamics for chemists by S.Glasstone.
2. Physical Chemistry by G.M. Barrow
3. Thermodymaics by R.C. Srivastava, S.K. Saha & A.K.Jain
4. Modern electrochemistry Vol.1 by J.O.M. Bockris and A.K.N. Reddy
5. Chemical Kinetics by K.J. Laidler
6. Kinetics & Mechanism of reaction rates by A.Frost & G.Pearson
7. Modern chemical kinetics by H.Eyring
8. Theories of reaction rates by K.J. laidler, H.Eyring & S. Glasstone.
9. Theoretical Chemistry by S. Glasstone

M.Sc. Chemistry (2nd Semester)

Paper X; CY (H)-203 Organic Chemistry-II 4 hrs. / Week
Credits: 04
Max. Marks: 80
Time: 3 Hrs.

Note:-Examiner will set 09 questions and the candidates will be required to attempt 05 questions in all. Out of 09 questions one question will be compulsory containing 08 short answer type questions covering the entire syllabus. Further examiner will set 02 questions from each section and the candidates will be required to attempt one question from each section. All questions will carry equal marks.

Aliphatic Nucleophilic Substtitution: The SN2, SN1, mixed SN1 and SN2' SNi , SN1', SN2', SNi' and SET mechanisms. The neighbouring group mechanisms, neighbouring group participation by π and σ bonds, anchimeric assistance. Classical and nonclassical carbocations, phenonium ions, common carbocation rearrangements. Applications of NMR spectroscopy in the detection of carbocations. Reactivity- effects of substrate structure, attacking nucleophile, leaving group and reaction medium.. Ambident nucleophiles and regioselectivity. Phase transfer catalysis.

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

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

Aromatic Nucleophilic Substitution: The ArSN1, ArSN2, Benzyne and SRN1 mechanisms. Reactivity – effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements.

Elimination Reactions: The E2, E1 and E1cB mechanisms . Orientation of the double bond . Reactivity –effects of substrate structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination.

Addition to Carbon-Carbon Multiple Bonds: Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio – and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring.
Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration.
Michael reaction. Sharpless asymmetric epoxidation.

Section-D

Addition to Carbon-Hetero Multiple Bonds: Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Wittig reaction. Mechanism of condensation reactions involving enolates – Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.

Books Recommended:

1. Advanced Organic Chemistry -Reactions, Mechanism and Structure by Jerry March.
2. Advanced Organic Chemistry by F.A. Carey and R.J. Sundberg.
3. A Guide Book to Mechanism in Organic Chemistry by Peter Sykes.
4. Structure and Mechanism in Organic Chemistry by C.K. Ingold.
5. Organic Chemistry by R.T. Morrison and R.N. Boyd.
6. Modern Organic Reactions by H.O. House .
7. Principles of Organic Synthesis by R.O.C. Norman and J.M. Coxon.
8. Reaction Mechanism in Organic Chemistry by S.M. Mukherji and S.P. Singh.

M.Sc. Chemistry (2nd semester)

INORGANIC CHEMISTRY PRACTICAL-II
Paper-XI, CY (H)- 204

120 Hrs./Week
Credits: 04
Time: 8Hrs.
Max. Marks: 50

1. Quantitative Inorganic Analysis

a) Separation and determination of two metal ions such as (25 Marks)

i) Silver- Copper,
ii) Copper-Nickel,
iii) Copper-Zinc,
iv) Nickel-Zinc,
v) Copper-Iron Involving volumetric and gravimetric methods.

b) Determination by Cerimetry (15 Marks)

i) Ferrous,
ii) Oxalate,
iii) Nitrite

2. Viva-Voce (05 Marks)

3. Note Book (05 Marks)

Books Recommended

1. A text Book of Quantitative Inorganic Analysis: A.I. Vogel.
2. Applied Analytical Chemistry: O.P. Vermani.

M.Sc. Chemistry (2nd semester)
Physical Chemistry Practical II
Paper XII; CY (H) -205

8Hrs./Week
Credits: 04
Max. Marks 50
Time: 8 Hrs.

1. Potentionmetry

(i) NaOH vs. HCl titration.
(ii) NaOH vs. Oxalic acid titration.
(iii) NaOH vs. CH_3 COOH titration.

2. pH metry

(i) NaOH Vs. HCl titration.
(ii) NaOH vs Oxalic acid titration.
(iii)NaOH vs. CH_3COOH titration.

3. Chemical Kinetics

(i) To study kinetics of hydrolysis of ester in the presence of acid.
(ii) To compare the relative strength of acids (HCl and H_2SO_4).

4. Distribution Law

(i) To determine partition coefficient of benzoic acid between benzene and water.
(ii)To determine partition coefficient of Iodine between Carbon tetrachloride and water.
(iii) Determination of Equilibrium constant for $I_2 + I^- = I_3$

Viva Voce (5 Marks)

Practical Note Book (5Marks)

Book Recommended

1.Senior practical physical chemistry: B.D. Khosla, V.C. Garg and A. Khosla.
2. Experimental Physical Chemistry: A Thawale and P. Mathur.
3. Practical Physical Chemistry: B. Vishwanatha and P. S Raghav
4. Practical in Physical Chemistry: P.S. Sindhu.

M.Sc. Chemistry (2nd semester)
Organic Chemistry Practical-II
Paper-XIII CY (H) -206

8Hrs/Week
Credits: 04
Max.Marks: 50
Time: 8 Hrs

1. Organic Synthesis and Checking purity of samples prepared.
Two Step preparations.

1. p-Nitroaniline from acetanilide.
2. p-Bromoaniline from acetanilide
3. Anthranilic acid from phthalic anhydride.
4. p-Bromoacetanilide from aniline.
5. p-Nitroacetanilide from aniline.
6. Sym-tribromobenzene from aniline.
7. 2,4-Dinitrophenyl hydrazine from chlorobenzene.
8. 2,5-Dihydroxyacetophenone from hydroquinone. 40 Marks

2. Viva-Voce 05 Marks

3. Note Book 05 Marks

Books Recommended

1 Experiments and Techniques in Organic Chemistry by D. Pasto, C. Johnson and M. Miller.
2 Macroscale and Microscale Organic Experiments by K. L. Williamson and D.C. Heath.
3 Systematic Qualitative Organic Analysis by H. Middleton.
4 Handbook of Organic Analysis-Qualitative and Quantitative by H. Clark
5 Vogel' s Textbook of Practical Organic Chemistry by A. R. Tatchell.

M.Sc. Chemistry 2nd semester

Paper- XIV; CY(S)-207 **General Spectroscopy** 3Hrs./Week
Credits: 03
Max. Marks: 60
Time: 03 Hrs.

Note: - Examiner will set 10 questions and the candidates will be required to attempt 05 questions in all. Out of 10 questions one question will be compulsory containing 06 short answer type questions covering the entire syllabus. Further examiner will set 03 questions from each section and the candidates will be required to attempt atleast one question from each section. All questions will carry equal marks.

Unit I

1. Electromagnetic radiation, interaction of electromagnetic radiation with matter, regions of the Spectrum the width and intensity of spectral transitions. Resolving power.
2. **Rotational spectra:**- The rotation of molecules, rotational spectra of diatomic molecules, the spectrum of non rigid rotator, the effect of isotopic substitutions rotational spectra of linear and symmetric top polyatomic molecules.
3. **Vibrational and Vibrational- Rotational Spectra:** The vibrating diatomic molecule; simple harmonic vibrations, anharmonicity of vibrations, the diatomic vibrating rotator, the interaction of rotations and vibrations the vibrations of polyatomic molecules, analysis by infrared technique.
4. **Electronics Spectra:** Electronic spectra of diatomic molecules, vibrational course structure, and rotational fine structure of electronic band. The Frank- Condon principle, intensity of vibrational-electronic band, dissociation energy, the Fortrat diagram.

Unit – II

Electronic Absorption Spectroscopy: Energy levels in diatomic molecules, introduction to electronic transition, Assignment of transitions, Spectra of transition metal complexes, Orgel diagrams

Nuclear Magnetic Resonance: Applications of spin-spin coupling to structure alignment of inorganic compounds, evaluation of reaction rates of fast exchange reactions. The double resonance technique.

Application of infra-red spectroscopy to the determination of inorganic compounds.

Unit III

NMR Spectra:- Spin active nuclei, chemical shift, shielding and deshielding, internal standards, spin-spin coupling, equivalent and non- Equivalent Protons, effect of changing solvents and hydrogen bonding on chemical shifts, anisotropic effect.

Principles and Applications of UV, IR and NMR Spectra in the structure elucidation of Organic Compounds.

Book Recommended

1. Physical Methods in Inorganic Chemistry- R.S. Drago.
2. Infrared Spectra of Inorganic and Coordination Compound- K. Nakamoto.
3. Fundamentals of Molecules Spectroscopy-C.N.Banwel.
4. Introduction to Magnetic Resonance Spectroscopy ESR, NMR, NRR-D.N. Sathyanarayana.

M.Sc. Chemistry 2nd Semester

Paper:-XV; CY(S) – 208 Characterization Techniques in Chemistry 3 Hrs./Week
Credits: 03
Max Marks: 60
Time: 03 Hrs

Note:- Examiner will set 10 questions and the candidates will be required to attempt 05 questions in all. Out of 10 questions one question will be compulsory containing 06 short answer type questions covering the entire syllabus. Further examiner will set 03 questions from each section and the candidates will be required to attempt atleast one question from each section. All questions will carry equal marks.

Unit-I

Atomic Absorption Spectroscopy - Principles, Instrumentation, Sensitivity and detection limits, Interferences in AAS and their elimination.

Atomic Emission Spectroscopy- Principles, Sources for excitation, Instrumentation, Applications in qualitative and quantitative Analysis.

Flame Photometry- Principles, Interferences, Evaluation methods in Flame Photometry, **Principle and Applications** of Thermogravimetric Analysis(TGA) and Differential Thermal Analysis (DTA).

Unite – II

Nano materials Technology:

Introduction to nanoscience and technology, synthesis of nanomaterials by Hydrothermal, Solvothermal, Microwave irradiation, sol-gel techqniques.

Principle and characterization of nanomaterials by X-ray diffraction (XRD), Scanning Electron Microscope (SEM), Energy dispersive X-ray Analysis. Transmission

Electron Microscope (TEM), Atomic Force microscopy (AFM) techniques.

Unite – III

Purification of organic compounds using chromatographic techniques: paper chromatography,

Thin- Layer Chromatography, Column Chromatography, High Pressure Liquid Chromatography

(HPLC), Gas Chromatography, Ion-Exchange Chromatography, Counter- Current distribution and Electrophoresis

Book Recommended

1. Introduction to nanotechnology : Charles P. Poole, Jr. Frank, J. Owens : Wiley India
2. Basics of nanochemistry., Sachdeva, Mamta V
3. Nanochemistry, Sergeev, G. B. and K. L. Klabunde, Elsevier, 2013.
4. Nano Technology and Nanoelectronics by W.R. Fahrner- Springer International.
5. Introducation to Nanoscience and Technology Edited By M. D. Vantra, S. Evoy, J.R. Heflin-Springer.
6. Introduction to Nanosciences by S. M. Lindsey Oxford Press.
7. Nano Science and Technolony by V. S. Muralidharan and A. Subramania.
8. Separation Chemistry by R.P. Budhiraja, New age International Publishers.
9. Basic Concepts of Analytical Chemistry by S.M. Khopkar, New age International Publishers.
10. Instrumental Methods of Chemical analysis, B.K. Sharma, Goel Publishing House.

M.Sc. Chemistry 2nd Semester

Paper:- XVI; CY(OE)-209 Environmental Chemistry -I

3 Hrs./Week
Credit: 3
Max. Marks: 75
Time: 3 Hrs

Note:- Examiner will set 10 questions and the candidates will be required to attempt 05 questions in all. Out of 10 questions one question will be compulsory containing 06 short answer type questions covering the entire syllabus. Further examiner will set 03 questions from each section and the candidates will be required to attempt atleast one question from each section. All questions will carry equal marks.

Unit-I

Environment: Atmosphere, environmental segments, composition of the atmosphere, earth's radiation balance, particulates, ions, radicals and their formation, chemical and photochemical reactions in the atmosphere, air pollution: oxides of C,N,S and their effects, acid-rain, smog formation, Green house effects (global warming and ozone depletion). Analytical Methods for measuring air pollutants. Continuous monitoring instruments.

Unit-II

Hydrosphere: Chemical composition of water bodies-lakes, streams rivers, sea etc, hydrological cycle, complexation in natural and waste water and microbially mediated redox reactions. Water pollution-inorganic, organic pesticides, industrial and radioactive materials, oil spills and oil pollutants eutrophication, acid-mine drainage, waste water treatment, domestic waste water aerobic and (anaerobic treatment), and industrial waste water treatment

Unit III

Noise Pollution: sources, effect on human health, mitigation and control.

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

Books Recommended

1. Environmental Chemistry- A.K. De
2. Environmental Chemistry – Manaham
3. Environmental Pollution Analysis- Khopkar
4. Environmental Chemistry, Sharma & Kaur.
5. Standard Method of Chemical analysis, F.J. Welcher vol. III
6. Environmental Toxicology, Ed.J.Rose.
7. Elemental Analysis of Airborne particles, Ed. S. Landsberger and M-Creatchman.
8. Environmental Chemistry, C.Baird.