

**M.Sc. Chemistry (Two years Course)**  
**CHOICE BASED CREDIT SYSTEM**  
**SCHEME OF EXAMINATION w.e.f. 2015-16**

(only for the dept. of Chemistry and not Applicable to the affiliated colleges)

**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	Computer for Chemists	2+0+0= 02	02	40

**Note:**

- CY (H), CY (FC) represents Hard core, Foundation Course papers in Chemistry.
- All the papers in M.Sc. 1<sup>st</sup> semester are hard core and mandatory for M.Sc. 1<sup>st</sup> 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. 1<sup>st</sup> 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 : 26  
Hard Core = 24; Foundation Course = 02

## M.Sc. 2<sup>nd</sup> Semester

Paper No.	Code	Nomenclature	Contact hours (L+T+P)	Credits	Max. Marks
Paper-VII	CY(H)-201	Inorganic Chemistry-II	4+0+0 =04	04	80+20
Paper-VIII	CY(H)-202	Physical Chemistry-II	4+0+0 =04	04	80+20
Paper-IX	CY(H)-203	Organic Chemistry-II	4+0+0 =04	04	80+20
Paper-X	CY(H)-204	Inorganic Chemistry Practical-II	0+0+8 =08	04	50
Paper-XI	CY(H)-205	Physical Chemistry Practical-II	0+0+8 =08	04	50
Paper-XII	CY(H)-206	Organic Chemistry Practical-II	0+0+8 =08	04	50
Paper-XIII	CY(S)-207	General Spectroscopy	3+0+0=03	03	60+15
Paper-XIV	CY(S)-208	Techniques in Chemistry	3+0+0 =03	03	60+15
Paper-XV	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. 2<sup>nd</sup> 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. 2<sup>nd</sup> 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. 3<sup>rd</sup> semester**

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

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- Hard core papers are mandatory for M.Sc. 3<sup>rd</sup> 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. 3<sup>rd</sup> 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

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**M.Sc. 4<sup>th</sup> 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.

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- Hard core papers are mandatory for M.Sc. 3<sup>rd</sup> 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. 4<sup>th</sup> 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: 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

**Stereochemistry and Bonding in Main Group compounds:** VSEPR theory,  $d\pi - p\pi$  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

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.

(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, 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, antiferite, rutile, antirutile, cristobalite, layer lattices-  $\text{CdI}_2$ ,  $\text{BiI}_3$ ;  $\text{ReO}_3$ ,  $\text{Mn}_2\text{O}_3$ , corundum, perovskite, 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 Reaction Mechanism – Basolo Pearson.
8. Structural Principles in Inorganic Compounds – W. E. Addison.



## M.Sc. Chemistry (1<sup>st</sup> 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  $\psi$  and the Heisenberg's uncertainty principle; Quantum mechanical operators and their commutation relations, Hermitian operators, (elementary ideas, quantum mechanical operator for linear momentum, angular momentum and energy as Hermitian operator). The average value of the square of Hermitian 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, pictorial 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:** Effect of temperature on reaction rates, Rate law for opposing reactions of 1<sup>st</sup> order and 2<sup>nd</sup> order, Rate law for consecutive & parallel reactions of 1<sup>st</sup> 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 mobility 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. Thermodynamics 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+20

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.

### Section-A

**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  $\pi$ -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

### Section-B

**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.

### Section-C

**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.

**Inorganic Chemistry Practical-I**  
**Paper –IV CY (H)- 104**

**M.Sc. Chemistry (1<sup>st</sup> Semester)**

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.

**Physical Chemistry Practical - I**  
**Paper V; CY (H) -105**

**M.Sc. Chemistry (1<sup>st</sup> Semester)**

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

**1. Conductometry**

- (i) To determine cell constant of conductivity cell.
- (ii) NaOH vs. HCl titration.
- (iii) NaOH vs. Oxalic acid titration.
- (iv) NaOH vs CH<sub>3</sub> COOH titration
- (v) Ba (NO<sub>3</sub>)<sub>2</sub> vs. Na<sub>2</sub> SO<sub>4</sub> titration

**2. Thermochemistry**

Determination of heat of neutralization of the followings:-

- (i) NaOH vs. Hcl
- (ii) NaOH vs. CH<sub>3</sub> 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.

**Organic Chemistry Practical-I  
Paper-VI CY (H) -106**

**M.Sc. Chemistry (1<sup>st</sup> Semester)**

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

**1. Quantitative Analysis.**

Separation, purification and identification of organic compounds in binary mixtures by chemical tests and preparation of their 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 CY (FC)-107 Computer for Chemists**

2 hrs. / Week

Credits: 02

Max. Marks: 40

Time: 2 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.

### Essentials of Computer:

Historical Evolution of Computers, Block diagram of a Computer and functions of various units; Classification of Computers; Input/Output devices ( Display Devices, Printers, etc. ) Memories: RAM, ROM, Cache Memory, Virtual memory; Mass-storage Media: Magnetic Disks, Magnetic Tapes and Optical Disks; Batch processing systems, Time sharing systems, Multiprocessor, Parallel Processing Systems.

Introduction to Programming languages: 1 GL to 5 GL languages. Software and its types; Operating System with DOS as an example, Introduction to UNIX and Windows.

Overview of: Information Technology (IT), Data Communication, Computer Networks (LAN, WAN and MAN) and their applications, Introduction to Internet and Intranet technology.

**Computer Applications:** Scientific, Business, Research, Sports, Medicine & Health Care, Engineering, Teaching etc.

**Problem Solving:** Problem Identification, Analysis, flowcharts, Decision Tables, Pseudo codes and algorithms, Program Coding, Program Testing and Execution.

### Books Suggested

- 1 Computers and Common Sense, R. Hunt and J. Shelley, Prentice Hall.
- 2 Computational Chemistry, A.C. Norris.
- 3 Microcomputer Quantum Mechanics, J.P. Killngbeck, Adam Hilger.



## M.Sc. Chemistry (2<sup>nd</sup> Semester)

Paper- VII 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

#### Metal-Ligand Bonding

Limitation of crystal field theory, molecular orbital theory, octahedral, tetrahedral or square planar complexes,  $\pi$ -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 1st series of transition metals, Orgel and Tanabe-Sugano diagrams for transition metal complexes ( $d^1 - d^9$  states) calculation of  $Dq$ ,  $B$  and  $\beta$  parameters, effect of distortion on the d-orbital energy levels. Structural evidence from electronic spectrum, Jahn-Teller effect, Spectrochemical and nephelauxetic series, charge transfer spectra, electronic spectra of molecular addition compounds.

(16 Hrs.)

### Section-C

#### Magnetic 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 -π 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, dinitrogen and dioxygen 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. Earnshaw.

## M.Sc. Chemistry (2<sup>nd</sup> Semester)

Paper VIII 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

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 (Nernst 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

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. Thermodynamics 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 (2<sup>nd</sup> Semester)

Paper IX CY(H)-203 Organic Chemistry-II

4 hrs. / Week

Credits:04

Max. Marks: 80+20

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

**Aliphatic Nucleophilic Substitution:** The SN<sub>2</sub>, SN<sub>1</sub>, mixed SN<sub>1</sub> and SN<sub>2</sub>, S<sub>N</sub>i, S<sub>N</sub>1', S<sub>N</sub>2', S<sub>N</sub>i' and SET mechanisms. The neighbouring group mechanisms, neighbouring group participation by  $\pi$  and  $\sigma$  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.

### Section-B

**Aliphatic Electrophilic Substitution:** Bimolecular mechanisms - S<sub>E</sub>2 and S<sub>E</sub>i. The S<sub>E</sub>1 mechanism, Electrophilic substitution accompanied 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, Vilsmeier reaction, Gattermann-Koch reaction.

**Aromatic Nucleophilic Substitution:** The ArS<sub>N</sub>1, ArS<sub>N</sub>2, Benzyne and S<sub>RN</sub>1 mechanisms. Reactivity – effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements.

### Section-C

**Elimination Reactions:** The E<sub>2</sub>, E<sub>1</sub> and E<sub>1</sub>cB 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.

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

**M.Sc. Chemistry (2<sup>nd</sup> semester)**

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.

**Physical Chemistry Practical II  
Paper XI; CY (H) -205**

**M.Sc. Chemistry (2<sup>nd</sup> semester)**

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<sub>3</sub>COOH titration.

**2. pH metry**

- (i) NaOH Vs. HCl titration.
- (ii) NaOH vs Oxalic acid titration.
- (iii) NaOH vs. CH<sub>3</sub>COOH 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<sub>2</sub>SO<sub>4</sub>).

**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.



**Organic Chemistry Practical-II**  
**Paper-XII CY (H) -206**

**M.Sc. Chemistry (2<sup>nd</sup> semester)**

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.(2<sup>nd</sup> Semester)

Paper- XIII; 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.(2<sup>nd</sup> Semester)**

**Paper:-XIV; CY(S) – 208**

**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, Qualitative and quantitative Analysis.

**Flame Photometry**- Principles, Interferences, Evaluation methods in Flame Photometry, Principle and Applications of TGA and DTA.

### **Unite – II**

#### **Nano materials Technology:**

Nano materials and their historical perspective. Applications of nanoscience and nanotechnology in various fields. Unique properties of nanomaterials due to their nanosize, Quantum dots, Techniques for their synthesis:- Hydrothermal, Solvothermal, Microwave irradiation, sol-gel, Precipitation, Reverse Micelle Synthesis, Physical Vapour deposition (PVD), Chemical Vapour Deposition (CVD), Electro deposition, 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. Properties of nanostructured materials: opticals, magnetic, chemical and photo catalytic properties.

### **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. Introduction 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.(2<sup>nd</sup> Semester)

Paper:- XV ; 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

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

### **Unit III**

**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.

## M.Sc.(3rd Semester)

Paper XVI (a) CY (H)-301(a) Inorganic Special-I

8 hrs. / Week

Credits: 04

(Instrumental Techniques)

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.

### Section-A

**Vibrational Spectroscopy:** Symmetry and shapes of  $AB_2$ ,  $AB_3$ ,  $AB_4$ ,  $AB_5$  and  $AB_6$ , modes of bonding of ambidentate ligands, ethylenediamine and diketonate complexes, application of resonance Raman Spectroscopy particularly for the study of active sites of metalloproteins as myoglobin and haemoglobin.

15 Hrs.

### Section-B

**Electron Spin Resonance Spectroscopy:** Principle, Presentation of the spectrum, hyperfine coupling, hyperfine splitting in various structures, Factors affecting magnitude of g, zero field splitting and Kramer's degeneracy, Applications to transition metal complexes having one and more than one unpaired electron, applications to inorganic free radicals, study of electron exchange reactions.

15 Hrs.

### Section-C

**Mossbauer Spectroscopy:** Basic Principles, spectral display, isomer shift, factors affecting the magnitude of isomer shift, quadrupole and magnetic hyperfine interaction, applications of technique to the study of bonding and structure of  $Fe^{2+}$ ,  $Fe^{3+}$ ;  $Sn^{2+}$  and  $Sn^{4+}$  compounds; detection of oxidation states, nature of M-L bond,.

( 8 Hrs.)

**Mass Spectrometry:** Principle, representation, interaction of molecule with high energy electrons, interpretation of mass spectrum, effect of isotopes on appearance of mass spectrum; applications- finger print application, molecular weight determination, evaluation of heat of sublimation of high melting solids.

(7 Hrs.)



## Section-D

**Nuclear Magnetic Resonance Spectroscopy:**  $^{19}\text{F}$  and  $^{31}\text{P}$  NMR spectra – Chemical shifts, coupling constants,  $^{19}\text{F}$  Spectra of fluoroacetone, 1-bromo-1-Fluoroethane, dimethyl phosphorus trifluoride and bromine pentafluoride ;  $^{31}\text{P}$  spectra of  $\text{HPF}_2$   $\text{HPO}(\text{OH})_2$   $\text{H}_2\text{PO}(\text{OH})$ , cis-  $\text{Pt}(\text{Pet}_3)_2 \text{Cl}_2$ , Application of  $^{31}\text{P}$  NMR for structural determination of Complexes with phosphorus ligands.

**Spectra of Paramagnetic materials:** Contact shift, its origin and application, Pseudo contact shift, Diamagnetic complexes, Spectra of free radicals, Lanthanide shift Reagents, Magnetic susceptibility Measurement.

Solid state NMR- Wide line NMR, Magnetic Angle spinning and Applications Magnetic Resonance Imaging.

**Nuclear Quadrupole Resonance Spectroscopy:** Introduction, Nuclear Quadropole Moment, Electric field gradient and Asymmetry Parameter.

Nuclear Quadrupole Transitions- Axially symmetric and Non-symmetric Molecules.

Effect of an External magnetic field

Application-(i) Chemical bonding and Structure

(ii) Solid state Effects.

(iii) Hydrogen Bonding.

Experimental aspects

### Books Recommended:

1. Vibrational Spectroscopy – D.N. Sathyanarayana.
2. Introduction to Magnetic Resonance Spectroscopy ESR, NMR, NQR - D.N. Sathyanarayana.
3. Physical methods in Inorganic Chemistry – Russel S. Drago.
4. Infrared & Raman Spectra of Inorganic & Co-ordination compounds – K. Nakamoto.
5. Inorganic Infrared & Raman Spectra – S.D. Ross.

## M.Sc. (3<sup>rd</sup> Semester)

Paper XVI (b) CY (H)-301(b) Physical Special-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.

### Section-A

**Electrified Interfaces:** Thermodynamics of electrified interfaces: electrocapillary thermodynamics, non-polarizable interface and thermodynamic equilibrium, fundamental thermodynamic equation of polarizable interfaces, determination of excess charge density on the electrode, electrical capacitance and surface excess of the interface, potential of zero charge, Helmholtz-Perrin model, Gouy - Chapman model and Stern model of electrified interfaces.

### Section-B

**Ionic Liquids:** The thermal dismantling of an ionic lattice, characteristics of ionic liquids, The fundamental problems in the study of pure liquid electrolytes, models of simple ionic liquids: lattice oriented models (Vacancy model, Hole model) , quantification of the hole model, The Furth approach to the work of hole formation, distribution function for the sizes of the holes and the average size of a hole.

**Electrodics:** Rate of charge- transfer reactions under zero fields, under the influence of an electric field, the equilibrium exchange current density, the non-equilibrium drift-current density (Butler - Volmer) equation. Some general and special cases of Butler- Volmer equation, the high-field and low-field approximations, physical meaning of the symmetry factor ( $\beta$ ), a preliminary to a second theory of  $\beta$ , a simple picture of the symmetry factor and its dependence on overpotential. Polarizable and non-polarizable interfaces.

### Section-C

**Adsorption :** Surface tension, capillary action, pressure difference across curved surface (Laplace equation), Gibb's adsorption equation and its applications, determination of BET equation and its application for the determination of surface area; surface active agents and their classification, concept of micelles, critical micelle concentration (cmc), determination of cmc by conductivity and surface tension methods; factors affecting cmc, counter - ion binding to micelles, thermodynamics of micellization

## Section-D

**Chemical Dynamics:** Study of fast reactions, Flow method, Relaxation method, Flash photolysis and shocktube method. Theories of unimolecular reactions: Lindemann's theory, Hinshelwoods treatment, R.R.K. and R.R.K.M. theories, The theory of absolute reaction rates, potential energy surfaces, activation energies, London— Eyring - Polanyi method for the calculation of energy of activation.

### Books Recommended:

1. Modern electrochemistry Vol.1 & 2 by J.O.M. Bockris and A.K.N. Reddy
1. Chemical Kinetics by K.J. Laidler
2. Kinetics & Mechanism of reaction rates by A.Frost & G.Pearson
3. Theories of reaction rates by K.J. Laidler, H.Eyring & S. Glasstone.
4. Electrochemistry by S.Glasstone.
- 5.

## M.Sc. (3<sup>rd</sup> Semester)

Paper XVI(c)      CY (H)-301(c)      Organic Special-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.

### Section-A

#### **Ultraviolet and Visible Spectroscopy:**

Introduction – Electronic energy levels, electronic transitions and selection rules. The origin, general appearance and designation of UV bands, absorption laws and measurement of absorption intensity, chromophores, auxochromes, bathochromic shift, hypsochromic shift, hypochromic effect and hyperchromic effect. The ultraviolet spectrometer-. Woodward and Fieser's rules for calculating ultraviolet absorption maxima for substituted dienes and conjugated dienes, unsaturated carbonyl compounds and aromatic carbonyl compounds. Applications of UV spectroscopy to problems in organic chemistry.

### Section-B

#### **Infrared Spectroscopy:**

Introduction – basic theory and instrumentation including FT IR infrared spectrum. Functional group and finger print regions. Absorption of infrared radiation and molecular vibrations. Fundamental vibrations and overtones. Intensity and position of infrared absorption bands and bands resulting from combination or difference of vibrational frequencies or by the interaction of overtones (or combination bands) with the fundamental vibrations (fermi resonance). Frequency of vibrations of a diatomic molecule, spectral features of major functional groups: alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols, ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams, conjugated carbonyl compounds and amines. Effect of hydrogen bonding and solvent effect on vibrational frequencies, Overtones, combination bands and fermi resonance. Applications of IR spectroscopy to problems in organic chemistry.

### Section-C

#### **Nuclear Magnetic Resonance Spectroscopy:**

Introduction – spin active nuclei behave as spinning nuclear magnets, orientation of spinning nuclear magnets in a uniform magnetic field and energy description of NMR phenomenon. Continuous wave (CW) NMR spectrometer and Fourier transform (FT) NMR spectrometer. Phenomenon of resonance and relaxation, chemical shift, chemical shift parameters and internal

standards, Factors affecting the chemical shift: shielding and deshielding of a nucleus, substitution effects leading to empirical co-relations for proton chemical shifts, anisotropic effect, effect of changing solvents, effect of hydrogen bonding, influence of chirality on the chemical shifts of enantiomers and intermolecular Vander Walls deshielding, Spin spin coupling, multiplicity of splitting and relative intensity of lines in a multiplet, integration, mechanism of coupling-one bond coupling ( $^1J$ ), two bond coupling ( $^2J$ ) three bond coupling ( $^3J$ ) including Karplus relationship. Techniques for simplification of complex spectra, solvent effects, Lanthanide shift reagents, spin decoupling (double resonance), Fourier Transform technique and Nuclear Overhauser effect (NOE). Effect of sensitivity of C-13 NMR compared to H-1 NMR, comparison of C-13 NMR and H-1 NMR, chemical shifts of C-13 NMR. Simplification of C-13 spectra by process of decoupling, off resonance decoupling.

### Section-D

#### Mass Spectroscopy:

Introduction – basic theory, instrumentation, process of introducing the sample into mass spectrometer. Methods of generation of positively charged ions, electron ionization method, chemical ionization, FD and fast atom bombardment (FAB) techniques. Mass spectrum, base peak, molecular and parent ion, Mass to charge ratio (M/Z), relative intensity, fragment ions, even electron rule, nitrogen rule, metastable ions, McLafferty rearrangement and ortho effect. Determination of molecular weight and molecular formula using mass spectrometry

#### Optical Rotatory Dispersion (ORD) and Circular Dichroism (CD):

Definition, haloketone rule, octant rule for ketones.

Cotton effect and Cotton curves, deduction of absolute configuration.

#### Books Recommended:

1. Spectroscopic Identification of Organic Compounds by R.M. Silverstein, G.C. Bassler and T.C. Morrill.
2. Introduction to NMR Spectroscopy by R.J. Abraham, J.Fisher and P.Loftus.
3. Applications of Spectroscopy of Organic Compounds by J.R. Dyer.
4. Spectroscopic Methods in Organic Chemistry by D.H. Williams and I.Fleming.
5. Organic Spectroscopy by Jag mohan.
6. Organic Spectroscopy by W. Kemp.
7. Organic Spectroscopy by Pavia.

## M.Sc. (3<sup>rd</sup> Semester)

Paper XVII (a) CY (H)-302 (a) Inorganic Special-II

4 hrs. / Week

Credits: 04

(Nuclear & Radiochemistry)

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.

### Section-A

**Nuclear Binding Energy:** Justifications and applications; nuclear stability rules and decay of unstable nuclei.

**Nuclear Structure:** Nuclear forces; liquid drop model, Shell Model and collective model. (15 hrs.)

### Section-B

**Interaction of Radiation with matter:** Physical and chemical effects of radiation on matter (photoelectric effect, Compton effect and pair production). (7 hrs.)

### **Radiochemical Techniques:**

NAA - Principle, Application and Limitation

IDA - Principle, Application and Limitation

Radiometric titrations.

(8 hrs.)

### Section-C

**Detection of Nuclear Radiation:** Various methods of detecting nuclear radiations, Gas-filled counters – Ionization chamber; Proportional counter and G.M. counters. Scintillation detectors; Solid state detectors. (15 hrs.)

### Section-D

**Nuclear Reactions:** Energetics of nuclear reactions; various types of nuclear reactions including photonuclear, thermonuclear and spallation reactions; mechanism of nuclear reaction by compound nucleus model.

**Nuclear fission** – Fission probability; energy release; theories of fission.

**Nuclear Fusion:** Brief idea about breeder reactors,; accelerators and cyclotron.

(15 hrs.)

### **Books Recommended:**

1. Essentials of Nuclear Chemistry – H. J. Arnikaar.
2. Radio Chemistry & Nuclear Chemistry – G.Choppin, J.O. Liljenzin & J.Rydberg.
3. Nuclear Chemistry – M. Sharon.
4. Modern Nuclear Chemistry – W.D. Loveland, D.J. Morrissey & G.T. Seaborg.
5. Handbook of Nuclear Chemistry: Instrumentation, Separation Techniques, Environmental issues – A. Vertes, S. Nagy & Z. Klencsar.

## M.Sc. (3<sup>rd</sup> Semester)

Paper XVII(b) CYH-302(b) Physical Special-II

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

### Section-A

**Statistical Thermodynamics:** Concept of distribution, Thermodynamic probability and most probable distribution; Canonical, grand canonical and micro canonical ensembles. Maxwell - Boltzmann statistics, Statistical thermodynamic formulation of Maxwell - Boltzmann distribution law, Maxwell - Boltzmann law of distribution of energy and evaluation of average velocity, root mean square velocity; Law of equipartition of energy; Partition function and its factorization, relationship of atomic and molar partition function to thermodynamic properties (i) internal energy (ii) entropy (iii) Gibbs free energy (iv) heat content (v) work function (vi) pressure and heat capacity at constant volume and pressure. Derivation of equation of state for a mono atomic ideal gas.

### Section-B

Translational partition function, calculation of absolute entropy of an ideal monoatomic gas, Sackur-Tetrode equation, Vibrational, Rotational, and electronic partition function of diatomic molecules, Derivation of expressions for translational, vibrational, rotational and electronic energies; expressions for entropy, Gibbs free energy, work function due to translational, vibrational and rotational motion of a molecule. Effect of change of zero point energy on partition function and also on thermodynamic properties like internal energy, Gibbs free energy, enthalpy, work function & entropy. Chemical equilibrium and equilibrium constant in terms of partition functions, Free energy function.

### Section-C

Quantum mechanical treatment of Helium atom and the failure of rigorous quantum mechanical method. Need of approximate methods, first order perturbation theory (excluding time dependent), Variation principle. Application of first order perturbation and variation principle to evaluate ground state of helium atom. Applicability of perturbation theory to an electron in a one dimensional box under the influence of electric field.

### Section-D

Valence bond method, valence bond method to hydrogen, hydrogen molecule ion (their symmetric and anti symmetric solution without actual valuation of various integrals, energy of molecular hydrogen system, LCAO-MO approximation, refined treatment of hydrogen molecules Concept of resonance and its role in the stability of hydrogen molecule ion, electron spin, Pauli's exclusion principle, hybridization.

Books Recommended:

1. Theoretical chemistry by S. Glasstone
2. Quantum chemistry by Levinine
3. Quantum chemistry by Pauling, Eyring & Wilson
4. Introduction to Statistical Mechanics by L.K. Nash.



## **M.Sc. (3<sup>rd</sup> Semester)**

**Paper XVII(c)      CY(H)-302(c)      Organic Special-II**

4 hrs. / Week

Credits: 04

Max. Marks: 80+20

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*

### **Section-A**

#### **Vitamins**

Structure and synthesis of vitamins A, B<sub>1</sub>, B<sub>2</sub>, B<sub>6</sub>, C, D, E, nicotinic acid, pantothenic acid and Biotin

### **Section-B**

#### **Carotenoids:**

General methods of structure elucidation and synthesis of  $\alpha$ -carotene,  $\beta$ -carotene, lycopene, and  $\gamma$ -carotene. Biosynthesis of carotenoids

#### **Porphyryns:**

Structure, spectral properties and synthesis of Porphyrins and Haemin. Structure of chlorophyll (without synthesis)

### **Section-C**

#### **Plant pigments:**

Occurance, general chemical and spectroscopic methods for structure determination.

Structure elucidation and synthesis of Flavone, Chrysin, Flavonol, Quercetin, Diadazin, Xanthone, Euxanthone, Cyanidin chloride, Malvidin chloride, Hirsudin chloride.

Biosynthesis of flavonoids: Acetate pathway and shikimic acid pathways.

## Section-D

### **Enzymes and co-enzymes:**

Introduction to biological catalysis, nomenclature, classification and specificity.

**Kind of reaction catalysed by enzymes:** Oxidation – reduction, isomerisation, epimerisation, hydrolysis, phosphorylation, acylation, methylation, decarboxylation and dehydration.

**Co-enzymes:** Chemistry of Co-enzymes; Co-I, Co-II, Co-A, Co-carboxylase, FMN, FAD and Pyridoxal phosphate

### **Books Recommended:**

1. Bioinorganic Chemistry: A Chemical Approach to Enzyme Action by Herman Duags and C. Penny.
2. Understanding Enzymes by Trevor Palmer
3. Enzyme Chemistry, Impact and Applications by Ed. Collin J. Suckling.
4. Enzyme Mechanisms Ed, M.I. Page and A. Williams
5. Fundamentals of Enzymology by N.C. Price and L. Stevens.
6. The Chemistry of Natural products by P.S. Kalsi.
7. Organic Chemistry by I.L. Finar.

## M.Sc.(3<sup>rd</sup> Semester)

Paper XVIII (a) CY (H)-303(a) Inorganic Special-III  
(Bio-Inorganic Chemistry and Environmental Chemistry)

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.

### Section-A

**Metal Ions in Biological Systems:** General survey of essential and trace metals, Disturbing factors in metabolic process and causes of diseases, different classes of drugs.

(5 Hrs.)

**Alkali and alkaline earth metals in biological systems:** Ionophores, active transport of cations across membranes, sodium pump, Calcium pump, Calcium carriers, role of carriers in muscle contraction, blood clotting and hormones.

(7 hrs.)

**Interaction of metal ions with Nucleotides:** metal ions in nucleotide systems, effect of metal ions on nuclei acids.

(3 hrs.)

### Section-B

Oxygen carriers: Porphyrins, metalloporphyrins, Hemoproteins, structure and functions of hemoglobin and myoglobin, synthetic oxygen carrier model systems (6 hrs.)

**Nitrogen fixation:** Biological nitrogen fixation, Nitrogenase, model for nitrogenase, metal-N<sub>2</sub> complexes, photosynthesis and chlorophyll. (6 hrs.)

**Metal transport and storage:** Transferrin, Ferritin, Siderophores (3 hrs.)

### Section-C

#### **Metalloenzymes:**

Zinc Enzymes – Carboxypeptidase & Carbonic anhydrase

Iron Enzymes – Catalase, peroxidase & cytochrome P- 450

Copper Enzymes – Superoxide dismutase, blue copper- proteins

Coenzymes – Vitamins B<sub>12</sub>

(15 hrs.)

## Section-D

**Environmental Chemistry:** Atmosphere: Chemical composition of atmosphere, atmospheric structure, Earth's radiation balance; oxides of N,C,S and their effects, Green house effect, acid rain, photochemical smog , air quality standards, depletion of ozone, particulate matter in atmosphere , mechanism of aerosol formation in air, Noise pollution and their health hazards.

### **Books Recommended:**

1. Inorganic Chemistry: Principles of Structure & Reactivity – J.E. Huheey.
2. Environmental Chemistry – A.K. De.
3. Environmental Pollution Analysis – Khopkar.
4. Environmental Chemistry – V. Subramaniam.

## M.Sc. (3<sup>rd</sup> Semester)

Paper XVIII(b) CY(H)-303(b) Physical Special-III

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

### Section-A

**Spin Resonance Spectroscopy:** Spin and an applied field; the nature of spinning particles, interaction between spin and magnetic field, Larmor precession, population of energy levels. Nuclear Magnetic Resonance Spectroscopy; Hydrogen Nuclei, the chemical shift, the coupling constant, coupling between several nuclei, analysis by NMR technique, exchange phenomena, simplification of complex spectra.

### Section-B

Electron spin resonance spectroscopy; the theory of E.S.R. the position of E.S.R. absorption, the g factor, the fine and hyperfine structures of E.S.R. absorption. Applications of E.S.R. spectroscopy.

**Moss Bauer Spectroscopy:** Theory of Moss-Bauer spectroscopy, the chemical shift quadrupole effects, the effect of magnetic field. Applications of Moss-Bauer spectroscopy.

### Section-C

**Introduction:** Definition of corrosion, importance and cost of corrosion classification of corrosion

**Electrochemistry of Corrosion:** Electrode reactions, electrode potentials, electrochemical cell formation, Nernst equation, exchange current density, polarization of electrode (resistance, concentration and activation), mixed potential theory, polarization diagrams, pourbaix diagrams, corrosion rate expression and weight loss method for corrosion rate, galvanic series. Electrochemical techniques to study corrosion – Galvanostatic and potentiostatic techniques, Stern –Geary equation, Tafel slopes, measurement of corrosion potential and corrosion current density, Tafel extrapolation and Linear polarization resistance methods, recording and interpretation of anodic and cathodic polarization curves.

## Section-D

**Kinetics of Passivity:** Introduction , electrochemical behaviour of active/passive metals, Flade potential, criteria for selecting a metal exhibiting passivity, factors influencing electrochemical passivity and corrosion rate, theories of passivity.

**Protection Methods against Corrosion:** Change of metal, design improvement, change of environment, anodic protection, cathodic protection and protective coatings.

Corrosion inhibitors: classification, mechanism, selection of corrosion inhibitors, inhibition efficiency and factors influencing inhibition efficiency, measurement of inhibition efficiency.

### Books Recommended:

1. Introduction of molecular spectroscopy by G.M. Barrow
2. Fundamental of molecular spectroscopy by C.N. Banwell
3. Corrosion inhibitors Principle & Applications by V.S. Sastri
4. Corrosion by K.R. Trephey & J. Chamberlain
5. Introduction to Metallic corrosion & its prevention by Raj Narain
6. An introduction to the Science of Corrosion and its inhibition By S.N. Banerjee.
7. Corrosion engineering by M.G. Fontana

## **M.Sc. (3<sup>rd</sup> Semester)**

**Paper XVIII (C)      CY(H)-303 (C)      Organic Special-III**

4 hrs. / Week

Credits: 04

Max. Marks: 80+20

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

### **Section-A**

**Heterocyclic Compounds:** General behaviour, Classification, Criteria of aromaticity, Tautomerism

**Five membered Heterocycles:** Synthesis and reactions of 1, 3-Azoles: Imidazole, Thiazole and Oxazole

### **Section-B**

**Six membered Heterocyclics with two heteroatoms:** Detailed study of Pyrimidines and Purines. Structural elucidation of uric acid and caffeine.

**Nucleosides and Nucleotides:** Structure of Nucleosides and Nucleotides, General synthesis of Nucleotides and polynucleotides.

### **Section-C**

#### **Ylides:**

General methods of formation, General study of reactions with their mechanisms of Nitrogen (Ammonium, Immonium, Diazonium and Nitrile), Phosphorous and Sulphur ylides and their applications.

## Section-D

### **Synthetic Drugs:**

Relation between physiological action and chemical constitution

Antimalarials, antipyretics, analgesics, sulpha drugs, Anthelmintics, antifertility and anticancer drugs.

### **Books Recommended:**

1. Heterocyclic Chemistry by R.R. Gupta, M. Kumar and V. Gupta.
2. Heterocyclic Chemistry by T.L. Gilchrist.
3. Heterocyclic Chemistry by V.K. Ahluwalia.
4. Organic Reaction Mechanism by V.K. Ahluwalia & R.K. Parashar.
5. Reaction Mechanism in Organic Synthesis by S.M. Mukherji, S.P. Singh & R.P. Kapoor.
6. Organic Name Reactions- A Unified Approach by Gautam Brahmachari.
7. Organic Chemistry by I.L. Finar.
8. An Introduction to Medicinal Chemistry by Graham L. Patrick.
9. Textbook of Organic Medicinal and Pharmaceutical Chemistry by Charles O. Wilson, Ole Gisvold & Robert F. Doerge.
10. Principles of Medicinal Chemistry by William O. Foye, Thomas L. Lemice and David A. Williams.
11. Burgers Medicinal Chemistry and Drug Discovery by M.E. Wolff.



**Inorganic Special Practical-I**  
**Paper-XIX (a)      CY(S)-304(a)**

**M.Sc. 3<sup>rd</sup> Semester**

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

(1) Preparation of selected Inorganic Compounds complexes. Handling of air and moisture sensitive compounds.

- |    |  |          |
|----|--|----------|
| a. | Chromous Acetate   | 40 Marks |
| b. | Hg [Co (SCN) <sub>4</sub> ]  |          |
| c. | [ Cu(NH <sub>3</sub> ) <sub>4</sub> ] So <sub>4</sub> . H <sub>2</sub> O   |          |
| d. | [ Ni(NH <sub>3</sub> ) <sub>6</sub> ] Cl <sub>2</sub>  |          |
| e. | K <sub>3</sub> [Fe (C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> ]   |          |
| f. | VO (acac) <sub>2</sub>   |          |
| g. | Prussian blue  |          |
| h. | [ Co (NH <sub>3</sub> ) <sub>5</sub> Cl]Cl <sub>2</sub> , [ Co (NH <sub>3</sub> ) <sub>5</sub> NO <sub>2</sub> ]Cl <sub>2</sub> , [ Co (NH <sub>3</sub> ) <sub>5</sub> ONO]Cl <sub>2</sub> |          |
| i. | K <sub>3</sub> [Al (C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> ]   |          |
| j. | [Ni (en) <sub>3</sub> ] S <sub>2</sub> O <sub>3</sub> etc.   |          |

Record File 05 marks

Viva-Voce 05 marks

**Physical Special Practical-I**  
**Paper-XIX (b) CY (S)-304(b)**

**M.Sc. Chemistry (3rd Semester)**

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

**1. Potentiometry**

- (i)  $\text{KMnO}_4$  vs. Mohr's salt or  $\text{FeSO}_4$  titration
- (ii)  $\text{K}_2\text{Cr}_2\text{O}_7$  vs. Mohr's salt or  $\text{FeSO}_4$  titration.
- (iii)  $\text{AgNO}_3$  vs.  $\text{KCl}$  or  $\text{KI}$  titration
- (iv)  $\text{AgNO}_3$  vs. ( $\text{KCl} + \text{KI}$ ) mixture titration
- (v)  $\text{AgNO}_3$  vs. ( $\text{KCl} + \text{KBr} + \text{KI}$ ) mixture titration
- (vi)  $\text{Fe}^{2+}$  vs  $\text{Ce}^{+4}$  titration.

**2. pH metry**

- (i)  $\text{NaOH}$  vs Succinic Acid titration
- (ii)  $\text{NaOH}$  vs Citric Acid titration
- (iii) To predict composition of Copper amine complex from  $\text{CuSO}_4$  vs.  $\text{NH}_4\text{OH}$  titration.
- (iv) To determine dissociation constant of weak acid
- (v) To determine dissociation constant of acetic acids in acetone by titrating with Potassium hydroxide.
- (vi) To determine degree of hydrolysis of aniline hydro chloride.

**3. Dipole metry**

To determine the dielectric constant of various organic liquids

Record File : 05 marks

Viva-Voce :05 marks

**Organic Special Practical-I**  
**Paper-XIX (c)      CY(S) -304 (c)**

**M.Sc. (3<sup>rd</sup> Semester)**

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

**1. Multi-step Synthesis**

- (i) Benzanilide from benzene
- (ii) Benzilic acid from benzaldehyde
- (iii)  $\alpha$ - Acetylamino cinnamic acid from glycine
- (iv) p-Nitrobenzanilide from benzophenone.

40 Marks

Record File

05 marks

Viva-Voce

05 marks

**Inorganic Special Practical-II**  
**Paper-XX(a) CY(S)-305 (a)**

**M.Sc. 3<sup>rd</sup> Semester**

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

- a. Spectrophotometric determination of Fe, Ni, Mn, Cr, V, Ti and fluoride, Nitrate and phosphate etc.
- b. Determination of pK value of an indicator spectrophotometrically.
- c. Study of complexation (Stoichiometry and stability constant) between Fe-thiocyanate, Fe-phenanthroline and Cu-ethylenediamine by Job's method/ Slop ratio method.

**Note:** Candidate is required to perform one experiment in the examination 40 marks

Record File 05 marks

Viva-Voce 05 marks

**Physical Special Practical-I**  
**Paper-XX (b) CY (S)-305(b)**

**M.Sc. Chemistry (3rd Semester)**

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

**1. Conductometry titrations**

- (i) NaOH vs. Citric acid
- (ii) NaOH vs. Succinic Acid
- (iii)  $\text{NH}_4\text{OH}$  vs  $\text{CH}_3\text{COOH}$
- (iv)  $\text{CH}_3\text{COONa}$  vs HCl
- (v) NaOH vs. (HCl +  $\text{CH}_3\text{COOH}$ ) mixture
- (vi) NaOH vs. (HCl +  $\text{CH}_3\text{COOH}$  +  $\text{CuSO}_4$ ) mixture.
- (vii) To study the conductometry titration of hydrochloric acid with sodium carbonate. Also determine the concentration of sodium carbonate in a commercial sample of soda ash.

**2. Polarimetry**

- (i) To determine specific rotation for various optically active substances.
- (ii) To determine concentration of glucose or fructose or sucrose or tartaric acid in solution

**3. Flame Photometry**

- (i) To determine the concentration of  $\text{Na}^+$  or  $\text{Li}^+$  or  $\text{Ca}^{++}$  ions in solution 40 marks

Record File 05 marks

Viva-Voce 05 marks

**Organic Special Practical-II**  
**Paper-XX(c) CY(S) -305 (c)**

**M.Sc. Chemistry (3rd Semester)**

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

**1. Quantitative Analysis**

- (a) Determination of percentage or number of hydroxyl groups in organic compound by acetylation method.
- (b) Estimation of Amines/phenols using bromate-bromide solution or acetylation method.
- (c) Determination of iodine and saponification values of oil samples.
- (d) Determination of concentration of Glucose or Sucrose in the given solution.

25Marks

**2. Isolation**

- (i) Caffeine from tea leaves
- (ii) Lactose from milk
- (iii) Cystine from human hair.

15 Marks

Record File

05 marks

Viva-Voce

05 marks

**Inorganic Special Practical-III**  
**Paper-XXI (a) CY(S)-306 (a)**

**M.Sc. 3<sup>rd</sup> Semester**

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

1. Polarographic determination of metal ions such as Zn, Cd, Mg, Tl etc. (Including mixture). Amperometric titration.
2. Estimation of metal ions by atomic absorption spectrophotometry and Flame Photometry.
3. Interpretation of Thermal Spectra (Thermogram) of the given sample by DTA/TGA  
40 marks

**Note:** Candidate is required to perform one experiment in the examination.

4. Viva-Voce 05 marks
5. Record file 05 marks

**Books Recommended:**

1. The Synthesis & Characterization of Inorganic compounds – W.L. Jolly.
2. A Text Book of Quantitative Analysis – A.I. Vogel.
3. A Text Book of Qualitative Analysis – A.I. Vogel.
4. Senior Practical Physical Chemistry – B.D. Khosla, V.C. Garg & A. Gulati

**Physical Special Practical-III**  
**Paper-XXI (b) CY (S)-306(b)**

**M.Sc. Chemistry (3rd Semester)**

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

**1. Ultrasonic Interferrometry**

- (i) To measure speed of sound for various liquids.

**2. Spectrocolorimetry**

- (i) To test the validity of Lambert Beer's Law for  $\text{KMnO}_4$  and  $\text{K}_2\text{Cr}_2\text{O}_7$   
(ii) To determine the concentration of copper sulphate, potassium permanganate and potassium dichromate in the given solution.

**3. Chemical Kinetics**

- (i) To determination the activation energy for the hydrolysis of ethyl or methyl acetate  
(ii) To determine the temperature coefficient for the hydrolysis of ethyl or methyl acetate  
(iii) To study the kinetics of reaction between potassium iodide and potassium persulphate solution

**4. Viva Voce**

**(05 marks)**

**5. Practical Note Book**

**(05 marks)**

**Books 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.



**Organic Special Practical-III**  
**Paper-XXI (c) CY(S) -306 (c)**

**M.Sc. 3<sup>rd</sup> Semester**

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

**1. Qualitative Analysis**

Identification of organic compound using spectroscopic methods ( UV, IR, NMR & Mass) followed by characterization by chemical methods.

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.(3<sup>rd</sup>Semester)**

**Paper:- XXII ; CY(OE)-307**

**Environmental Chemistry-II 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**

**Water Quality parameters and standards:** Analytical methods for measuring DO, BOD, COD, fluoride, oils and grease and metals (As, Cd, Hg, Pb, Zn Cu, Cr), Biochemical effects of As, Cd, Hg, Pb, Cr, CN and pesticides.

**Lithosphere:** soil composition, micro and macro nutrients, soil pollution-fertilizers, pesticides.

### **Unit-II**

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

### **Unit-III**

**Green Chemistry:-** Importance, Principles of Green Chemistry, Thrust Areas, Applications of non-conventional techniques in organic synthesis: Ultrasonic, microwave and grinding, solid state synthesis and synthesis under solvent free conditions, Use of Ionic Liquids.

**Persistent Organic Pollutants:** Aldrin, chlordane, Dieldrin,, Dioxins, DDT, Endrin, Furans, Heptachlor, Hexachlorobenzene, Mirex, Polychlorinated biphenyls, Toxaphene.

### **Books Recommended**

1. Environmental Chemistry – A.K. De
2. Environmental Chemistry- Manaham.
3. Environmental Pollution Analysis- Khopkar.
4. Environmental Chemistry- V. Subra maniam.
5. Chemistry of Atmosphere-Murray J. Mc Ewan and Leon F. Philips.
6. Atmospheric Chemistry – J. Heichlen.

## M.Sc. (4<sup>th</sup> Semester)

### Paper XXIII (a) CY (H)-401(a) Inorganic Special-IV (Organotransition metal Chemistry)

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.

#### Section-A

Introduction and Classification of organometallic compounds by bond types viz. covalent, ionic, electron deficient and cluster compounds. (7 Hrs.)

**Alkyls and Aryls of Transition Metals:** Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis. (8 Hrs.)

#### Section-B

**Transition Metal  $\pi$ -Complexes:** Transition metal  $\pi$ -complexes with unsaturated molecules-alkenes, alkynes, allyl, & diene(metallocene) complexes, preparation, properties and nature of bonding and structural features, important reactions related to nucleophilic and electrophilic attack on ligands and to organic synthesis.

(15 Hrs.)

#### Section-C

**Compounds of Transition Metal-Carbon Multiple Bonds:** Transition metal-carbene complexes: Fischer type and Schrock type carbene complexes, their synthesis, reactions and structures & bonding; Transition metal-carbyne complexes: their synthesis, reactions and structural features.

(15 Hrs.)

#### Section-D

**Fluxional Organometallic Compounds:** Fluxionality & dynamic equilibria in compounds such as acyclic alkenes,  $\sigma$ -bonded and  $\pi$ -bonded cyclic alkenes, rotation of ligands on metals, ligand scrambling on metals.

(7 Hrs.)

**Applications of Transition metal Organometallics as Catalysts:** Zeigler-Natta polymerization ; homogeneous catalytic hydrogenation; alkene hydrogenation-Wilkinson Catalyst; Oxidation of

olefins-Wacker's process; hydroformylation of olefins – the oxo process.

**8 Hrs.)**

### **Books Recommended**

1. Principles & Applications of Organotransition metal Chemistry by J.P. Collman, L.S. Hegehus, J.R. Norton & R.G. Finke.
2. Organometallic Chemistry – R.C. Mehrotra & A.Singh.
3. Principles of Organometallic Chemistry – G.E. Coates, M.L.H. Green, P. Powel & K. Wade.
4. Transition Metal Organometallic Chemistry – R.B. King.
5. Organotransition Metal Chemistry – V. Ishii & M.Tsutsui
6. The Organometallic Chemistry of the Transition Metals – R.H. Crabtree.

## M.Sc. (4<sup>th</sup> Semester)

Paper XXIII (b); CY (H)-401(b) Physical Special-IV

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.

### Section-A

**Applications of Electrochemistry:** The maximum intrinsic efficiency, actual efficiency and current - potential relation in an electrochemical energy converter, factors influencing the electrochemical energy conversion, the power output of an electrochemical energy converter. Electrochemical electricity generators (fuel cells), brief idea about H<sub>2</sub>- O<sub>2</sub>, hydrocarbon - air, and natural gas & CO -air fuel cells. Electricity storage: some important quantities in electricity storage (electricity storage density, energy density, power), desirable conditions for an ideal storor , storage of electricity using the lead-Acid battery, dry cell, silver-zinc cell and Sodium-Sulfur cell, Amperometric titrations determination of activation energy for an irreversible electrode process.

### Section-B

**Polarography:** General principles of polarography, the limiting current, diffusion current, derivation of Ilkovic equation, consequences of the Ilkovic equation, Koutecky's equation for diffusion current, half -wave potential, equations for reversible cathodic, anodic, and cathodic-anodic waves, analysis of reversible polarographic wave, factors affecting the half- wave potential, reversible processes controlled by diffusion of complex ions, (Me<sup>n+</sup> + pX<sup>m-</sup> ⇌ [MeX<sub>p</sub>]<sup>(mp-n)-</sup> , reversible reduction of organic substances (quinone - quinol system).

Irreversible electrode processes : An approximate treatment of a slow electrode process and regorous treatment of a slow electrode process, irreversible reduction of complexes, polarography of organic substances, polarographic coulometry at constant potential, determination of number of electrons by analysis of the decrease in the limiting current.

### Section-C

**Polymers:** Classification of polymers and polymerisation, condensation and addition polymers, kinetics of condensation (step-wise) polymerisation, size distribution in linear condensation polymers, molecular size control, degree of polymerization; mechanism of vinyl radical polymerisation, molecular weight and its determination, effect of temperature and pressure on chain polymerisation, stereochemistry of polymer chain & stereo regular polymerisation, Ionic polymerisation (similarities and contrast), kinetics of cationic, anionic polymerisation, kinetics of copolymerisation, criteria for polymer solubility; Mass number and Mass average molecular weight, determination of molecular weight of polymers by osmometry, viscometry, light scattering and sedimentation methods.

## Section-D

### Polymers:

Statistical method of biopolymers: Chain configuration of polymer chains, statistical distribution of end to end dimensions (freely jointed chains in **ID & 3 D**); influence of bond angle restriction, radius of gyration, thermodynamics of biopolymer solution (entropy of mixing & liquid state model along with limitation), free volume theory, heat and free energy of mixing.

### Books Recommended:

1. Text book of Polymer science by F.W. Billmeyer & Jr. Wiley
2. Contemporary polymer chemistry by H.R. Alcock & F.W. Lambe.
3. Physics & Chemistry of polymer by J.M.C. Cowie
4. Polymer Chemistry by P.J. Flory
5. Modern Electrochemistry Vol.1 & II by J.O.M. Bockris & A.K.N. Reddy
6. Electrochemistry by S. Glasstone
7. Electrochemistry by P.H. Reiger.
8. Polarography by Heyrovsky.
9. Introduction to Polarography & Allied Techniques by Zutshi Kannala

M.Sc. (4<sup>th</sup> Semester)

**Paper- XXIII (c)      CY (H)-401 (c)      Organic Special-IV**      4 hrs. / Week  
Credits: 04  
Max. Marks: 80+20  
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

### Section-A

#### Photochemistry

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

**Photochemistry of Alkenes:** Intramolecular reactions of the olefinic bond- geometrical isomerism, cyclisation reactions, rearrangement of 1,4 and 1,5 – dienes.

**Photochemistry of Carbonyl Compounds:** Intramolecular reactions of carbonyl compounds, saturated, cyclic, acyclic, and  $\alpha$ ,  $\beta$  unsaturated compounds. Cyclohexadienones.

### Section-B

Intermolecular cycloaddition reactions – dimerisations and oxetane formation. **Photochemistry of Aromatic Compounds:** Isomerisations, additions and substitutions. **Miscellaneous**

**Photochemical Reactions:** Photo-Fries reactions of anilides. Photo-Fries rearrangement. Barton reaction. Singlet molecular oxygen reactions. Photodegradation of polymers.

**Free Radicals:** Free radicals stability, generation and detection. Types of free radical reactions, free radicals substitution at an aromatic substrate, Hunsdiecker reaction.

### Section-C

#### Pericyclic Reactions:

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward – Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions – conrotatory and disrotatory motions,  $4n$ ,  $4n+2$  and allyl systems. Cycloadditions – antarafacial and suprafacial additions,  $4n$  and  $4n+2$  systems, Sigmatropic rearrangements – suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties, 3,3-and 5,5-sigmatropic rearrangements. Claisen and Cope rearrangements



## Section-D

### Stereochemistry

Conformational analysis of medium and large membered rings, trans annular reactions, conformational analysis of cyclohexanone, effect of conformation on reactivity of acyclic and cyclic compounds.

Stereochemistry of nitrogen containing compounds, strain and their consequences in small ring heterocycles, conformation of six membered heterocycles. Barrier to ring inversion, pyramidal inversion and 1,3-diaxial interactions.

### Books Recommended:

- 1 Molecular Photochemistry by N. J. Turro and W.A. Benjamin.
- 2 Introductory Photochemistry by A. Cox and T. Camp.
- 3 Photochemistry by R.P. Kundall and A. Gilbert.
- 4 Organic Photochemistry by J. Coxon and B. Halton.
- 5 Organic Photochemistry by Orville L. Chapman.
- 6 Pericyclic Reactions by S.M. Mukherji.
- 7 The Conservation of Orbital Symmetry by R.B. Woodward and R. Hoffman.
- 8 Orbital Symmetry by R.E. Lehr and A.P. Merchant.
- 9 Reaction Mechanism in Organic Chemistry by S.M. Mukherji and S.P. Singh.
- 10 Stereochemistry of Organic Compounds by D. Nasipuri.
- 11 Stereochemistry of Organic Compounds by P. S.Kalsi.

## M.Sc. (4<sup>th</sup> Semester)

### Paper XIV (a) CY (H)-402(a) Inorganic Special-V (Electro Analytical Chemistry)

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.

#### Section-A

Electrons at and across interfaces, Electro-chemical and chemical reactions,.

Basic principles, residual current, migration current, diffusion current and limiting current, saturated calomel electrode(SCE) and dropping mercury electrode(DME). Ilkovic equation, Koutecky equation for diffusion current, Polarographic waves(anodic and cathodic), Half wave potentials. Oxygen interference, maxima, function of supporting electrolyte,

(15 Hrs.)

#### Section-B

Determination of stability constants of complexes (reversible systems only) by D.C.Polarography, Catalytic hydrogen wave. Principles of Amperometric titrations, types of titration curves, apparatus and techniques.

Hanging mercury drop electrode, rotating dropping mercury electrode, platinum electrodes(RPE), Gold electrode, carbon paste electrode, glassy carbon electrode and graphite electrode.

(15 Hrs.)

#### Section-C.

Super imposed a.c. Polarography, voltametry in quiet and stirred solution with electrode other than mercury, square-wave polarography, normal and differential pulse polarography, chronopotentiometry, chronoamperometry and coulometry.

(15 Hrs.)

### **Section-D**

Theory of anodic stripping voltametry, concentration process, rest period, stripping process, Cathodic stripping voltametry, Anodic deposition, Cathodic redissolution, Experimental and applications of above system to Inorganic systems. Theory of ion selective electrodes, Experimental and applications of ISE to Inorganic systems.

**(15 Hrs.)**

#### **Books Recommended:**

1. Introduction to Polarography & Allied Techniques – K. Zutshi
2. Basic concepts of Analytical Chemistry – S.M. Khopkar.
3. Principles of Polarography – R.C. Kapoor & B.S. Aggarwal.
4. Fundamentals of Analytical Chemistry – Skoog West.

## M.Sc. (4<sup>th</sup> Semester)

Paper XXIV (b) CY(H)-402 (b) Physical Special-V

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

### Section-A

#### Statistical Thermodynamics:

Free energy functions and the partition functions, calculation of equilibrium constant using partition function, Bose - Einstein statistics, statistics of photon gas, gas degeneration, Fermi-Dirac statistics, extreme gas degeneration, energy of Bosons & Fermi particles, specific heat of electron gas, , Thermionic emission, comparison of Maxwell-Boltzmann, Bose -Einstein and Fermi-Dirac statistics.

### Section-B

**Non -Equilibrium Thermodynamics:** General theory of non-equilibrium processes, entropy production and entropy flow; thermodynamic criteria for non-equilibrium states, entropy production in heat flow, mass flow, electric current, chemical reactions, Saxen's relation, Onsager's reciprocity relation, , Electro kinetic phenomenon.

Theory of fluctuation, energy fluctuations in the canonical ensemble, distribution function and fluctuations, fluctuations of density and energy.

### Section-C

**Angular Momentum :** Angular momentum, angular momentum operators in cartesian coordinates, eigen function & eigen values, commutation relation between angular momentum operators (  $L_x, L_y, L_z, L^2$  ), total orbital angular momentum and spin angular momentum, commutation relation between components of total orbital angular momentum and spin angular momentum, ladder operators, commutators of  $[L^2, L_+]$  and  $[L^2, L_-]$  , application of ladder operators to an eigen function of  $L_z$ .

## Section-D

**Molecular Orbital Theory:** Huckel molecular orbital (HMO) theory of linear and cyclic conjugated systems, Applications of HMO theory to (i) set up and solve Huckel determinant equation; (ii) calculate resonance energy; (iii) wave functions for molecular orbitals and molecular diagrams for the following :

(a) Ethylene molecule (b) Allyl system (Allyl radical and the related cation and anion) (c) Butadiene; (d) Cyclobutadiene (e) Cyclopropenyl system (cyclopropenyl radical and the related cation and anion)

### **Books Recommended:**

1. Non-Equilibrium Thermodynamics by I. Prigogine
2. Non-Equilibrium Thermodynamics by C. Kalidas.
3. Theoretical Chemistry by S. Glasston.
4. Quantum Mechanics by M.S. Pathania.
5. Quantum Chemistry by Pauling , Eyring and Wilson.

## M.Sc. (4<sup>th</sup> Semester)

**Paper- XXIV(c)      CY (H)-402(c)    Organic Special-V**    4 hrs. / Week  
Credits: 04  
Max. Marks: 80+20  
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

### Section-A

#### **Terpenoids:**

Classification, nomenclature, occurrence and general method of structural determination, Isoprene rule, Structure determination, stereochemistry and synthesis of Citral, Farnesol, Zingibrene, Santonin,  $\alpha$ -Cadinene, Camphor and Abietic acid, Biogenetic pathways and biosynthesis

### Section:- B

#### **Alkaloids:**

Classification, occurrence, general methods of isolation and structure elucidation. Structure, stereochemistry, synthesis and biosynthesis of following: Papaverine, Nicotine, Quinine, Morphine, lysergic acid and Reserpine

### Section-C

#### **Steroids and Hormones**

Occurrence and General methods of isolation. Structure elucidation and synthesis of Cholesterol, Bile acids, Oestrogens, Testosterone, Progesterone, Esterone and synthetic non-steroidal estrogens.

Structure elucidation and synthesis of Adrenaline and Thyroxine.

### Section-D

#### **Antibiotics**

Structure elucidation of Pencillin, chloramphenicol, Streptomycin and Tetracyclins.

#### **Prostaglandins:**

Classification, Physiological effects and synthesis of PGE<sub>2</sub> and PGF<sub>2</sub>  $\alpha$ .

### Books Recommended:

1. Natural Products-Chemistry and Biological Significance by J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne.
2. Organic Chemistry by I.L. Finar.

- 3 Rodds Chemistry of Carbon Compounds by S. Coffey.
- 4 New Trends in Natural Products Chemistry by Atta-ur-Rehman, M.I. Choudhary.
- 5 The Chemistry of Natural Products by P.S. Kalsi.
- 6 Chemistry of Natural Products by Nakamshi.
- 7 Organic Chemistry by I.L.Finar.

**M.Sc.(4<sup>th</sup> Semester)**

**Paper XXV(a) CY(H)-403(a) Inorganic Special-VI**

**(Medicinal Aspects of Inorganic Chemistry)**

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.

**Section-A**

**Metals in Medicine:** Biochemical bases of essential metal deficient diseases; Iron, copper and zinc deficiencies and their therapies, carcinogens and carcinostatic agents, zinc in tumour growth and inhibition, anticancer activity and mechanism of platinum complexes, anticancer activity of Rhodium, copper and Gold complexes, anti cancer activity of Selenium, antibacterial and antiviral properties of metal complexes, polyamino carboxylic acids and polyethylene amines as chelating drugs.

(16 hrs.)

**Section-B**

**Miscellaneous applications of Inorganic compounds as medicines:** Drugs in hypo and hyper activity of thyroids, Inorganic drugs in dental carries, clinical disorders of alkali and alkaline earth metals and their remedies, lithium drugs in psychiatry.

(7 hrs.)

**Heavy metals in Biological systems:** Toxicity of heavy metals – and their detoxification, role of Selenium in Biological systems with reference to its essentiality and toxicity, mechanism of metal ion induced toxicity, interaction between orally administered drugs and metal ions in gut.

(7 hrs.)

**Section-C**

**Ligand Therapy:** Ligand induced toxicity, interference with haemoglobin in oxygen transport system, interference with metallo-enzymes, beneficial effects of ligand chelation; carcinogenic ligands, carcinostatic ligands, alkylating agents as anticancer drugs, Thiosemicarbazones as anticancer drugs, macrocyclic antibiotic ligands and probable mechanism of the drug, antiviral activity of chelating agents, aspirin chelation, drugs where chelation and therapeutic activity are unrelated.

(15 hrs.)

**Section-D**

Vitamins and their functions in general, recommended dietary allowances, deficiencies and supplementations, dietary minerals, calcium and vitamin D, antioxidants and their health effects, biom mineralisation

(8 hrs.)

Radiopharmacology, nuclear medicines, radioiodine -131, technetium – 99m, gallium and indium scan.

(7 hrs.)



### **Books Recommended**

1. A Text Book on Medicinal Aspects of Bio-Inorganic Chemistry – A.K. Das.
2. Bioinorganic Medicinal Chemistry – E.Alessio.
3. Bioinorganic Chemistry – K.H. Reddy.
4. Inorganic Chemistry: Principle of Structure Reactivity – J.E. Huheey, E.A. Keiter & R.L.Keiter.
5. Handbook of Radiopharmaceuticals: Radio Chemistry & Applications – M.J. Welch & C.S. Redvanly.
6. Perspectives on Bioinorganic Chemistry – R.W. Hay, J.R. Dilworth & K.B. Nolan.

## M.Sc. (4<sup>th</sup>-Semester)

Paper XXV(b) CY(H)-403 (b) Physical Special-VI

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

### Section-A

**Symmetry and Group Theory in Chemistry:** Symmetry elements and symmetry operation group and its properties, Multiplication table, point symmetry groups. Schonflies symbol, representations of groups by matrices (representation for the  $C_n$ ,  $C_{nv}$ ,  $C_{nh}$ ,  $D_{nh}$  etc. groups to be worked out explicitly) Irreducible representation of groups. The great orthogonality theorem (without proof) and its importance. Character tables and their use in spectroscopy.

### Section-B

**Electronic Spectroscopy of Polyatomic Molecules :** Free electron model, spectra of carbonyl group, spectra of ethene, n-II and II-II transitions, spectra of benzene, spectra of transition metals, charge-transfer transition, fluorescence phosphorescence.

**Raman Spectroscopy :** Quantum theory of Raman effect, Classical theory of Raman effect, Pure rotational Raman spectra, Raman activity of vibrations, vibrational Raman spectra, polarization of light and Raman effect, applications.

### Section-C

**Forms of Corrosion:** Uniform corrosion, galvanic corrosion, pitting corrosion, crevice corrosion, intergranular corrosion, stress corrosion cracking, corrosion fatigue, fretting corrosion, dealloying, hydrogen embrittlement, erosion corrosion, microbial induced corrosion, filiform corrosion and exfoliation.

## Section-D

**Industrial Corrosion Problems:** Atmospheric corrosion and high temperature oxidation. Corrosion in industrial cooling water system, corrosion in boilers and condensate pipe lines, corrosion due to acids, corrosion during metal surface cleaning and descaling, corrosion in chemical industries, corrosion in oil and gas wells, corrosion in refinery and petrochemical plants, corrosion in fertilizer industries.

### **Books Recommended:**

1. Molecular symmetry and group theory by A.Vincent
2. Applied group theory by A. Nass Bauim
3. Group theory in Chemistry by S.Swarnlakshmi, T.Saroja & R.M. Ezhilarasi.
4. Introduction of molecular spectroscopy by G.M. Barrow
5. Fundamental of molecular spectroscopy by C.N. Banwell
6. Corrosion inhibitors Principle & Applications by V.S. Sastri
7. Corrosion by K.R. Trephevey & J. Chamberlain
8. Introduction to Metallic corrosion & its prevention by Raj Narain
9. An introduction to the Science of Corrosion and its inhibiton By S.N. Banerjee
10. Corrosion engineering by M.G. Fontana

**M.Sc. (4<sup>th</sup> Semester)**

**Paper- XXV(c)**

**CY (H)-403 (c) Organic Special-VI**

4 hrs. / Week

Credits: 04

Max. Marks: 80+20

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

**Section-A**

Preparation, properties and applications of following reagents in organic synthesis with mechanistic details.

**Organometallic Reagents:**

n-Butyllithium, Grignard reagent, Organo chromium(III) compounds, Dialkyl copper lithium, Pentacarbonyl iron, Tetracarbonyl nickel, octacarbonyl dicobalt, Alkene Palladium (II) complexes, Wilkinsons catalyst, Methyl triisopropoxy titanium, Tri-n-butyl tin hydride, Trimethyl silyl iodide, Diborane.

**Section-B**

**General Reagents:**

DCC I, 1,3-dithianes, Polyphosphoric acid, Diazomethane, Ethyldiazoacetate, Boron Trifluoride, Trifluoro acetic acid, Cuprous chloride, N-Bromosuccinamide, Mont- K-10, and KSF (clays). Phase Transfer catalysts.

**Section-C**

**Oxidation:**

Leadtetraacetate, Osmium tetraoxide, Selenium dioxide, Potassium permanganate, Fenton's reagent, Ozone, Perbenzoic acid, Periodic acid, Chromium oxide, Thallium (III) nitrate.

**Reduction:**

Catalytic hydrogenation, lithium aluminium hydride, Sodium borohydride, Sodamide, Zinc dust, Sodium liquid ammonia

**Section-D**

**Rearrangements:**

General mechanistic considerations – nature of migration, migratory aptitude. A detailed study of following rearrangements: Pinacol – pinacolone, Wagner-Meerwein, Demjanov, Benzil-Benzilic acid, Favorskii, Arndt-Eistert synthesis, Neber, Beckmann, Hofman, Curtius, Schmidt, Baeyer-Villiger and Shapiro reaction.

### **Books Recommended:**

1. Designing Organic Synthesis by S. Warren .
2. Organic Synthesis Concept, Methods and Starting Materials by J.Fuhrhop and G. Penzillin.
3. Some Modern Methods of Organic Synthesis by W.Carruthers.
4. Modern Synthesis Reactions by H.O. House & W.A. Benjamin.
5. Advanced Organic Chemistry -Reactions Mechanism and Structure by Jerry March.
6. Principles of Organic Synthesis by R. Norman and J.M. Coxon.
7. Advanced Organic Chemistry Part-B by F.A. Carey and R.J. Sundburg.
8. Organometallic Chemistry-A Unified Approach by R.C. Mehrotra & A. Singh.
9. Concise Coordination Chemistry by R. Gopalan & V. Ramalingam
10. Organometallic Chemistry by G.S. Sondhi

**Inorganic Special Practical-IV**  
**Paper-XXVI (a) CY(S)-404 a**

**M.Sc. Chemistry (4th Semester)**

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

Interpretation of IR spectrum and determination of structure/bonding in some simple inorganic compounds and coordination compounds, such as: 40 marks

- (i) Ammonium salts [ $\text{NH}_4\text{Cl}$ ,  $(\text{NH}_4)_2\text{SO}_4$ ,  $\text{NH}_4\text{SCN}$ ,  $\text{NH}_4\text{NO}_3$ ]
- (ii) Sulphate ions in different bonding mode: ionic –  $\text{K}_2\text{SO}_4$ ,  $\text{CaSO}_4$  etc., unidentate, bidentate, bridged etc.
- (iii) Thiocyanate and Isothiocyanate complexes.
- (iv) Oxalato complexes
- (v) Cyano complexes –  $\text{K}_4\text{Fe}(\text{CN})_6$ ,  $\text{Na}_2[\text{Fe}(\text{CN})_5\text{NO}]$
- (vi) Ammine complexes
- (vii) Spectra of isomers – Nitro – and Nitrito

Record File 05 marks

Viva-Voce 05 marks

**Physical Special Practical-IV**  
**Paper-XXVI (b) CY (S)-404(b)**

**M.Sc. Chemistry (4<sup>th</sup> Semester)**

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

**1. Potentiometry**

- (i) NaOH vs. H<sub>3</sub>PO<sub>4</sub> titration.
- (ii) NaOH vs. (HCl + CH<sub>3</sub>COOH) mixture
- (iii) NaOH vs. Boric Acid
- (iv) ZnSO<sub>4</sub> vs K<sub>4</sub>[Fe(CN)<sub>6</sub>]
- (v) Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> vs Iodine
- (vi) To determine solubility and solubility product of sparingly soluble salts BaSO<sub>4</sub>, AgCl and PbSO<sub>4</sub>
- (vii) To determine degree of hydrolysis of aniline hydro chloride
- (viii) To determine dissociation constant of weak acid.

**2. pH metry Titrations**

- (i) NaOH vs. H<sub>3</sub>PO<sub>4</sub>
- (ii) NaOH vs. (HCl + CH<sub>3</sub>COOH) mixture
- (iii) NH<sub>4</sub>OH vs. HCl
- (iv) NH<sub>4</sub>OH vs. CH<sub>3</sub>COOH
- (v) NaOH vs. Boric Acid

**3. Dipole metry**

To determine dipole moment of various organic liquids

Record File

05 marks

Viva-Voce

05 marks

**Organic Special Practical-IV**  
**Paper-XXVI (c) CY(S) -404(c)**

**M.Sc. Chemistry (4<sup>th</sup> Semester)**

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

**1. Multi-step Synthesis**

- (i) m-Nitroaniline from benzene.
- (ii) 5-Acetoxy-1,3-benzoxathiol-2-one from hydroquinone.
- (iii) 2'-Hydroxy-4-methoxyphenylstyryl ketone from resorcinol.
- (iv) Acridone from anthranilic acid.

40 Marks

Record File

05 marks

Viva-Voce

05 marks



**Inorganic Special Practical-V  
Paper-XXVII (a) CY(S)-405 a**

**M.Sc.Chemistry ( 4<sup>th</sup> Semester)**

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

- 1 Conductometrically- Composition of mixture of weak and strong acids, Precipitation and displacement titrations.
- 2 pH-metry-Composition of mixture of strong and weak acids pK value of organic acids.
- 3 Potentiometry- redox titrations, Precipitations, Simultaneous determination of Halide ions.
- 4 Ion- selective electrodes – F, Ca, Na, K etc.

Note: Candidate is required to perform one experiment in the examination. 40 marks

Record File 05 marks

Viva-Voce 05 marks

**Physical Special Practical-IV**  
**Paper-XXVII (b) CY (S)-405(b)**

**M.Sc. Chemistry (4<sup>th</sup> Semester)**

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

**1. Conductometry Titrations**

- (i)  $\text{AgNO}_3$  vs  $\text{KCl}$  or  $\text{KI}$
- (ii)  $\text{AgNO}_3$  vs  $\text{KCl} + \text{KI}$
- iii) To determine concentration of Salicylic acid by
  - (a) Salt line method and (b) Double alkali method
- (iv) To determine solubility and solubility product of sparingly soluble salts ( $\text{AgCl}$ ,  $\text{PbSO}_4$ ,  $\text{BaSO}_4$ )
- (v) To study the kinetics of saponification of ester conductometrically
- (vi) Verification of D.H.O. equation for strong electrolytes.
- (vii) To estimate the concentration of each component in a mixture of  $\text{AgNO}_3$  and  $\text{HNO}_3$ .

**2. Polarometry**

- (i) To determine the percentage composition of optical substances in the binary mixture (components comprise of Glucose or Fructose or sucrose or Tartaric acid )
- (ii) To determine the rate constant for inversion of sugar using polarometry technique.

**3. Determination of Heat capacity**

To determine the heat capacity of organic liquids

Record File

05 marks

Viva-Voce

05 marks

**Organic Special Practical-V**  
**Paper-XXVII(c) CY(S) -405(c)**

**M.Sc. Chemistry (4<sup>th</sup> Semester)**

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

**1. Spectrophotometric (UV/VISIBLE) Estimations:**

- (a) Amino acids
- (b) Proteins
- (c) Carbohydrates
- (d) Ascorbic acid
- (e) Aspirin
- (f) Caffeine
- (g) Cholesterol

25 Marks

**2. Isolation**

- (i) Casein from milk
- (ii) D (+) Glucose from cane sugar
- (iii) Hippuric acid from urine

15 Marks

Record File

05 marks

Viva-Voce

05 marks

**Inorganic Special Practical-VI**  
**Paper-XXVIII (a) CY(S) -406(a)**

**M.Sc. Chemistry (4th Semester)**

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

Ion Exchange methods in Column Chromatographic Analysis:-

- (i) Determination of the capacity of a cation – exchange resin i.e. Amberlite IR – 120.
- (ii) Determination of the capacity of an anion exchange resin i.e. Amberlite IRA – 400 or De – Acidite FF.
- (iii) Separation of Ions by Ion –exchangers.

40 Marks

Note: Candidate is required to perform one experiment in the examination.

Viva-Voce  
Record file

05 marks  
05 marks

**Books Recommended:**

1. A Text Book of Quantitative Analysis – A.I. Vogel.
2. A Text Book of Qualitative Analysis – A.I. Vogel.
3. Senior Practical Physical Chemistry – B.D. Khosla, V.C. Garg & A. Gulati
4. Infrared and Raman Spectra of Inorganic & Co-ordination compounds – K. Nakamoto.
5. Inorganic Infrared & Raman Spectra – S.D. Ross.
6. Basic Concepts of Analytical Chemistry – S.M. Khopkar.

**Physical Special Practical-IV**  
**Paper-XXVIII (b) CY (S)-406(b)**

**M.Sc. Chemistry (4<sup>th</sup> Semester)**

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

**1. Ultrasonic Interferometry:**

- (i) To determine the isentropic compressibility of liquids.
- (ii) To determine excess isentropic compressibility of given binary liquid mixture.

**2. Spectrocolorimetry:**

- (i) Determine the composition of  $\text{KMnO}_4$  and  $\text{K}_2\text{Cr}_2\text{O}_7$  in the given mixture.
- (ii) Determine the pK value of the methyl red and phenolphthalein indicator.
- (iii) To study complex formation between ferric and thiocyanate ions.

**3. Chemical Kinetics:**

- (i) To study of kinetics of iodination of acetone.
- (ii) To study the kinetics of saponification of ethyl or methyl acetate.
- (iii) To study the kinetics of acid catalyzed inversion of cane sugar.
- (iv) To study of kinetics of bromination of Gallic acid by bromide-bromate mixture in acid medium. (Clock reaction).

- 4. **Viva-Voce** 05 marks
- 5. **Practical Note Book** 05 marks

**Books 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.

**Organic Special Practical-VI  
Paper-XXVIII (c) CY(S) -406 (c)**

**M.Sc. Chemistry (4<sup>th</sup> Semester)**

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

**1. Qualitative Analysis:**

Identification of organic compound using spectroscopic methods (UV, IR, NMR & Mass) followed by characterization by chemical methods.

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.