

**NORTH MAHARASHTRA  
UNIVERSITY  
JALGAON**

**SYLLABUS FOR**

**Master of Science  
In  
CHEMISTRY  
PART – I**

**(Semester I and II)  
w.e.f. 2014-2015**

**NORTH MAHARASHTRA UNIVERSITY, JALGAON**

**M.Sc. (Part-I) Chemistry**

**Semester I and II**

**Syllabus w.e.f. 2014-2015**

**SEMESTER – I**

CH-110:- Physical Chemistry – I

CH- 130:- Inorganic Chemistry – I

CH- 150:- Reaction Mechanism and Stereo Chemistry

Ch-P-1:- Physical Chemistry Practicals (Annual)

CH-I-1:- Inorganic Chemistry Practicals (Annual)

CH-O-1:- Organic Chemistry Practicals (Annual)

**SEMESTER – II**

CH-210:- Physical Chemistry – II

CH- 230:- Inorganic Chemistry – II

CH-250:- Synthetic Organic Chemistry & Spectroscopy

CH-290:- General Chemistry

**Practical Courses (Annual)**

<b>Course Title</b>	<b>Semester</b>	<b>Periods</b>	<b>Marks</b>	
CH-P-1:-Physical Chemistry Practical	Annual	104	80	20
CH-I-1:-Inorganic Chemistry Practical	Annual	104	80	20
CH-O-1:- Organic Chemistry Practical	Annual	104	80	20

Note:

1. There are in all three theory courses for first semester, four theory papers for second semester and Three annual practical courses.

2. The marks for each paper are distributed as external (80marks) and internal (20 marks) examinations. For internal assessment of each theory course 3 written test / tutorial will be taken in which best of two will be considered for internal marks.

3. Each theory course to be completed in 60 lectures of 60 min duration each.

4. Practical courses to be conducted during the whole year. The examination of practical courses will be conducted only once, at the end of academic year (annually). Each practical course will carry 100 Marks out of which 20 Marks will be allotted for internal assessment and University Examination will be conducted for 80 Marks.

5. Each practical course is having weight age Six Hours per week.

The annual examination for the practical courses CH-P-1, CH-I-1, CH-O-1 will be held at the end of semester II.

The internal examination of 20 Marks for practical courses will be held before the annual practical examination.

A student will not be permitted to appear at the practical examination unless he / she produce a certified journal. If the journal is lost, the student should produce a certificate from Head of the department / Head of the Institution stating that he / she has satisfactorily completed the practical work.

**Rules for personal safety:**

1) For eye protection, safety goggles must be worn in the laboratory at all times. If the student wears contact lenses, full protection goggles, which provide total seal around eyes, must be worn. All students are expected to wear safety goggles.

2) A long sleeved, knee length laboratory coat is recommended. Long pants and closed toed shoes must be worn for individual safety. Loose clothing, open style shoes and sandals are prohibited. Long hair must be tied up. Each student will have to get his / her own necessary protection items.

3) Prior to the practical examination, the teacher-in-charge will check all protective equipment to ensure that they are in order.

4) Pipetting by mouth should be avoided. Use of pre-pipette bulbs is recommended.

5) All laboratories should be equipped with safety chart, adequate first aid requirements and fire extinguishers.

# NORTH MAHARASHTRA UNIVERSITY, JALGAON

## M. Sc. I - Physical Chemistry Syllabus

### SEM - I CH-110

#### 1. QUANTUM CHEMISTRY

(24 L)

Wave-particle duality of matter, Heisenberg uncertainty principle, Schrodinger equation (time independent, derivation expected), wave function, its interpretation and properties, eigenfunctions and eigenvalues, Schrodinger equation in eigenvalue form, normalization, orthogonality and orthonormality of wavefunction. Operators: algebra of operators, commutative property, linear operators, Hermitian operator and its theorems, linear momentum, kinetic energy and total energy operators, postulates of quantum mechanics, free particle, particle in one two and three dimensional box, wavefunction and probability density plots, degeneracy, simple harmonic oscillator, Hermite polynomials, energy eigenvalues,  $\psi$  and  $\psi^2$  plots, even and odd functions, rigid rotator, spherical polar coordinates, separation of variables, energy eigenvalues, hydrogenlike atoms, Schrodinger equation and its separation, complete wave-function, radial and radial distribution function plots, angular dependence of wave function, shapes of orbitals, variation principle, LCAO-MO,  $H_2^+$  molecular ion, HMO theory and its application to ethylene and butadiene. Ref. 8, 9, 10, 11 and 12

#### 2. NUCLEAR AND RADIATION CHEMISTRY

(20 L)

Parent-daughter decay-growth relationships: daughter nucleus stable, general expression for activity of daughter, parent shorter and longer lived than daughter, parent and daughter of nearly the same half life, secular and transient equilibria. Applications of radioactivity: Szillard - Chalmer's reaction, isotope dilution and neutron activation analysis.

Elements of radiation chemistry: primary effects of interaction of radiation with matter, LET, Bremsstrahlung. Interaction of gamma radiation with matter: photoelectric effect, Compton scattering and pair production, units of measuring radiation absorption.

Radiation dosimetry: units of dose, Fricke and ceric sulphate dosimeters, conversion of measured dose values. Ref: 7 and 12

#### 3. ELECTROCHEMISTRY

(10 L)

Strong electrolytes, Debye-Huckel theory of conductivity (mathematical derivations not expected), ionic atmosphere, relaxation and electrophoretic effects, DHO equation, its validity and deviations, ionic strength, activity and activity coefficients of strong electrolytes.

Debye-Huckel theory of activity coefficients: Debye-Huckel limiting law (derivation expected), its testing, deviations and modifications.

Transport number: definition and its relation to ionic mobility, moving boundary and Hittorf's method. Ref: 2, 3, 5,6 and 12

#### **4. SURFACE CHEMISTRY (6 L)**

Adsorption, Langmuir adsorption isotherm (derivation expected), BET theory, derivation of BET equation and its application to determine surface area of adsorbent, derivation of Gibbs adsorption isotherm.

Ref.: 2, 3, 5, 12

### **SEM - II CH-210**

#### **1. THERMODYNAMICS (17 L)**

State functions, exact and inexact differentials, test of exactness, internal energy change in terms of internal pressure and  $C_v$ , change in internal energy at constant pressure, expansion coefficient, temperature dependence of enthalpy, isothermal compressibility. Joule-Thomson effect: J-T experiment, J-T coefficient, inversion temperature, difference between heat capacities. Thermodynamic description of mixtures: partial molar quantities, Gibbs-Duhem equation, determination of partial molar volume by intercept and slope methods, chemical potential, thermodynamics of mixing of gases. Some thermodynamic relations; Maxwell relations, thermodynamic equations of state and their applications: J-T coefficient in terms expansion coefficient and  $C_p$ , internal pressure and J-T coefficient for van der Waals gas, real gases and fugacity, determination of fugacity for real gases, fugacity for van der Waals gas.

Ref. : 1, 2, 3, 6 and 13

#### **2. STATISTICAL THERMODYNAMICS (8 L)**

Thermodynamic probability, Stirling approximation, Boltzmann distribution law, partition function and its significance, energy and entropy in terms of partition function, separation of

partition functions, translational partition function, translation energy and entropy from it, rotational partition, function, rotational energy and entropy from it, vibrational partition function, vibrational energy and entropy from it.

Ref.: 2, 3, 5, 6 and 13

### **3. CHEMICAL KINETICS**

**(17 L)**

Accounting for the rate laws: reactions approaching equilibrium, consecutive elementary reactions, rate determining steps, steady state approximation, pre-equilibria, Michaelis-Menten mechanism, Lindemann-Hinshelwood mechanism, , chain reactions, rate laws of chain reactions, explosions. Polymerization kinetics: chain and stepwise polymerization and their rate laws, chain length and average number of units in each chain. Molecular reaction dynamics: Collision theory of bimolecular gaseous reactions, steric requirement, activated complex theory, Eyring equation (derivation expected), Eyring equation for reaction between structureless particles, estimation of steric factor, thermodynamic aspects.

Reactions in solutions: Comparison of solution and gas-phase encounter, diffusion controlled reactions. Reactions between ions: effect of solvent dielectric constant and ionic strength. Influence of substituents: Hammett equation, linear Gibbs energy relations, Taft equation. Fast reactions: flow methods and relaxation methods.

Ref: 1, 2, 3 and 13

### **4. MOLECULAR SPECTROSCOPY**

**(18 L)**

**Infrared spectroscopy:** simple harmonic oscillator, vibrational spectra of diatomic molecules, anharmonic oscillator, diatomic vibrating rotator, vibration-rotation spectrum of diatomic molecule applying Born-Oppenheimer approximation, vibration-rotation spectra of linear polyatomic molecules and symmetric top molecules, influence of nuclear spin, breakdown of Born-oppenheimer approximation, vibrations of polyatomic molecules, fundamental vibrations and infrared activity.

**Raman spectroscopy:** Raleigh and Raman scattering, quantum and classical theories of Raman effect, pure rotational Raman spectra of linear and symmetric top molecules, Raman activity of vibrations, rule of mutual exclusion, vibrational Raman spectra, and rotational fine structure

**Electronic spectroscopy:** electronic vibrational spectra, intensity of vibrational-electronic spectra, Franck-Condon principle, rotational fine structure, Fortrat diagram, dissociation energy, pre-dissociation. Ref: 2, 4 and 13

### REFERENCE

1. Physical chemistry 5th or 6th edition  
P. Atkins, J. D. Paula, Oxford University Press
2. Physical Chemistry 2nd edition  
K. J. Laidler, J. H. Meiser (CBS Publications)
3. Principles of Physical Chemistry, 41st millennium edition  
Sharma, Puri and Pathaniya
4. Fundamentals of molecular spectroscopy, 4th edition  
C. N. Banwell and McCash, Tata Mac-Graw Hill
5. Principles of Physical Chemistry, 4th edition  
Prutton and Maron
6. Thermodynamics for chemists  
S. Glasstone
7. Essentials of Nuclear Chemistry, 4th edition  
H. J. Arnikar
8. Quantum Chemistry  
R. K. Prasad, New Age International
9. Physical Chemistry: A molecular approach  
Donald, McQuarrie, J. D. Simon Viva books
10. Quantum Chemistry  
Donald, McQuarrie

11. Quantum Chemistry  
Levine
12. Physical Chemistry, Shree Book Co.  
Dr. L. S. Patil
13. Physical Chemistry - II, Shree Book Co.  
Dr. L. S. Patil



## M.Sc. I- Skeleton for question paper of

CH – 110 (Physical Chemistry - I) &  
CH – 210 (Physical Chemistry – II )

Time Allowed:- 3 hours.

Marks:-80

	Periods	Marks	Marks With Option
TOTAL	60	80	120

### M.Sc.-I Physical Chemistry

#### Pattern of question paper

#### CH - 110

1. Answer the following: (12)
  - a) Quantum Chemistry    b) Radioactivity    c) Electrochemistry
  - d) Elements of radiation chemistry    e) Quantum chemistry
  - f) Surface chemistry
2. Quantum Chemistry (17)
  - a) \_\_\_\_\_ OR a) \_\_\_\_\_ (6)
  - b) \_\_\_\_\_ OR b) \_\_\_\_\_ (6)
  - c) Problem (5)
3. a) Radioactivity OR a) Radioactivity (6)  
b) Elements of radiation chemistry (6)  
OR  
b) Elements of radiation Chemistry (6)  
c) Problem on radioactivity (5)
4. (A) Answer any three of the following (12)
  - a) Quantum chemistry    b) Radioactivity
  - c) Quantum chemistry    d) Elements of radiation chemistry(B) Problem on elements of radiation chemistry

5. a) Surface chemistry OR a) surface chemistry (6)  
 b) Electrochemistry OR b) Electrochemistry (6)  
 c) Problem on electrochemistry (5)

1.	Quantum Chemistry	$2 + 2 + 17 + 4 =$	25
2.	Radioactivity	$2 + 6 + 5 + 4 =$	17
3.	Elements of Radiation Chemistry	$2 + 6 + 5 + 4 =$	17
4.	Electrochemistry	$2 + 6 + 5 =$	13
5.	Surface Chemistry	$2 + 6 =$	8

**Total** **80**

### CH - 210

1. Answer the following: (12)
- a) Thermodynamics      b) Kinetics      c) Spectroscopy  
 d) Thermodynamics      e) Statistical thermodynamics  
 f) Kinetics
2. Chemical Kinetics (17)
- a) \_\_\_\_\_ OR a) \_\_\_\_\_ (6)  
 b) \_\_\_\_\_ OR b) \_\_\_\_\_ (6)
- OR
- (A) Answer any two of the following: (12)
- i) \_\_\_\_\_      ii) \_\_\_\_\_      iii) \_\_\_\_\_  
 c) Problem (5)
3. Spectroscopy (17)
- a) \_\_\_\_\_ OR a) \_\_\_\_\_ (6)  
 b) \_\_\_\_\_ OR b) \_\_\_\_\_ (6)

- c) problem (5)
4. (A) Answer any three of the following (12)
- a) Thermodynamics    b) Spectroscopy
- c) Chemical Kinetics    d) Thermodynamics or statistical thermodynamics
- (B) Problem on statistical thermodynamics (5)
5. a) Thermodynamics    OR    a) Thermodynamics (6)
- b) Statistical thermodynamics    OR    b) Statistical thermodynamics (6)
- c) Problem on thermodynamics (5)

1.	Thermodynamics	$2 + 2 + 6 + 4 + 5$	=	19
2.	Statistical thermodynamics	$2 + 6 + 5$	=	13
3.	Chemistry Kinetics	$2 + 2 + 6 + 6 + 5 + 4$	=	25
4.	Spectroscopy	$2 + 6 + 6 + 5 + 4$	=	23
	<b>Total</b>			<b>80</b>

# NORTH MAHARASHTRA UNIVERSITY JALGAON

## M. Sc. - Chemistry ( Part- I )

### Physical Chemistry Practical Syllabus

#### CH-P-1

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- The student should perform minimum of 09 experiments from each Semester that is 18 experiments annually.
- It is expected to perform at least one experiment from each technique.

### SEM -I

#### INSTRUMENTAL:-

##### Conductometry:-

- 1) Determination of degree of hydrolysis and hydrolysis constant of sodium acetate conductometrically.
- 2) Determination of the concentration of sulphuric acid, acetic acid and copper sulphate by conductometric titration with sodium hydroxide.

##### Potentiometry:-

- 1) To determine the stability constant of a complex ion  $[Ag(S_2O_3)]^{-3}$  potentiometrically.
- 2) To determine standard free energy change  $\Delta G^0$  and equilibrium constant for the reaction  $Cu + 2Ag^+ = Cu^{+2} + 2Ag$  potentiometrically.

##### pH -metry:-

- 1) Determination of Hammett constant of a given substituted benzoic acid by pH measurements.
- 2) To determine the amount of aspirin in the given tablet.

##### Colorimetry/ Spectrophotometry:-

- 1) To determine pKa and Ka of given indicator by colorimetry/ spectrophotometry.
- 2) To determine the empirical formula of Ferric salicylate complex by Job's method and verify by slope ratio method.

##### Surface Chemistry

- 1) To determine CMC of the given surfactant (Sodium Lauryl Sulphate) by surface tension method.
- 2) To determine the critical micelle concentration of soap by surface tension method.

#### NON INSTRUMENTAL:-

##### Chemical kinetics:-

- 1) To determine the rate constant for depolymerization of diacetone alcohol catalyzed by sodium hydroxide using dilatometer.
- 2) Kinetics of reaction between potassium persulphate and KI. Determination of rate constant; study of influence of ionic strength.

- 3) To determine the order of the reaction between potassium persulphate and potassium iodide by fractional change method.

**Non instrumental:-**

- 1) Determine the transport number of  $H^+$  and  $Cl^-$  ions by moving boundary method.

## SEM -II

**INSTRUMENTAL:-**

**Conductometry:-**

- 1) Determination of the dissociation constant of acetic acid in DMSO, DMF, acetone and dioxane by titrating it with KOH.
- 2) Determination of critical micellar concentration (CMC) of sodium lauryl sulphate from the measurement of conductivities at different concentrations.

**Potentiometry:-**

- 1) To determine the amount of each halide in a mixture of halides containing a) KI and KBr/KCl or b) KI, KBr and KCl potentiometrically.
- 2) To titrate ferrous ammonium sulphate solution with potassium dichromate solution potentiometrically using bimetallic electrode pair.

**pH -metry:-**

- 1) To determine acidic and basic dissociation constants of an amino acid and hence the isoelectric point of the acid.
- 2) To determine the three dissociation constants of polybasic acid such as  $H_3PO_4$  by pH measurements.

**Colorimetry/ Spectrophotometry:-**

- 1) Determination of iron in water using a colorimeter.
- 2) Simultaneous determination of  $Cr_2O_7^{2-}$  and  $MnO_4^-$  ions or  $Co^{2+}$  and  $Ni^{2+}$  in the solution by spectrophotometry.
- 3) Record the UV spectrum of Benzene, Pyridine and Pyrimidine in methanol. Compare and discuss the various transition involved in terms of MO theory.

**Polarimetry:-**

- 1) Polarimetric determination of the specific rotation of camphor in benzene and carbon tetrachloride.
- 2) Determine the percentage of two optically active substances (d-glucose and d-tartaric acid) in a mixture polarimetrically.

**NON INSTRUMENTAL:-**

**Chemical kinetics:-**

- 1) To investigate the kinetics of iodination of acetone.
- 2) To determine energy of activation of the hydrolysis of methyl acetate in presence of hydrochloric acid (Calculations and graphs expected from excel programming).

**Non instrumental:-**

- 1) To obtain solubility curve for liquid say water-acetic acid-chloroform system.
- 2) Determination of partial molar volume of ethanol in dilute aqueous solutions.
- 3) To study the effect of addition of an electrolyte (KCl, NaCl, NH<sub>4</sub>Cl, Na<sub>2</sub>SO<sub>4</sub>, K<sub>2</sub>SO<sub>4</sub>) on solubility of an organic acid (benzoic acid or salicylic acid).

**References:-**

- 1) Findley's Practical Physical Chemistry (9<sup>th</sup> edition), Edited By B.P. Levitt (Longman group Ltd).
- 2) Systematic Experimental Physical Chemistry (3<sup>rd</sup> edition), By S.W. Rajbhoj and Dr. T.K. Chondekar (Anjali Publication, Aurangabad).
- 3) Advanced Practical Physical Chemistry (19<sup>th</sup> edition or latest edition), By J.B. Yadav (Goel Publishing House, Meerut).
- 4) Experimental physical Chemistry, By V.D. Athawale P. Mathur (New age international Ltd, New Delhi).
- 5) Advanced Practicals in Physical Chemistry (4<sup>th</sup> revised edition 2008 or latest 13 edition). By Dr. Pande, Dr. Mrs. Datar &, Dr. Mrs. Bhadane (Manali Publication, Pune).
- 6) University Practical Chemistry (2008 or latest edition), By P.C. Kamboj (Vishal Publishing Co. Jalandhar, Panjab).
- 7) Practical Physical Chemistry, A.M. James and F.F. Prichard Longman Group Ltd.

**NORTH MAHARASHTRA UNIVERSITY JALGAON**

**M. Sc. - Chemistry ( Part- I )**

**CH-P-1 Physical Chemistry Practical**

Skeleton for question paper of CH – P -1

Time – 6.5 hours

Marks : 80

Q 1: Instrumental	30 marks
Q 2:Non-Instrumental	30 marks
Q 3: Oral	10 marks
Q 4: Journal	10 marks

Note- Out of two questions, if both are instrumental then both must be from different techniques.

**M.Sc. Part-I**  
**INORGANIC CHEMISTRY – I (CH- 130)**

**Chapter-I:- Atomic Structure**

**(P-14,M-18)**

Nature and Path of Electron: Idea of de Broglie matter waves, Heisenberg uncertainty principle, Atomic orbitals, Shapes of s, p, d orbitals. Quantum Mechanical Approach: Schrodinger wave equation (no derivation), significance of  $\psi$  and  $\psi^2$ , quantum numbers, radial and angular wave functions and probability distribution curves. Concept of quantization, atomic spectra (no derivation), wave particle duality, Uncertainty principle, wavefunction and its interpretation, well-behaved function, Hamiltonian (energy) operator, sketching of wavefunction and probability densities for 1D box, degeneracy

**Ref.6 Pages 11-29**

**Ref.7 Pages 84-**

**CHAPTER -2: Molecular Orbital Theory:-**

**(P-12,M-16)**

Linear tri-atomic molecules – BeH<sub>2</sub>, CO<sub>2</sub>. Trigonal planar molecule BF<sub>3</sub>, Tetrahedral Molecule – CH<sub>4</sub>, Trigonal pyramidal molecule NH<sub>3</sub>, Angular Tri-atomic molecules H<sub>2</sub>O, NO<sub>2</sub>.MOT as applied to octahedral complexes.

Ref 8: - Relevant pages.

**CHAPTER -3:Organometallic compounds of transition metals:- (P-12,M-16)**

The 18 electron rule, Molecule orbital theory and 18 electron rule, Counting electrons in complexes . Alkyl & aryl complexes, Alkene complexes, Allyl and butadiene complexes, Complexes containing delocalized cyclic systems, carbenes (alkylidene) and carbene (alkylidyne) complexes, Organometallic compounds in homogeneous catalysis.

Ref 1,3,5,6,15,17 - Relevant pages.

**CHAPTER -4:Molecular symmetry:-**

**(P-10,M-14)**

Symmetry elements and operations, Symmetry planes, reflections, inversion centre, proper / improper axes of rotation, equivalent symmetry elements and atoms, symmetry elements and optical isomerism, procedure to determine point groups, With examples-H<sub>2</sub>O, NH<sub>3</sub>, C<sub>2</sub>H<sub>2</sub>Cl<sub>2</sub>, (cis & trans) , BF<sub>3</sub>, PCl<sub>5</sub>, H<sub>2</sub>O<sub>2</sub> (trans), XeF<sub>4</sub>, H<sub>3</sub>BO<sub>3</sub>, CO<sub>2</sub>, POCl<sub>3</sub>, C<sub>2</sub>H<sub>2</sub> , NO<sub>3</sub><sup>-</sup>

Ref: - 4,6,14,16 - Relevant pages.



**CHAPTER -5: The Ionic bond:-****(P-12,M-16)**

Structures of ionic solids, radius ratio rules, calculation of limiting radius ratio

Values of coordination no. 3, 4, 6, close packing, classification of ionic structures – Ionic compounds of the type AX

(ZnS, NaCl, CsCl), Ionic compounds of the type AX<sub>2</sub> (CaF<sub>2</sub>, TiO<sub>2</sub>, SiO<sub>2</sub>) ; Layer structures (CdI<sub>2</sub>, [NiAs] ) Structures containing polyatomic ions. Lattice energy. The Born - Haber cycle, Applications of lattice energetics.

Ref :-2,3,6 - Relevant pages

**INORGANIC CHEMISTRY – II (CH- 230)****Chapter-I:- Wave mechanics****(P-12,M16)**

Hamiltonian operator, construction of Hamiltonian operator for He, He<sup>2+</sup>, H<sub>2</sub>, H<sub>2</sub><sup>+</sup>, Li, Be, B, N and C. Term symbols of atoms and ions for atomic numbers < 30 Quantum numbers. Aufbau and Pauli's exclusion principles. Hund's multiplicity rule, electronic configuration of elements, effective nuclear charge and shielding; radial and angular wave functions and distribution curves.

Ref.1 Pages 10-27

Ref.6 Pages 29-34, 145-168

Ref.7 Pages 107-127, 129-131

**CHAPTER -2: Spectra:-****(P-14,M-18)**

Energy levels in an atom, coupling of orbital angular momenta, coupling of spin angular momenta, spin orbit coupling. Determining the ground state terms – Hund's rule, Hole formulation, Derivation of the terms for a P<sup>2</sup> & P<sup>3</sup> configuration, calculation of the number of microstates, Electronic spectra of transition metal complexes – Laporte 'orbital' selection rule, spin selection rule, splitting of electronic energy levels and spectroscopic states. Spectra of d<sup>1</sup> & d<sup>9</sup> ions, d<sup>2</sup> & d<sup>8</sup> ions

Ref :2,6 - Relevant pages.

**CHAPTER -3: The Structure and Reactivity of molecules:- (P-10,M-14)**

VSEPR Theory, structures of molecules containing lone pair of electrons.

Sulphur tetrafluoride, Bromine trifluoride, Dichloroiodate (I) anion, Pentafluorotellurate (IV) anion, Tetrachloroiodate (III) anion, Nitrogen dioxide, nitrite ion and nitryl ion, phosphorotrihalides, carbonyl fluoride, summary of VSEPR Rules.

Ref 1- Relevant pages

#### **CHAPTER -4: Reaction mechanism in transition metal complexes:-(P-14,M-18)**

Ligand substitution reaction, The classification of mechanism, The substitution of square planer complexes, the nucleophilicity of entering group, the shape of activated 18 complexes, K1 pathway, Substitution in Octahedral complexes, Rate law and their interpretation, The activation of octahedral complexes, Base hydrolysis, Stereochemistry, Isomerisation reactions.

Ref- 1,5,6,15.- Relevant pages.

#### **CHAPTER -5: Catalysis:- (P-10,M-14)**

Catalysis, Description of catalyst, Properties of catalyst, Homogeneous catalyst, Catalytic steps, Hydrogenation of alkenes, Hydroformylation, Monsanto acetic acid synthesis, Wacker oxidation of alkenes, Alkene polymerization, Heterogeneous catalysis, Nature of heterogeneous catalyst.

Ref-1,5,6. - Relevant pages.

#### **References:-**

- 1) Inorganic Chemistry Principles of Structures and Reactivity, 4th edition; James E. Huheey, Ellen A. Keiter, Richard L. Keiter.
- 2) Concise Inorganic Chemistry, 5th edition J. D. Lee.
- 3) Inorganic chemistry, 3rd edition Alan G. Sharpe.
- 4) Chemical Applications of Group Theory, F.A. Cotton.
- 5) Inorganic Chemistry, Fourth Edition; Shriver & Atkins Intern. student edition.
- 6) Principles of Inorganic Chemistry; Late B.R. Puri, L.R. Sharma & K.C. Kalia.
- 7) Principles of Physical Chemistry; Late B.R. Puri, L.R. Sharma & Pathania.
- 8) Electrons and Chemical bonding By H.B. Gray.
- 9) Modern Aspects of Inorganic Chemistry, By H. J. Emeleus and A.G. Sharpe; Universal BookStall, New Delhi – 2.19
- 10) Advanced Inorganic Chemistry; Dr. S.K. Agarwala, Dr. Keemtilal, Pragati Prakashan, Meerut.
- 11) Theoretical Principles of Inorganic Chemistry, G.S. Manku , Tata McGraw-Hill Ed.

- 12) Concepts and Models of Inorganic Chemistry, 2nd edition, B. Douglas, D.H. Mc. Daniel, J.J.Alexander.
- 13) General & Inorg. Chem. (Part one), R. Sarkar, New Central Book Agency ; Kolkata.
- 14) Group Theory and its Chemical applications, P.K. Bhattacharya, Himalaya Publishing House.
- 15) Advance Inorganic Chemistry , Cotton &Wilkinson.
- 16) Concept and Applications of Group Theory, Dr. Kishor Arora, Anmol Publication Pvt. Ltd., New Delhi.
- 17) Modern Inorganic Chemistry by William L.Jolly, 2nd edition, Tata Mc Graw Hill Co.

**M.Sc. Part- I**  
**Skeleton for question paper of**  
**CH – 130 (Inorganic Chemistry –I)**  
**& CH – 230 (Inorganic Chemistry: – II)**  
Time Allowed: – **3 hours**. Marks: - **80**

	<b>Periods</b>	<b>Marks</b>	<b>Marks with Option</b>
<b>Total</b>	<b>60</b>	<b>80</b>	<b>120</b>

**Questions:—There are total four questions.**

1. Answer any four of the following: **(24)**

- a)
- b)
- c)
- d)
- e)
- f)

2. Attempt any four of the following: **(16)**

- a)
- b)
- c)
- d)
- e)
- f)

3. Answer any four of the following: **(24)**

- a)
- b)
- c)
- d)
- e)
- f)

4. Attempt any four of the following: **(16)**

- a)
  - b)
  - c)
  - d)
  - e)
  - f)
-

**NORTH MAHARASHTRA UNIVERSITY JALGAON**

**M. Sc. - Chemistry ( Part- I )  
Inorganic Chemistry Practical  
CH-I-1**

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**SEM-I**

**1. Analysis of ore (Any two)**

- a) Pyrolusite ore - Estimation of silica gravimetrically and Manganese volumetrically.
- b) Haematite - Estimation of copper volumetrically and Iron gravimetrically.
- c) Chromite ore – Estimation of Iron gravimetrically and chromium volumetrically.

**2. Analysis of binary mixtures by gravimetric and volumetric methods from the Mixture Solutions (any three)**

- 1. Copper- Nickel
- 2. Copper -Magnesium
- 3. Copper-Zinc
- 4. Iron-Magnesium
- 5. Silver-Zinc
- 6. Lead-Tin

**3. Instrumental method of Analysis**

- A) To study complex formation between Fe (III) and salicylic acid and find the Formula and stability constant of the complex spectrophotometrically.
- B) To determine the strength of given mixture of carbonate and bicarbonate in the Given mixture by pH metric method
- C) To determine the Li / Na/ K/Ca in given solution flame photometrically, by calibration curve Method.

#### 4. Preparation of the following :

- (i) Potassium trioxalato Chromate(III)
- (ii) Tris(acetylacetonato)iron(III)

### SEM-II

#### 1. Instrumental method of Analysis

- A) To determine the amount of copper present in given solution by iodometric Method potentiometrically.
- B) Ion – exchange chromatography; Separation & estimation of ( $Zn^{+2}/ Cd^{+2}$ ) & ( $Zn^{+2}/Mg^{+2}$ ) in mixtures using Amberlite IRA 400 anion exchanger.
- C) Separation and Determination of iron by solvent extraction techniques in a mixture of  $Fe^{+3} + Al^{+3}$  &  $Fe^{+3} + Ni^{+3}$  using 8 - hydroxyquinoline reagent.

#### 2. Preparation and purity determination from the given solution.

- a) Bis (ethylene diamine) copper (II) sulphate.
- b) Tris (acetylacetonato) Iron (III).
- c) Nitropentammino cobalt (III) chloride.
- d) 8-hydroxy Quinoline Ni(II).

#### 3. Drug Analysis

Determination of iron from given drug sample.

#### 4. Thermochemistry

To determine the lattice energy of binary salts ( NaCl, KCl, CaCl<sub>2</sub>, MnCl<sub>2</sub>, CuCl<sub>2</sub>). (any two salts)

#### References:-

- 1. A Text book of Quantitative Analysis by A.I.Vogel , 4th edition

2. Advanced Practical Inorganic Chemistry By Gurdeep Raj Goel Publishing House.
3. Post Graduate Practical Chemistry (Part – 1) by H.N. Patel, S.P. Turakhia,  
S.S. Kelkar, S.R. Puniyani, Himalaya Publishing House.
4. Applied Analytical Chemistry: Vermani.
5. Commercial Methods of Analysis: Shell & Biffen

NORTH MAHARASHTRA UNIVERSITY, JALGAON

M.Sc. (Part) – I Organic Chemistry

(Semester I and II)

Course structure –

Semester – I Reaction Mechanism and Stereochemistry (CH-150)

Sr. No.	Name of the chapter	No. of periods	Weightage without option	Weightage with option
1	Nucleophilic substitution at saturated carbon	12	16	24
2	Addition reaction	12	16	24
3	Elimination reactions	12	16	24
4	Electrophilic and Nucleophilic substitutions reactions of aromatic compounds	12	16	24
5	Stereochemistry	12	16	24
	TOTAL	60	80	120

Semester – II : Synthetic Organic Chemistry and Spectroscopy (CH-250)

Sr. No.	Name of the chapter	No. of periods	Weightage without option	Weightage with option
1	Synthetic reagents	15	19	30
2	Rearangments	10	13	20
3	Named reaction	08	11	16
4	Pericyhclie	07	10	14
5	Spectroscopy	20	27	40
	TOTAL	60	80	120



# Organic Chemistry

## Semester – I

### CH-150

#### Reaction Mechanism and stereochemistry.

##### 1. Structure and reactivity:

(12 L)

- a) Chemical bonding and basis of reactivity- Chemical bond, delocalization, conjugation, resonance, hyperconjugation, tautomerism, inductive effects, MOT and VBT approach.
- b) Bonding other than covalent bonding: Ionic, hydrogen bond, inclusion compounds, rotaxanes, catenanes, cyclodextrins, cryptands, fullerenes, crown ethers.
- c) Acidity and basicity: various structural effects, hard and soft acid and base concept.
- d) Aromaticity: Benzenoid and non-benzenoid compounds, Huckels rule, antiaromaticity, Application to carbocyclic and heterocyclic systems, annulenes, azulenes, Current concepts of aromaticity.
- e) Structure and stability of reactive intermediates, carbenes, nitrenes, carbocations, carbanions and free radicals.

##### 2. Stereochemistry:

(18 L)

- a) Stereochemical principles, enantiomeric relationship, distereomeric relationship, R and S, E and Z nomenclature in C, N, S, P containing compounds, Introduction of optical activity in absence of chiral centre (biphenyls, spiranes, allenes and helical structures) and with one and two chiral carbons .
- b) Conformational analysis of cyclic and acyclic compounds.

##### 3. Nucleophilic substitution at saturated carbon:

( 10L)

- a)  $SN^1$ ,  $SN^2$  and  $SN^i$  reactions, Mechanism and stereochemistry, regioselectivity and stereo specificity of substitution reaction.
- b) Scope at saturated carbon, allylic carbon and vinylic carbon.

Reference:- 3 Pages 309-335.

- c) Scope of nucleophilic substitution halides, oxygen, sulphur and nitrogen as nucleophile.

Reference:- 1 Pages 351-354 and 359-375.

- d) Neighbouring group participation by pi and sigma bonds, Nonclassical carbocations.

Reference:- 4 Pages 312-322.

Reference:- 1 Pages 317-339.

Reference:- 2 Relevant pages.

Reference:- 3 Pages 309-335.

Reference:- 6 Relevant pages.

#### **4. Addition reaction:**

**10L**

Mechanistic and stereo chemical aspect of carbon-carbon multiple bonds and carbon heteroatom multiple bonds. Scope- The mechanism of electrophilic addition ADE2 mechanism. Structural effects and reactivity halogenations, hydrohalogenation, Hydration, Hydroxylation, Hydroboration, Epoxidation, Carbene addition Hydrogenation, Ozonolysis.

Reference:- 1 Pages 521-554.

Reference:- 3 relevant pages.

Reference:- 6 relevant pages.

#### **5. Elimination reactions:**

**10L**

Scope, The reaction mechanism  $E_1$ ,  $E_2$ ,  $E_1CB$ ,  $E_1$  versus  $E_2$  and Elimination versus substitution.

a) Anti and syn elimination, Stereo electronics factors.

b) Dehydrohalogenation, Dehalogenation, Dehydration, Hoffmann and Saytzeffs elimination, Pyrolytic elimination.

Reference:- 1 pages 465-499.

Reference:- 6 relevant pages.

#### **References:**

1. Organic Chemistry – by J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford)

2. Advanced Organic Chemistry – by J. March (Latest Edition)

3. Advance Organic Chemistry (part A ) –by A. Carey and R.J. Sundberg

4. Stereochemistry of carbon compound-by E.L.Eliel

5. Stereochemistry of organic compound-by Nasipuri

6. Guide book to Reaction Mechanism –Peter Sykes.

7. Organic Chemistry (6th Edition) by Paula Y. Bruice.

8. Reaction Rearrangement and Reagrnts By S.N. Sanyal.

9. Organic Chemistry 6th Edition by L.G. Wade and Maya Shankar Singh.

10. Organic Chemistry by T. W. Graham Solomons , Craig B. Fryhle

11. Organic Chemistry: A Brief Course by Robert C. Atkins , Francis A Carey

**Organic Chemistry**  
**Semester – II**  
**CH-250**

**Synthetic organic chemistry and spectroscopy**

**1. a) Aromatic Electrophilic substitution** **12L**

Arenium ion mechanism, orientation and reactivity, energy profile diagram, ortho, para, ipso attack, orientation in other ring systems, naphthalene, anthracene, six and five membered heterocycles, diazonium coupling. Important reactions like Friedel crafts alkylation and acylation, Nitration, halogenations, formylation, chloromethylation, sulphonation.

**b) Aromatic nucleophilic substitution**

$S_NAr$ ,  $S_N1$ , Benzyne and  $S_NR1$  reactions, reactivity: effect of substrate structure, leaving group and attacking nucleophile.

**2. Oxidation reactions:** **8L**

$CrO_3$ , PDC, PCC,  $KMnO_4$ ,  $MnO_2$ ,  $SeO_2$ ,  $Pb(OAc)_4$ , Pd-C,  $OsO_4$ , mCPBA,  $O_3$ ,  $NaIO_4$ ,  $HIO_4$

**3. Reduction reactions:** **5L**

Boranes and hydroboration reactions,  $R_3SiH$ ,  $Bu_3SnH$ , MPV,  $H_2/Pd-C$ , Willkinsons,  $NaCNBH_3$ ,  $NH_2NH_2$ , DIBAL

**4. Rearrangements:** **8L**

Beckmann, Hofmann, Curtius, Smith, Wolff, Lossen, Bayer-villiger, Sommelet, Favorskii, Pinacol-pinacolone, Benzil-benzilic acid, Claisen, Cope, Fries.

**5. Spectroscopy:** **27L**

a) UV: Factors affecting UV absorption and interpretation of UV spectra

b) IR: Ideas about IR frequencies, interpretation of IR spectra

c) PMR: Fundamentals of NMR, CW and FT-NMR, factors affecting chemical shift, integration coupling (1<sup>st</sup> order analysis)

d) Introduction of CMR and mass spectrometry

e) Problems on UV, IR and PMR

**References:**

1. Organic Chemistry – J.Clayden, N.Greeves, S. Warren and P. Warren (Oxford)
2. Modern Synthetic reactions – H.O. House
3. Organic Synthesis – M.B. Smith
4. Advanced Organic Chemistry (part A & B)-A. Carey and R.J. Sundberg
5. Stereochemistry conformations and mechanism by P.S. Kalsi
6. Organic Chemistry – by Cram, Hammond, Pine and Handrikson
7. Introduction to spectroscopy – D.I. Pavia, G.M. Lampman, G.S. Kriz, 3<sup>rd</sup> Edition
8. Spectroscopic methods in organic molecules – D.H. William & I Flemming Mc Graw Hill
9. Mechanism and Structure in Organic Chemistry – E.S. Gould

**Skeleton for question paper of**  
**CH – 150 (Organic Chemistry - I) &**  
**CH – 250 (Organic Chemistry – II )**

Time Allowed:- 3 hours.

Marks:-80

	<b>Periods</b>	<b>Marks</b>	<b>Marks With Option</b>
<b>TOTAL</b>	60	80	120

**Question:- There are total four questions.**

1. Answer any four of the following: (16)

- a)
- b)
- c)
- d)
- e)
- f)

2. Attempt any four of the following: (16)

- a)
- b)
- c)
- d)
- e)
- f)

3. Answer any four of the following: (16)

- a)
- b)
- c)
- d)
- e)
- f)

4. Attempt any four of the following: (16)

- a)
- b)
- c)
- d)
- e)
- f)

5. Attempt any four of the following: (16)

- a)
- b)
- c)
- d)
- e)
- f)

**MSc-I**  
**Organic Chemistry Practical Syllabus**  
**(CH-O-1)**

**SEM-I**

**A) Use of Computers:-**

1) Use of Chemistry softwares like, **ISI draw, Chem DRAW, Chem Sketch**

Draw the structure of simple aliphatic and aromatic compounds, heterocyclic compounds with different substituent's, IUPAC name and predict the NMR Signals (**Minimum Ten compounds**).

2) Design reaction mechanism scheme of any two addition and two substitution reactions.

3) Literature Search and references.

**B) Preparation of derivatives monitored by TLC (any 2)**

1) Aryloxy derivative of Phenol.

2) Phenyl hydrazone derivative of Aldehyde/ketone.

3) Anilide derivative of carboxylic acid.

**C) Green Chemistry Preparations (any 3):-**

1) Preparation of Benzilic Acid using NaOH /KOH under Solvent-free Conditions

2) Photoreduction of benzophenone to benzopinacol in presence of sun light using isopropanol and acetic acid.

3) Bromination of acetanilide using Ceric ammonium nitrate.

4) Preparation of 1,1-bis-2-naphthol from 2-naphthol using Iron(III) chloride.

5) Preparation of benzopinacolone from Benzopinacol using iodine and acetic acid.

6) Synthesis of acetanilide from aniline by using ZnO/AcOH (Acylation).

**D) Purification Techniques(Demonstrations) (any 1)**

1) Steam distillation.

2) Column Chromatography.

3) Distillation under reduced pressure.

**References**

- 1) Practical Organic Chemistry By Vogel.
- 2) Monograph on Green Chemistry Laboratory Experiments

## SEM-II

### E) Single Stage Preparation Monitored by TLC (any 5):-

- 1) Acetophenone to Benzalacetophenone.
- 2) Toluene to 4-methyl acetophenone
- 3) Resorcinol to 7-hydroxy, 4-methyl coumarin.
- 4) Camphor to Borneol.
- 5) Benzophenone to Benzhydrol.
- 6) Paramino Benzoic Acid to Parachloro Benzoic Acid.
- 7) p-nitro toluene to p-nitro benzoic acid.
- 8) o-hydroxyacetophenone to o-Benzoyloxyacetophenone.
- 9)  $\beta$ -Naphthol to 2-methoxy naphthalene.

### F) Two Stage Preparation Monitored by TLC (any 2):-

1. Toluene — p-nitrotoluene — p-nitrobenzoic acid.
2. Phthalic acid — phthalic anhydride — phthalimide.
3. Cyclohexanone — Cyclohexanoneoxime — caprolactam.
4. Chlorobenzene — 2,4-dinitrochloro benzene — 2,4 dinitrophenol.

### References

- 1) Practical Organic Chemistry By Vogel.

**MSc-I**  
**Organic Chemistry Practical Syllabus**  
**(CH-O-1)**

**Skeleton of question paper**

1. Derivatives/ Green chemistry preparation/ Techniques–	<b>20</b>
2. Computer techniques.-	<b>10</b>
3. Single stage preparation /one stage from two stage preparation–	<b>30</b>
4. Oral-	<b>10</b>
5. Journal-	<b><u>10</u></b>
<b>Total-</b>	<b>80</b>



# NORTH MAHARASHTRA UNIVERSITY, JALGAON

## M.Sc. Part –I (Semester- II)

### Course - CH-290-General Chemistry

#### SECTION –I : CHEMICAL MATHS

Sr. No	Name of the chapter	No.of periods	Weightage without option	Weightage with option
1	Units	02	03	04
2	Differential Calculus	06	07	12
3	Integral Calculus	06	07	12
4	Partial differentiation	04	05	08
5	Differential equation	02	03	04
6	Probability and errors	02	03	04
7	Graphical methods in physical chemistry	02	03	04
8	Computer application in chemistry	02	03	04
9	Vector,Matrics and Determinant	02	03	04
10	Problem in Physical chemistry	02	03	04
	<b>TOTAL</b>	<b>30</b>	<b>40</b>	<b>60</b>

#### SECTION –II : ANALYTICAL CHEMISTRY (CH-290)

Sr. No	Name of the chapter	No.of periods	Weightage without option	Weightage with option
1	Statistics	10	10	15
2	Gas Chromatography	10	10	15
3	High Performance Liquid Chromatography	06	10	15
4	Supercritical - Fluid Cromatography	02	05	08
5	Capillary Electrophoresis	02	05	07
	<b>TOTAL</b>	<b>30</b>	<b>40</b>	<b>60</b>

#### SECTION-III : INSTRUMENTAL METHODS OF ANALYSIS

Sr. No	Name of the chapter	No.of periods	Weightage without option	Weightage with option
1	Voltammetry	08	10	15

2	Fluorescence and Phosphorescence	12	15	25
3	Photoacoustic Spectroscopy	04	05	10
4	Thermal Analysis	06	10	10
	<b>TOTAL</b>	<b>30</b>	<b>40</b>	<b>60</b>

## **SECTION-I: CHEMICAL MATHS (30 L )**

(No Derivations. Only essential formulae and their applications for solving the problems in Chemistry is expected.)

### **1. Units (02L)**

- a) Basic & Derived CGS & SI Units: Pressure, volume, density, force, energy, Gas Constant(R).
- b) Non conventional units: Pressure, volume, density, force, energy, R.

### **2. Differential Calculus (06L)**

- a) Derivative, Basic rules.
- b) Differentiation of functions of function, logarithmic functions.
- c) Algebraic simplification.
- d) Graphical significance of differentiation, Applications of Maxima & Minima.
- e) The differential.

Ref:-1 Pages 70-113

### **3. Integral Calculus (06L)**

- a) Basic rules, definite & indefinite integral, “e” and its significance, compound interest low, exponential equations.
- b) Integration of trigonometric functions.
- c) Algebraic simplification, Integration- by substitution & by partial fractions.

Ref:-1 Pages 114- 156

### **4. Partial Differentiation (04L)**

- a) The fundamental theorem - special cases, Successive Partial Differentiation.

Ref:-1 Pages 174-186

### **5. Differential Equations (02L)**

Simple differential equations in Chemistry, Homogeneous differential equations, Exact and Inexact differential equations, linear differential equations.

Ref:-1 Pages 187-199

### **6. Probability And Errors (02L)**

Ref:-1 Pages 210-216, 220-225

### **7. Graphical Methods In Physical Chemistry (02L)**

Ref:-1 Pages 225-239

### **8. Computer:Applications In Chemistry (02L)**

Introduction, Components of Computer, Hardware, Software, binary arithmetic, Softwares in chemistry - MOPAC, GAMESS, GAUSSION, MOLDRAW, etc. Internet surfing, e-

journals, literature Search (Project on Specific topics on Recent Advances in Chemistry).

Ref:-2 Pages 36-68

Ref:-3 Relevant pages

### **9. Vector, Matrices, & Determinant:- (02L)**

Ref:- 4 Pages 1048-1070

### **10. Problems In Physical Chemistry (02L)**

To be referred for Problems on the respective chapters in the syllabus.

Ref.-1 Pages 247-259 Appendix-I

### **References:-**

**Ref. 1.** Mathematical Preparation for physical chemistry-Farrington Daniels Mc Graw Hill.

**Ref. 2.** Principal of Physical Chemistry- Puri, Sharma & Pathania. ISBN-81-8646-00-8 Millennium Ed.

**Ref. 3.** Physical Chemistry- Thomas Engel, Philip Reid, Pearson- 2006, LPE Ed.

**Ref. 4.** Physical Chemistry- P.W Atkins, 7th Ed.

## **SECTION-II: ANALYTICAL CHEMISTRY**

### **1. Statistics:- (10L)**

Introduction to Chemometrics Mean and Standard deviation, distribution of random errors, reliability of results, comparing of means of two samples, paired t-test, the number of replicate determinations, correlation and regression, linear regression, errors in slope and intercept, errors in the estimate of concentration, standard additions, comparison of more than two means, experimental design, two way analysis of variance, chemometrics and experimental design, factorial design.

Ref:-1, Pages 123 to 149

### **2. Gas Chromatography: (10L)**

Instruments for Gas Liquid Chromatography: Carrier Gas System, Sample Injection System, Column Configurations and Column Ovens, Detection systems.

Gas Chromatography Columns and Stationary Phases: Capillary or Open Tubular Columns, Packed Columns, Liquid Stationary Phases.

Applications of Gas Liquid Chromatography: Qualitative analysis, Quantitative analysis.

Ref. 2. Pages 947-968

### **3. High Performance Liquid Chromatography: (06L)**

Instrumentation: Mobile Phase Reservoirs and Solvent Treatment systems, Pumping systems, Sample injection systems, Columns for High Performance Liquid Chromatography, Detectors.

Ref. 2. Pages From 971-980

### **4. Supercritical - Fluid Chromatography: (02L)**

Important Properties of Supercritical Fluids, Instrumentation and Operating variables, Supercritical - Fluid Chromatography Versus Other Column Methods, Applications.

Ref. 2. Pages 996-1000

### **5. Capillary Electrophoresis: (02L)**

Instrumentation for Capillary Electrophoresis, Electroosmotic Flow, The Basis for Electrophoretic Separations, Applications of Capillary Electrophoresis

Ref. 2. Pages 1003-1010

### **References:-**

**Ref. 1.** Vogel's Text Book of Quantitative Chemical analysis (Sixth Edition) By- J. Mendham, R.C.Denny, J.D. Barnes, M.J.K. Thomas (Pearson Education- Low Price Edition).

**Ref. 2.** Fundamentals of Analytical Chemistry, Eighth Edition, D. A. Skoog, D. M. West, F. J. Holler, S. R. Croch

**Ref. 3.** Introduction to Instrumental Analysis, Robert D. Braun, Mc. Graw Hill (1987)

**Ref. 4.** Analytical Chemistry (Sixth Edition) Wiley International Edition. By- Gary D. Christian John wiley and sons INC.

## **SECTION-III : INSTRUMENTAL METHODS OF ANALYSIS**

### **1. Voltammetry: (08L)**

Excitation signals

Linear-sweep Voltammetry- Voltammetric Instruments, Voltammetric Electrodes, Voltammograms, Hydrodynamic voltammetry, Voltammetric Detectors

Amperometric Sensors, Amperometric Titrations

Ref. 1. Pages 665-684

### **2. Fluorescence and Phosphorescence: (12L)**

Fluorescence, Photoluminescent Theory, Electron Transitions During Photoluminescence, Factors That Affect Photoluminescence, Luminescent Apparatus, Optical Excitatory Sources, Wavelength selectors, Cells, Detector and Readout, Photoluminescent spectra, Photoluminescent Analysis, Analysis of Nonluminescing Compounds, Determination of Mixtures, Phosphorescence.

Ref. 2. Pages. 316-343

### **3. Photoacoustic Spectroscopy (PAS): (04L)**

Theory,

Instrumentation-Sources, wavelength Selectors, Cells, Detectors, Readout Devices

Typical instruments

Qualitative

Quantitative analysis.

Ref. 2. Pages 410 - 423

#### **4. Thermal Analysis: (06L)**

Thermogravimetry, Thermogravimetric Analysis, Derivative Thermogravimetry, Differential Thermal Analysis, Differential Scanning Calorimetry, Thermomechanical and Dynamic Mechanical analysis, Thermometric titrations, Enthalpimetry

Ref. 2. Pages 932-947

#### **References:**

**Ref. 1.** Fundamentals of Analytical Chemistry, Eighth Edition, D. A. Skoog, D. M. West, F. J.

Holler, S. R. Croch

**Ref. 2.** Introduction to Instrumental Analysis, Robert D. Braun, Mc. Graw Hill (1987)

**Ref. 3.** Analytical Chemistry (Sixth Edition) Wiley International Edition.By- Gary D. Christian

John wiley and sons INC.

**Ref. 4.** Instrumental methods of chemical analysis by H. Willard, L Merrit, J.A. Dean and F. A. settle, 16th edition CBS (1986).

**Ref. 5.** Instumental methods of chemical analysis by Chatwal and Anand.

## **Job/Career Opportunities after M.Sc. in Chemistry**

There exist enormous career opportunities for aspirants who have completed their master degree in Chemistry. M.Sc. course allows candidates to get specialized in diverse areas of Chemistry (Polymer chemistry, Organic Chemistry etc.). Both public as well as private sector firms recruit candidates for their varied operations. Those who are interested to work out side India, can work with better compensation packages.

Candidates who have completed their post graduation in Chemistry can pursue their career in both public and private sector organizations. Candidates can join organizations such as Advanced Centre for Treatment Research and Education in Cancer and Indian Institute of Chemical Technology as Junior Research Fellow or Project Assistant. Petroleum Industry is another major field that offers plenty of job opportunities for candidates who have completed post graduation in Chemistry. Apart from this, candidates can seek job opportunities in private firms such as Dabur, Glaxo Smith Kline etc as Junior Chemist with attractive pay packages. Experienced professional can apply for job opportunities available in various industries abroad.

### **Job opportunities in Public sector after M. Sc in Chemistry:**

Candidates can seek employment in various job positions such as Biochemist, Industrial Research Scientist, Laboratory Assistant and Quality Controller etc in public sector companies. They can find ample career openings with government owned pharmaceutical companies or with other public sector undertaking chemical factories. Candidates having industrial experience of a minimum of 2 to 3 years can apply for jobs abroad. Candidates who have first class marks in post graduation can join as Junior Research Fellow in research institutes. Candidates who qualify the NET exam are eligible to apply for the post of faculty in Government and Private Colleges. Apart from these jobs, candidates can apply for faculty post in private [engineering](#) colleges.

## **Government jobs after M.Sc.:**

M.Sc Applied Chemistry graduates can find lots of job opportunities in various fields of government sector. Most popular field among them is research field. Teaching profession is yet another popular field in the government sector. Details of jobs available in government sector for M.Sc Applied Chemistry graduates are given below.

### **Jobs in Government Sector:**

Lots of job opportunities are arising for the graduates due to the growth of several public sector undertakings. Candidates who have completed M.Sc. Applied Chemistry can thus find jobs in these public sector undertakings. Hindustan Petroleum Corporation Limited (HPCL) is one among them. Governmental research organizations also recruit these graduates for various posts. Several exams are conducted for the graduates to recruit them for various vacancies available in different departments of State and Central government. M.Sc. Applied Chemistry graduates can also attend those exams to get such jobs in government sector. These graduates can also pursue their career in teaching as there are several educational institutions run by state and central government.

### **Central Government Jobs after M.Sc. Applied Chemistry:**

M.Sc. Applied Chemistry graduates can work as Research Manager or Scientist in various government research organizations such as Indian Space Research Organization (ISRO), Bhabha Atomic Research Centre (BARC) and Defense Research and Development Organization laboratories. These graduates can attend the various exams conducted by Union Public Service Commission (UPSC), CSIR – UGC and Staff Selection Committee (SSC) to get jobs in various departments in central government. Candidates who secure any government job can write the concerned departmental exams to get promotion to higher positions. Civil Service Exams like IFS, IAS and IES are another alternative for these graduates.

### **Teaching Profession in Government Sector after M.Sc Applied Chemistry:**



M.Sc Applied Chemistry graduates who have good teaching aptitude can find teaching jobs in various universities offering applied chemistry courses. They should need to qualify the NET exam to apply for the lecture post available in various colleges or universities. Apart from qualifying the NET exam, candidates should also possess M.Ed degree to get a teaching job in any university or college.

### **Carrer abroad after M.Sc.:**

Foreign nations are also in need of qualified candidates in Chemistry. Those candidates with enough job experience are highly proffered by international firms. Chemical firms and Pharmaceutical firms in European nations often recruit candidates with proven experience. They also offer good remuneration to deserving professional.