

॥ अंतरी पेटवू ज्ञानज्योत ॥



North Maharashtra University,  
Jalgaon.

**Syllabus for M.Sc.  
(Part-II)**

**(Semester III & IV)**

**CHEMISTRY**

**W.E. From June, 2003**

॥ अंतरी पेटवु ज्ञानज्योत ॥

**NORTH MAHARASHTRA UNIVERSITY, JALGAON.**

**Syllabus For M.Sc. (Part-II)**  
**INORGANIC CHEMISTRY.**  
**(Semester -III & IV)**  
**(W.E.F. June, 2003)**

**PROPOSED SYLLABUS**

**COURSE STRUCTURE**

1. Each theory course should be covered in 5 periods each of 60 minutes per week. 4 periods for lectures & one period tutorials, seminars etc.
2. Each practical course will require 6 hours of laboratory work per week and course will be extended over two semesters and the candidate will be examined at the end of year.
3. There should not be more than 10 students in a batch of M.Sc. Practical course.
4. The distribution of courses will be as follows.

**SEMESTER-III**

- |    |         |  |
|----|---------|--|
| 1] | CH: 330 | Coordination Chemistry (I)                   |
|    | CH: 331 | Polymer Chemistry                            |
|    | CH: 332 | Solid State Chemistry                        |
|    | CH: 333 | Some selected topics in Inorganic Chemistry. |

**SEMESTER-IV**

- |    |         |   |
|----|---------|---|
| 2] | CH: 430 | Coordination Chemistry (II)             |
|    | CH: 431 | Physical methods in Inorganic Chemistry |
|    | CH: 432 | Organometallic Chemistry and Catalysis. |

**PRACTICAL COURSES**

- |          |  |
|----------|--|
| CH: I-2: | Inorganic Chemistry Practical Course-II  |
| CH: I-3: | Inorganic Chemistry Practical Course-III |
| CH: I-4: | Inorganic Chemistry Practical Course-IV  |

**OR**

- |          |                           |
|----------|---------------------------|
| CH: I-4: | A short Research Project. |
|----------|---------------------------|
-

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**NORTH MAHARASHTRA UNIVERSITY, JALGAON,**

**Syllabus For M.Sc. (Part-II)**

**INORGANIC CHEMISTRY.**

**(Semester -III & IV)**

**(W.E.F. June, 2003)**

**CH : 330 Coordination Chemistry ( I )**

- [a] Coordination compounds in Biology and Medicine (24)**  
 Binding groups for metals in biology, Roles for metals, calcium in control process. The coordination chemistry of Porphyrins, solution studies, complex formation, the redox chemistry of iron porphyrins. The cytochromes, Iron-sulphur proteins, Molybdenum cofactor, Nitrogen fixation, Therapeutic uses of coordination compounds as anticancer, antiarthritis drugs in treatment of deficiencies and chelation therapy.
- [b] Inorganic reaction mechanism (24)**  
 Main reaction types, substitution reactions, Electron transfer reactions, Reactions in solid state.

**References**

1. Comprehensive coordination Chemistry – by G.Wilkinson, R.D.Gillard & J.A. McCleverty ( Pergamon, 1987 ) Vol.6.
2. Inorganic Chemistry of Biological Process – by M.N. Hughes ( 11nd Edition ) Willey.
3. Mechanism of Inorganic reactions – by D. Benson (McGraw Hill)
4. Inorganic Chemistry Principles and Applications – by Butler and Harrod.
5. "Solid State Chemistry" – by Hannay N.B., Prentice –Hall of India Pvt. Ltd., New Delhi-1 (1976)

**CH : 331 Polymer Chemistry**

1. The genesis of polymers : History, Preparation and Classification [2]
2. Properties of Polymers : [12]  
 The linear polymer molecule, size and shape of linear polymer molecules, crystalline and amorphous polymers, polymer solubility, solubility parameter, glass transition temperature, viscoelastic behaviour, modulus temperature curves, flow viscosity of linear polymers, kinetic theory of rubber elasticity, chemical flow and stress relaxation.
3. Inorganic Chemistry : [10]  
 The bridge between small and infinite molecules, polyboranes, polysilylenes. Heteropolar Inorganic Polymers – Ring and chain molecules containing nitrogen, oxyanions and polyoxanions.  
 Organopolysiloxanes : The silicones, some transition metal polyoxyanions, heteropolyanions.  
 Fluorocarbon polymers.  
 Co-ordination polymers.
4. Metal chelate polymers : Introduction, synthetic methods, chemical and physical properties. [5]
5. Metal clusters : Higher boranes, carboranes, metallo carboranes. [15]  
 Metal carbonyl and halide clusters. Compounds with metal metal multiple bonds.  
 Metal – metal bonds, bonding in metal clusters, synthesis of metal clusters.
6. Isopoly and heteropoly acids and salts.. [4]

## References

1. Polymer Science : V.R. Gowarikar, N.V. Viswanathan and Jayadev Sreedhar., Wiley Eastern Ltd.
2. Inorganic Polymers : F.G.A.Stone and W.A.G. Graham, Academic Press.
3. Inorganic Chemistry : Principles and Applications, Ian S. Butler, John F. Harrod., The Benjamin/Cuming Publishing Company.
4. Developments in Inorganic Polymers Chemistry : M.F. Lappert and G.J. Leigh., Elsevier Publishing Company.
5. Modern aspects of Inorganic Chemistry : H.J.Emeleus and A.G.Sharpe., 4<sup>th</sup> Edn., universal Book Stall.
6. Advanced Inorganic Chemistry : F.Albert Cotton and Geoffrey Wilkinson, 5<sup>th</sup> Edition.
7. Inorganic Polymers : N.H.Ray, Academic Press.(1978).

## CH : 332 Solid State Chemistry

- |    |  |      |
|----|--|------|
| 1. | Nature of Solids<br>Chemical bonding in solids, structure of crystals, Amorphous solids.   | [4]  |
| 2. | Electronic structure of solids<br>Quantum mechanical description of solids, Distribution law for occupancy of electronic states, types of solids, Ligand field theory. | [5]  |
| 3. | Imperfections in solids.<br>Atomic imperfections, Line defects, Plane defects.   | [3]  |
| 4. | Formation of Crystals<br>Crystal growth, Twinning, Growth in the solid state.  | [3]  |
| 5. | Structural transformation in solids<br>Order-disorder transformations, recrystallisation and grain growth, precipitation, High pressure transformations, Sintering.    | [6]  |
| 6. | Properties of metals<br>Electrical, magnetic and thermal.  | [10] |
| 7. | Properties of Semiconductors<br>Conductivity, optical properties, Junction properties.   | [10] |
| 8. | Properties of insulators<br>Electrical, optical, magnetic.   | [7]  |

## References

1. Solid State Chemistry - by N.B.Hanny.
2. Inorganic Chemistry Principles and applications.- by Butler, Harrod.
3. Introduction to Solids - by Azaroff, TMH edition, 14<sup>th</sup> reprint 1995.
4. Solid State Chemistry - by C.N.R.Rao.

## CH : 333 Some selected topics in Inorganic Chemistry PART- A Group Theory

- |    |  |     |
|----|--|-----|
| 1. | Symmetry, Types of symmetry, symmetry elements, symmetry operations, Types of symmetry operation. ( Rotation reflection)   | [3] |
| 2. | Systematic procedure for classification of molecules (point groups), Examples of point group ( square planer, Tetrahedral, Octahedral, Trigonal planer, Trigonal pyramidal, Trigonal bipyramidal, linear, Pentagonal, Hexagonal, etc.) symmetries with multiple high order axes (only Oh & Td) | [6] |
| 3. | Matrices notations for Geometric transformations, Group multiplication table (C <sub>2</sub> V), (C <sub>4</sub> V), (D <sub>2</sub> h) , (C <sub>3</sub> V), (C <sub>2</sub> h). Properties of a group, classes.  | [6] |

4. Reducible and irreducible representation, The great Orthogonality theorem and its rules, character tables ( $C_{2v}$ ), ( $C_{3v}$ ), ( $C_{4v}$ ) ( $D_{2h}$ ), ( $D_{3h}$ ) and ( $C_{2h}$ ). [6]
5. Reduction of a reducible representation in to its irreducible representation on the basis of character table, 6 – bond scheme for 6 – bond in  $AB_4$  tetrahedral molecules, Hybrid orbitals for  $AB_n$  types of molecules, hybridization scheme for bonding. [3]

### References

1. Chemical application of group theory by – F.A. Cotton, 2<sup>nd</sup> edition Willey Eastern Ltd.
2. Symmetry in Chemistry – by H.H.Jaffe & M.Orchin.

### PART- B

1. Alloys : [6]  
Ionic compounds, interstitial alloys and related compounds, substitutional alloys, characteristic structures of ionic solids. ( rock salt structure, cesium chloride, wurtzite structure ),
2. Thin Film : [8]  
Introduction, Thin film deposition techniques :  
I. Thermal evaporation principle, Evaporation Methods : (i) Resistive heating (ii) Flash Evaporation (iii) Arc evaporation (iv) Exploding wire technique (v) Laser evaporation , (vi) R.F.heating vii] Electron bombardment heating.  
II. Chemical Methods : Electrodeposition : (i) Electrolytic deposition, (ii) Electroless deposition ,(iii) Anodic oxidation.  
III. Chemical Vapour Deposition ( CVD ) : (i) Pyrolysis (ii) Hydrogen Reduction, (iii) Halide disproportionation (iv) Transfer reaction , (v) Polymerization.
3. The Chlor alkali industry – Introduction, Le-Blanc process, Weldon [6]  
and Deacon processes, Electrolytic processes, Diaphragm cell, Mercury cathode cell, quantities, sodium carbonate, The solvay ( or Ammonia soda ) process.
4. The noble gases : Introduction , Electronic structure, clathrate [4]  
compounds structure and bonding in xenon compounds (  $XeF_2$ ,  $XeF_4$ ,  $XeF_6$ ).

### References

1. Concise Inorganic Chemistry – by J.D.Lee 5<sup>th</sup> Edition.
2. Thin Film Phenomenon – by K.L.Chopra. Mc Graw Hill book Company.

### CH : 430 Co ordiantion Chemistry - II

1. Crystal Field Theory : [14]  
Introduction, high spin and low spin complexes, Orgel, diagram of  $d^1$  ion, spectral properties of  $d^1$  ion, selection rules, Orgel diagram for ions with D ground term, ions with F ground term, spectral properties of  $d^2$  and  $d^3$  ions from Orgel diagram, Orgel diagram for  $d^5$  case, Spectrochemical series, spectra of lanthanide ions, Gemstones and lasers, some structural and thermodynamic effects of crystal fields
2. Co ordination numbers ( 1 to 8 ) Cage and cluster structures, valency shell electron pair repulsion model. [6]
3. Stability complexes in solution, stepwise stability constant, overall stability constant. [4]
4. Electronic spectra. [10]

5. Magnetic properties of d – and f – block compounds.  
Antiferromagnetism – Types of antiferro magnetism, Antiferromagnetic exchange pathway's. Examples of antiferromagnetic binuclear complexes. [10]
6. Job's and mole ratio method, Bjerrum's methods. [4]

### References

1. Inorganic Chemistry ( Principles and applications ) -by Butler, Harrod.
2. Elements of magnetochemistry -by R.L.Datta and A Syamal
3. Advanced Inorganic Chemistry - by Cotton and Wilkinson 5<sup>th</sup> Edition.
4. Instrumental methods of Chemical analysis - by Chatwal, Anand 2<sup>nd</sup> Edition  
Himalaya Publishing House.
5. Advanced Physico Chemical experiments - by J. Rose. Sir Isaac Fitman and Sons Ltd.

### CH : 431 Physical Methods in Inorganic Chemistry

1. Nuclear Magnetic Resonance Spectroscopy ( NMR ) [12]  
Theory of NMR spectroscopy, the chemical shift, mechanism of electron shielding and factors contributing to the magnitude of the chemical shift , chemical shifts for local diamagnetic terms, Spin-Spin splitting, spin-spin coupling mechanism, applications of spin-spin coupling to structure determination and magnitude of coupling constants, complex spectra, chemical exchange and other factors affecting line width, effect of chemical exchange on spectra and the evaluation of reaction rates for fast reactions, double resonance technique exchange reactions between ligand and metal ions, NMR of paramagnetic complexes, other applications.
2. Nuclear Quadrupole Resonance Spectroscopy (NQR ) [4]  
Principle, effect of magnetic field on the spectra relationship between the electric field gradient  $q$  and molecular structure.  
Applications like interpretation of  $eQq$  data, effect of crystal lattice on the magnitude of  $eQq$ , structural information from NQR spectra.
3. Electron Paramagnetic Resonance Spectroscopy (EPR/ESR) [8]  
Principle, presentation of spectrum, hyperfine splitting in some simple systems, hyperfine splitting in various structures, factors affecting the magnitude of 'g' values, interactions affecting the energies of unpaired electrons in transition metal ion complexes. Zero-field splitting and Kramer's degeneracy anisotropy in hyperfine coupling constant, nuclear quadrupole interaction, the spin Hamiltonian, line width in solid state EPR, electron delocalisation, applications of EPR.
4. Moss Bauer spectroscopy [8]  
Principle, instrumentation and applications.
5. Electron Spectroscopy for Chemical Analysis.(ESCA) [4]  
Principle, instrumentation and applications.
6. Thermal methods [12]  
Principle, Methodology and applications of the following technique- TGA,DTA, DSC and Enthalpimetric methods.

## References

1. Physical methods in Inorganic Chemistry., 2<sup>nd</sup> Edition, R.S.Drago, Reinhold Publishing Corporation, New York.
2. Instrumental methods of Analysis, 6<sup>th</sup> edition, Willard, Merrit, Dean.
3. Instrumental methods of chemical analysis., 5<sup>th</sup> edition, Golen W.Ewing.
4. Principles of Instrumental Analysis, 3<sup>rd</sup> edition Douglas A. Skoog.
5. Inorganic Chemistry – Principles and applications., Ian S.Butler, John F. Harrod.
6. Instrumental methods of Cehmical Analysis., Anand, Chatwal.
7. Fundamentals of Molecular Spectroscopy., 3<sup>rd</sup> edition, C.N.Banwell.
8. Basic Principles of Spectroscopy., Raymond, Chang.
9. Introduction to Instrumental Analysis by R.D.Braun McGraw-Hill Publications. International edition.

## CH : 432 Organometallic Chemistry and Catalysis

1. Transition metal carbon monoxide compounds. [8]
2. Transition metal compounds with bonds to hydrogen. [8]
3. Compounds of transition metals with single, double and triple bonds to carbon. [8]
4. Compounds of transition metals with alkenes, alkynes and delocalized hydrogen systems. [7]
5. Oxidative addition & migration ( insertion ) reactions. [7]
6. Homogeneous catalytic synthesis of organic chemicals by transition metal complexes. [10]

## References

1. Advanced Inorganic Chemistry by Cotton and Wilkinson (5<sup>th</sup> edition)
2. Inorganic Chemistry Principles and applications by Butler and Harrod.
3. Organo-transition metal Chemistry – Application to Organic Synthesis by S.G.Davies (Pergamon).

## Theory - References

### CH-330

Ref.1	-	Pages	546-549, 615-617, 657-658, 755-767.
Ref.2	-	Pages	278-286, 147-163, 188-209, 309-316.
Ref.3	-	Pages	20-46, 60-76, 84-87, 91-95, 104-110, 110-123, 123-128, 128-132.
Ref.4	-	Pages	602-605, 605-607.
Ref.5	-	Pages	160-173.

### CH-331

Ref.1	-	Pages	1-14.
Ref.2	-	Pages	10-27
Ref.3	-	Pages	443-503
Ref.4	-	Pages	6-18, 256-273.
Ref.5	-	Pages	272-274.
Ref.6	-	Pages	1052-1096
Ref.7	-	Pages	155-161

## CH-332

- Ref.1 - Pages 1-15, 21-41, 45-59, 146-157.  
 Ref.3 - Pages 140-165, 236-278, 310-352, 379-407.

## CH-333

## Part- A

## Part- B

- Ref.1 - Relevant Pages                      Ref.3 - Relevant Pages  
 Ref.2 - Relevant Pages                      Ref.4 - Pages 1 & 2, 11-22, 43-51.

## CH-430

- Ref.1 - Pages 428-440.  
 Ref.2 - Pages 127-133, 144-150, 157-160.  
 Ref.3 - Pages 10-18  
 Ref.4 - Pages 120-122, 474-487.  
 Ref.5 - Pages 76-80.

## CH-431

- Ref.1 - Pages 239-314, 315-327, 328-360.  
 Ref.2 - Pages 394-402.  
 Ref.3 - Pages 147-152  
 Ref.4 - Pages 721-726  
 Ref.6 - Pages 481-530  
 Ref.9 - Pages 410-425.

## CH-432

- Ref.1 - Pages 1021-1051, 1097-1121, 1122-1151,  
 1152-1185, 1186-1223, 1224-1282.

**M.Sc. (II) Inorganic Chemistry from July, 2003.  
 PRACTICAL SYLLABUS**

## CH-I-2

- I Analysis of Cement**
- i. Silica ( gravimetrically )
  - ii. Calcium ( volumetrically )
  - iii. Magnesium ( volumetrically )
  - iv. Iron ( gravimetrically ) / ( colorimetrically )
- II Analysis of chalcopyrites**
- i. Silica (gravimetrically)
  - ii. Copper ( volumetrically )
  - iii. Iron ( gravimetrically )
- III Analysis of ilmenite**
- i. Silica (gravimetrically)
  - ii. Iron (gravimetrically)
  - iii. Titanium ( gravimetrically ) / ( colorimetrically )



- IV Analysis of type metal**
- i. Antimony (volumetrically)
  - ii. Lead (gravimetrically)
  - iii. Zinc (gravimetrically)
- V Analysis of bronze**
- i. Tin ( gravimetrically )
  - ii. Copper (volumetrically)
  - iii. Zinc (gravimetrically)
- VI Estimation of vitamin – C from lemon juice (volumetrically)**
- VII Estimation of iron from soap-bar ( colorimetrically )**
- VIII Estimation of bismuth by complexometric titration with EDTA.**
- IX Analysis of pigment**
- X Analysis of plaster of paris**
- i. Calcium (volumetrically )
  - ii. Iron (colorimetrically)
- XI Semimicroqualitative analysis**  
(Binary mixture of two cations )  
( $\text{Cu}^{2+}$ ,  $\text{Bi}^{3+}$ ,  $\text{Hg}^{2+}$ , As (ous), As(ic),  $\text{Sn}^{2+}$ ,  $\text{Sn}^{4+}$ ,  $\text{Sb}^{3+}$ ,  $\text{Fe}^{2+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Cr}^{3+}$ ,  
 $\text{Zn}^{2+}$ ,  $\text{Co}^{2+}$  and  $\text{Ni}^{2+}$ )  
[ Study four mixtures ].

### CH-I-3

- I Stability constant**  
Determination of stability constant of metal-ligand by spectrophotometry  $\text{Ni}^{2+}$   
Ethylenediamine system.
- II Synthesis of complexes such as the following and their metal percentage analysis:**  
(any two)
- i. Ni (II) - 8 hydroxyquinoline
  - ii. Co(II) - hydrazine hydrate
  - iii. Cu(II) - ethylxanthate
- III Synthesis of**
- i. Bis aniline copper (II) chloride
  - ii. Bis aniline copper (II) sulphate
- Percentage estimation of copper, chloride and sulphate from above adducts.
- IV Magnetochemistry**  
Magnetic susceptibility measurements of the following complexes –
- i. Ni (II) - 8 - hydroxy quinoline
  - ii. Co(II) - hydrazine hydrate
- V Flame emission spectroscopy**  
Determination of alkali metals by flame photometric technique.
- VI Corrosion**  
Determination of the rate of corrosion of steel and aluminium.
- VII Determination of boric acid conductometrically using ammonium hydroxide.**
- VIII To find the composition of Fe (III) salicylic acid complex by Job's continuous variation method.**
- IX Estimation of barium as barium sulphate gravimetrically by homogeneous precipitation technique.**

- X Estimation of uranium by complexometric titration with EDTA.
- XI Turbidity determination.  
Determination of chloride in tap water by turbidimetry.
- XII Separation and estimation of zinc/cobalt and magnesium/nickel on an anion exchanger.
- XIII Separation and estimation of chloride and bromide on an anion exchanger.

### CH- I-4

- I Thermogravimetric analysis (TGA)  
Determination of number of water molecules from the given hydrated compound.
- II Investigation of the reaction kinetics between potassium persulphate and potassium iodide by colorimetric measurements.  
Rajbhoj and Chondhekar "Systematic experimental Physical Chemistry "
- III Electronic Spectra  
Analysis of electronic spectra of Ni(II) and Cr(III) – complexes IR/NMR/ table work.
- IV Coordination chemistry  
Synthesis and analysis of coordination compounds ( any two )
  - i. Potassium trioxalato ferrate (III) trihydrate and estimation of iron (volumetrically) and oxalate (volumetrically) from it.
  - ii. Bis acetyl acetonate copper (II) and estimation of copper (volumetrically) from it.
  - iii. Hexamine cobaltic (III) chloride and estimation of cobalt (volumetrically) from it.
- V Stability constants of metal complexes by Bjerrrums (potentiometric) method.
- VI Spectrophotometric study  
Kinetics of aquation of tris(1,10-phenanthroline) iron(II) in acid solution by spectrophotometry.
- VII Phase diagram  
Study of phase diagram of Sn-Sb alloy system.
- VIII Coordination Chemistry  
Synthesis and analysis of the co-ordination compounds.
  - i. Preparation of ferrosferric oxide ( $Fe_3O_4$ ) and estimation of iron from it.
  - ii. Preparation of trans-dichlorobis ethylene diamine cobalt (III) chloride and estimation of cobalt volumetrically.
- IX Drug analysis  
Estimation of iron volumetrically/colorimetrically and copper volumetrically from drug sample.
- X Kinetic masking  
Determination of chromium (III) and iron (III) in a mixture.
- XI Determination of percent purity of given sample of commercial washing soda by potentiometric titration.
- XII Estimation of dissolved  $NO_3^-/F^-/Cl^-$  in the given sample by colorimetry.

OR

CH-I-4      A short Research Project .

### Reference Books for Practical Courses

- 1) "A text book of quantitative inorganic analysis – by A.I.Vogel, ELBS London.
- 2) "Standard methods of chemical analysis – by F.J.Welcher.
- 3) "Instrumental analysis manual – by G.G.Guilbault and L.G. Hargis, Marcell Dekker, New York.
- 4) "Analytical Chemistry – by G.D.Christian, John Wiley, London,
- 5) "Practical inorganic chemistry" – by Marr and B.W.Rockett.
- 6) "Experimental inorganic chemistry" by Palmer, Cambridge University Press, London.
- 7) "Inorganic Synthesis " Series of volumes published by Wiley-Interscience.
- 8) "Synthesis and technique in inorganic chemistry – by R.J.Angelic, W.B.Saunders company, London.
- 9) "Inorganic experiments" – by U.Hofacker, M.Dekker, London.
- 10) "Coordination chemistry Experimental methods"- by K.Burger, Butterworths, London.

### M.Sc. PART-II SEMESTER III & IV

Skeleton for the revision of the syllabus at M.Sc.(Organic Chemistry)  
from July-2003.

#### COURSE STRUCTURE

1. Each theory course should be covered in 5 periods each of 60 minutes per week. (4 periods for lectures & one period tutorials, seminars etc.)
2. Each practical course will require 6 hours of laboratory work per week and course will be extended over two semesters and the candidate will be examined at the end of the year.
3. The distribution of the courses for the two semesters will be as under :-

#### Theory Courses

##### SEMESTER-III

- |    |          |   |
|----|----------|---|
| 1] | CH : 350 | Organic Reaction Mechanism                  |
|    | CH : 351 | Physical Methods in Structure Determination |
|    | CH : 352 | Organic Stereochemistry                     |
|    | CH : 353 | Heterocyclic Chemistry                      |

##### SEMESTER-IV

- |    |          |  |
|----|----------|--|
| 2] | CH : 450 | Chemistry of Natural Products          |
|    | CH : 451 | Synthetic Methods in Organic Chemistry |
|    | CH : 452 | Medicinal Chemistry                    |

#### Practical Courses

- |         |   |  |
|---------|---|--|
| CH -0-2 | : | Organic Chemistry Practical Course II  |
| CH-0-3  | : | Organic Chemistry Practical Course III |
| CH-0-4  | : | Organic Chemistry Practical Course IV  |
|         |   | OR                                     |
| CH-0-4  | : | A Short Research Project.              |

## CH-350 Organic Reaction Mechanism

1. **Linear free energy relationships :** [10]
  - a) Hammett plot. Hammett equation.  
Substituent and reaction constants, Physical significance of substituent and reaction constants, Substituent constant involving through conjugation.
  - b) Use of Hammett plot and equation.  
Deviation from straight line plot. Concave upward deviation.  
Concave downward deviation.
  - c) Steric effects. Taft equation. Steric parameters, solvent effect. Change of reaction constant.  
Ref. 1      Pages      358-372, 374-389  
Ref. 6      Relevant Pages
  
2. **Carbanions :** [12]
  - a) Formation of carbanions, stabilization of carbanions, Keto-enol equilibrium.
  - b) Mechanism of important reactions : Halogenation of ketones ( acid and base catalysed ). Aldol condensation, Mannich reaction. Perkin reaction, Michael reaction. Beuzoin condensation, Knoevenagel and stobbe reaction. Claisen-schmidt reaction. Dieckmann reaction. Hydrolysis of haloform, Reimer-Tiemann reaction.  
Ref. 2.      Pages      365-399  
Ref. 3.      Pages      398-416, 418-438.
  
3. **Reactions of carboxylic acids, esters, amides and related compounds:** [10]
  - a. Formation and hydrolysis of esters. Different types of ester hydrolysis mechanism.:  $B_{AC}^2, A_{AC}^2, B_{AL}^2, B_{AL}^1, A_{AL}^1, A_{AC}^1,$
  - b) Formation and hydrolysis of amides  $B_{AC}^2, A_{AC}^2$  mechanisms.
  - c) Caisen ester condensation, cleavage of Beta-diketones.
  - d) Decarboxylation of beta keto acids, beta amino acids, Decarboxylation catalysed by heavy metal ions, Decarboxylation of  $\alpha, \beta$  and beta, gamma unsaturated acids, Decarboxylation of silver salts. Hundsdiecker reaction.  
Ref. 2      Pages      314-356.  
Ref. 3      Relevant Pages
  
4. **Photochemistry :** [8]  
General principles, Orbital symmetry considerations. Photochemistry of carbonyl groups, alkenes and dienes. Aromatic compounds.
  
5. **Free Radical Reactions :** [8]  
History characteristics of free radicals : Formation propagation and termination. Reactivity. Stereochemistry.  
Reactions : Fragmentation, substitution, addition, Oxidation, reduction. Detection of free radicals.  
Ref. 3.      Pages      909-943.  
Ref. 4.      Relevant pages  
Ref. 6.      Relevant pages

### References

1. A Guidebook to mechanism in organic chemistry 6<sup>th</sup> edition. – by Peter Sykes. Orient Longman.
2. Mechanism and structure in organic Chemistry – by Edwin S.Gould. Holt, Rinechart and Winston.
3. Organic Chemistry 5<sup>th</sup> edition. – by S.H.Pine. McGraw-Hill International editions.
4. Advance Organic Chemistry 3<sup>rd</sup> edition by Jerry March. John Wiley and Sons.
5. Principles of organic synthesis. 3<sup>rd</sup> edition. – by R.O.C. Norman and J. M. Coxon 3<sup>rd</sup> edition ELBS.
6. advanced Organic Chemistry Part A and B, 2<sup>nd</sup> edition . – by F. A. Carey and R. J. Sundberg. Plenum Press. New York and London.

### CH-351 Physical Methods in Structure Determination.

1. Proton magnetic resonance : General introduction and elementary ideas [16]  
of instrumentation, advanced ideas of chemical shift, chemical exchange, effect of deuteration, stereochemistry, hindered rotation identification of complex spin system, AB,ABC, ABX, and AMX systems.  
Factors affecting vicinal and geminal coupling, long range coupling.  
Simplification of complex spectra, nuclear double resonance, nuclear overhauser effect, contact shift reagents.  
Nuclear magnetic resonance of other nuclei : P and F.
2. Carbon magnetic resonance : Elementary ideas of instrumentation, [8]  
chemical shift, chemical shift features of aliphatic, olefinic, alkyne, aromatic, hetero atomic and carbonyl carbons.
3. Mass Spectroscopy : theory instrumentation, Mass spectral fragmentation of [12]  
organic compounds containing common functional groups, McLafferty rearrangement. Molecular ion peak, meta stable peak, isotope peaks. Examples of mass spectral fragmentation of organic compounds with respect of their structure determination.
4. Problems based on joint application of u.v., I.R., NMR, CMR, and mass spectroscopy. [12]

### References

1. Spectroscopic methods in organic chemistry. D.H.William and Ian Flemming, 4<sup>th</sup> edition.
2. Spectrometric identification of organic compound. T.C.Morril, R.S.Silverstein, G.C.Bessler 4<sup>th</sup> edition.
3. Mass Spectroscopy. K.G.Das.
4. Absorption Spectroscopy of organic molecules.V.M.Parikh.

### CH-352 Organic Stereochemistry.

1. Stereochemistry of natural products : menthol, ajmaline, steroids. [6]  
Ref. 6. Pages 531-533.
2. Pericyclic reactions :Electrocyclic, Cycloaddition and sigmatropic reactions.[16]
3. Fused rings and bridged rings. [10]
4. Stereoisomerism of allenes, related compounds and biphenyls. [4]
5. O R D and C D : Nomenclature, principles, application to structure, Octant and axial haloketone rule. [8]
6. Asymmetric synthesis [4]  
Ref. 1 : Pages 68 – 74.

## References

- 1) Stereochemistry of carbon compounds. E.L.Eliel.
- 2) Conservation of orbital symmetry R.B.Woodward and Hofmann.
- 3) Stereochemistry. Nasipuri.
- 4) Orbital Symmetry : Problem solving approach. R.E.Lehr and Merchand.
- 5) Frontal orbitals and organic chemical reactions. Ian Flemming.
- 6) Organic Chemistry – by Finar.

## CH-353 Heterocyclic Chemistry

1. Nomenclature of three membered and four membered rings containing one and two heteroatoms ( Synthesis and reactions of aziridines, oxiranes and oxetanes ) [4]  
 Synthesis and reactions of following :
2. Furan, pyrrole, thiophene. [10]
3. Benzofuran, Indole, benz(b) thiophene. [6]
4. Imidazole, Oxazole, thiazole. [8]
5. Pyridine, Quinoline, Isoquinoline. [12]
6. Six membered ring containing two heteroatoms. [8]

## References

1. Heterocyclic Chemistry - J.Joule and G. Smith
2. Principles of modern heterocyclic Chemistry - Leo A Paquette.

## CH-450 Chemistry of Natural Products

1. Structure, stereochemistry and biogenesis of Hardwickiic acid, Magnamycin and Podophyllotoxin. [12]
2. Synthesis of [16]
 

Cholesterol	:	Woodward Synthesis
Cortisone	:	Sarret Synthesis
Reserpine	:	Woodward Synthesis
Atisine	:	Nagata Synthesis
Cephalosporin	:	Woodward Synthesis
Prostaglandin F <sub>2</sub>	:	E.J.Corey Synthesis, and its Comparison with modified synthesis.
3. Primary and secondary metabolism, Enzymes and coenzymes, introduction of one carbon unit. Metabolites derived from mevalonates, from shikimic acid and secondary metabolism of amino acids. [20]

Ref. 1      Pages      6,7, 11-18., 80-137,153-167,171-222.

## References

1. Secondary Metabolism. J.Mann (Oxford 1978)
2. Organic Chemistry, Vol.II I.L.Finar.
3. Principles of Organic Synthesis.  
R.O.C.Norman.
4. Steroides. L.Fieser and Fieser.
5. Structure determination. P. Yates.
6. Biosynthesis of Natural Products. P.Manito.

## CH:451 Synthetic Methods in Organic Chemistry. :

1. Synthetic uses of Organo-lithium, aluminium, Phosphorous and boranes. [10]  
Ref. 5
2. Transitional metal complexes in organic synthesis : Copper, thalium, [8]  
nickel, Cobalt, Mercury complexes. Wilkinson catalyst, Ziegler-Natta Catalyst.
3. Enamines in Organic Synthesis. [4]  
Ref. 4.
4. Umpolung in organic synthesis [4]  
Ref. 4
5. Nitrogen, Phosphorous and sulphur ylides in organic synthesis. [3]  
Ref. 4
6. Designing organic Synthesis. [16]  
Ref. 3
7. Protecting groups in organic synthesis : Hydroxyl, carboxyl and [3]  
aldehyde functions as illustrated in the synthesis of polypeptide  
and polynucleotide.  
Ref. 6 and 7 Relevant Pages

### References

- 1) Transition metal intermediates in organic synthesis. C.W.Birds.
- 2) Organometallic in organic synthesis. Swan and Black
- 3) Designing organic synthesis. Stuart Warren
- 4) Some modern methods of organic synthesis W. Carruthers.
- 5) Principles of organometallic Chemistry Coats, Green and Wade.
- 6) Organic Chemistry – by Robert T. Morrison and Robert N. Boyd. 5<sup>th</sup> edition.
- 7) Organic Chemistry – by I.L. Finar (Vol.2.) 5<sup>th</sup> edition.

## CH:452 Medicinal Chemistry

- 1) Classification and nomenclature of drugs [5]  
Ref. 1: Pages 14-36
- 2) Theories of drugs design. [4]  
Ref. 1: Pages 37-64
- 3) Anticoagulants, coagulants and Plasma extenderd. [7]  
Anticoagulants :
  - Heparin, Chemistry and mode of action.
  - Coumarin derivatives, Chemistry and mode of action.
  - Citric acid.
 Coagulants :
  - Proteins and amino acids.
- 4) Non-sterodal anti-inflammatory drugs : [10]
  - Role of chemical mediators in inflammation.
  - Prostaglandin thromboxanes prostacyclin, leutotrienes.
  - Antipyretics, analgesics
  - Anti-inflammatory agents : aspirin, Phenylbutazone indomethacin, iboprofen diclofenac, fenamic acid, proxicam.
  - Antimalerials agents.
  - Agents used for treatment of Gout.
  - Uricorasic agents.

- ❖ (Structure-activity relationship and metabolism of above NSAID is not expected).

Ref. 2 : Relevant pages

5) Cancer Chemotherapy. : [6]

- Nature of cancer, terminology, external causes of cancer, treatment of cancer, surgery, photoradiation, radiation, immunotherapy, chemotherapy, combination therapy, adjuvant therapy.
- Antineoplastic drugs : mercaptopurine, 6-thioguanine, 5-fluorouracil, allopurinol, methotrexate,
- Alkylating agents .
- DNA intercalating agents, effect of alkylating agents on DNA.
- Antimitotic agents.
- Other compounds.

Ref. 2 : Relevant pages.

6) Anti-AIDS. [6]

- Structure and life cycle of aids virus,
- Potential anti HIV agents :
- RT inhibitors
- Protease inhibitors
- Inhibition of gene expression.
- Glucosidase inhibition.
- Inhibition of viral binding.

Ref. 2 : Relevant pages.

7) Synthesis of following drugs : [10]

Warfarin, Dicoumarol, Ibuprofen, oxyphenbutazone, Diclofenac sodium, Indomethacin, AZT, Adranaline, Chloramphenicol, Ascorbic acid, Griesofulvin, Methotrexate, chloroquine, Dapsone, Primaquine, melphalan.

### References :

1. Medicinal Chemistry G.R.Chatwal.
2. Principles of medicinal chemistry (4<sup>th</sup> edition ) W.D.Foye, T.L.Lemke, D.A.Williams.
3. Organic chemistry of drug action and design. R.B.Siwerman, (academic press, 1993)

## CH:02 Organic Chemistry Practical course II

Separation, purification and identification of the components of a mixture of three organic compounds. The mixture should involve nitrophenols, amino acids, low boiling substances, water soluble substances, amines, phenols and acids.

The purity of the compounds separated should be checked by T.L.C.

The separation of at least nine mixture of three component should be carried out.



## CH : 03 Organic Chemistry Practical Course III

- Two stage preparations ( at least 8 )  
The exercise should illustrate the use of organic reagents and may involve the name reactions.
- Three stage preparations ( at least two such three stage preparation, should be carried out ).  
The purity of the product of each step should be checked by T. L. C.

## CH : 04 Organic Chemistry Practical Course IV

- Students should carry out at least ten experiments to illustrate the principles of organic reaction mechanism, stereochemistry or selectivity of reagents.  
Completion of the reaction should be followed by T.L.C.  
LiAlH<sub>4</sub>, NaBH<sub>4</sub>, SeO<sub>2</sub>, B<sub>2</sub>H<sub>6</sub>, Grignard reagent, butyltriethyl ammonium Chloride, Pb(OAc)<sub>4</sub>, NaIO<sub>4</sub>, KMnO<sub>4</sub>, ceric ammonium nitrate, enamine POCl<sub>3</sub> – D M F , D M S , hydrazine, Zn/Hg/HCl , PCC, PPA , NBS.
- Spectral identification of organic compounds by using IR and NMR spectra.  
Spectral analysis of at least six organic compounds should be carried out.

OR

## CH ; 04 Organic Chemistry Practical :

The students should carry out a small research project. This should make him familiar with literature. Survey, research methodologies, identification of product by analytical and spectral methods and familiarity with chromatographic techniques.

### M.Sc. PART-II SEMESTER III & IV Syllabus in Analytical Chemistry from July,2003. PROPOSED SYLLABUS COURSE STRUCTURE

- Each theory course should be covered in 5 periods each of 60 minutes per week. 4 periods for lectures & one period tutorials, seminars etc.
- Each practical course will require 6 hours of laboratory work per week and course will be extended over two semesters and the candidate will be examined at the end of year.
- There should not be more than 10 students in a batch of M.Sc. Practical course.
- Once in a year a visit to chemical industry/research institute/science & technology institute is expected.
- The distribution of courses will be as follows.

#### SEMESTER-III

- |          |                                  |
|----------|----------------------------------|
| CH : 391 | Concepts of Analytical Chemistry |
| CH : 392 | Modern separation science        |
| CH : 393 | Instrumental methods of analysis |
| CH : 380 | Pharmaceutical Analysis          |

OR

- |          |                                     |
|----------|-------------------------------------|
| CH : 381 | Analysis of Organics and Medicinals |
|----------|-------------------------------------|

**SEMESTER-IV**

- 2] CH : 491 Absorption and Emission Spectroscopic methods of analysis.  
 CH : 492 Special analytical methods and analysis of complex materials.  
 CH : 480 Environmental analysis

OR

- CH : 481 Bioanalysis and analysis of food.

**PRACTICAL COURSES**

1. CH : A-1 Analytical Chemistry Practical Course - I  
 2. CH : A-2 Analytical Chemistry Practical Course - II  
 3. CH : A-3 Analytical Chemistry Practical Course - III

OR

4. CH : A-3 A short Research Project .

**SEMESTERWISE DISTRIBUTION OF COURSE****Sem. III Theory Courses**

1. CH:391 – Concepts of Analytical Chemistry  
 2. CH:392 – Modern Separation Science  
 3. CH:393 – Instrumental Methods of Analysis  
 4. CH:380 – Pharmaceutical Analysis

OR

4. CH:381 – Analysis of Organics and Medicinals

**Sem. IV Theory Courses**

1. CH:491 – Absorption and Emission spectroscopic methods of Analysis  
 2. CH: 492 –Special Analytical Methods and analysis of complex materials  
 3. CH: 480 Environmental Analysis

OR

3. CH : 481 Bio-Analysis and analysis of food.

**Practical Courses**

- 1.CH:A-1- Analytical Chemistry Practical Course-I  
 2.CH:A-2- Analytical Chemistry Practical Course-II  
 3.CH:A-3- Analytical Chemistry Practical Course-III

OR

A short Research Project

**M.Sc. PART-II SEMESTER III & IV**  
**Syllabus in Analytical Chemistry from July,2003.**

**CH : 391 Concepts of Analytical Chemistry.**

- 1) Principle of Separation [8]  
 Introduction, Basic concepts  
 A) Goal of separation    B) Calculation    C) Partition Technology.  
 Calculation –  
 A) Outline of types of contact,  
 B) Cross-current process  
 C) Counter current processes  
 Special Topics – A) Optimal conditions, B) Determination of partition ratios C) Distribution behaviour of chemical structure, D) Roles played by rates E) Selection of separation method, F) Continuous separation G) Principles shared by separation and determination.  
 Ref. 1.Pages 917-952.
- 2) Decomposition and Dissolution of Inorganic Samples [6]  
 Introduction, Acids as solvent, oxidising and non-oxidising alkaline fluxes and acid fluxes, Use of Chlorine and Bromine at high temperature.  
 Ref. 1. Pages 1027 – 1047.
- 3) Decomposition and Dissolution of Organic Samples [6]  
 Introduction, Dry and wet ashing methods, Specials reagents, peroxide Bomb, Alkali metal fusion, Lamp method, Lisbeg method.  
 Ref. 1 Pages 1051 – 1083.
- 4) Sample D.C. and A.C.Electric Circuits. [10]  
 D.C. Circuits, current and potential measuring devices, A.C. Circuits.  
 Ref. 2 Pages 9 – 48.
- 5) Introductory Electronics. [8]  
 Introduction to semi conductors, diodes, transistors, FET, Practical amplifier circuits, ( Darlington, cascode and push pull only ), typical Power Supply.  
 Ref. 2 Pages 49 – 79.
- 6) Introduction to Digital Computers [10]  
 Introduction to I.C., Op-Amp., Micro Processor, Gates and Boolean algebra, Digital Computers.  
 Ref. 2 Pages 81 – 135.

**REFERENCES :**

- 1     Standard methods of analysis ( Volume, Two Part-A )  
        -     F.J.Welcher.
- 2     Introduction to instrumental analysis.  
        -     R.D.Braun.

## CH : 392 MODERN SEPARATION SCIENCE

1. **CHROMATOGRAPHY :- GENERAL PRINCIPLES** [8]  
Theory, Behaviour of solutes, column efficiency and band broadening, Resolution, Column process, Reduced variable, Time of analysis Qualitative and quantitative analysis, problems.  
Ref.1. Pages 430-453, Ref. 2. Pages 821 – 838.
2. **GAS CHROMATOGRAPHY** [10]  
Optimisation of experimental condition, Retention time and Retention Volume, Detectos- Thermionic, Flame photometric, Helium and Coulson conductivity detectors, Supercritical fluid chromatography, Qualitative and Quantitative analysis, problems.  
Ref.1. Pages 454-493, Ref.2. Pages 890-931.
3. **LIQUID COLUMN CHROMATOGRAPHY :-** [10]  
Introduction, Solvent delivery system, Sample injection. Separation columns Detectors, Optimisation of column performance, Problems.  
Ref.1. Pages 495-527 , Ref.2. Relevant pages
4. **HIGH PERFORMANCE LIQUID CHROMATOGRAPHY :-** [10]  
Adsorption HPLC, Partition HPLC, Ion exchange HPLC, Exclusion HPLC, Problem.  
Ref.1. Pages. 550 – 553, Ref. 2. Pages 855-859.
5. **ION CHROMATOGRAPHY :-** [2]  
Introduction , Technique and application.  
Ref.1. Pages 550-553, Ref.2. Pages 855-859.
6. **PRINCIPLES, TECHNIQUE AND TYPICAL APPLICATIONS OF FOLLOWING TECHNIQUES.** [8]  
Reverse osmosis, Zone refining, Electrophoresis, Micro distillation and Fractional distillation.  
Ref. 3. Relevant Pages.

### References

1. Instrumental methods of chemical analysis (6<sup>th</sup> edition)  
H. H. Willard, L. L. Merritt, J. D. Dean, S. A. Settle, Jr.
2. Introduction to Instrumental analysis – R.D. Braun.
3. Introduction to separation science. – L.R. Snyder & O.H. Hawarth.

## CH : 393 INSTRUMENTAL METHODS OF ANALYSIS

1. **pH AND ION SELECTIVE POTENTIOMETRY :-** [10]  
Glass membrane electrodes, Solid-state sensors, Liquid membrane electrodes, Gas sensing and Enzyme electrodes, Interference, ion activity evaluation method, pH measurement, Glass electrode, for pH measurement, Electrometric measurement, of pH & pI, Problems.  
Ref. 1. Pages 640-663, & Pages – 720 – 735.

2. **VOLTAMMETRIC METHODS** [8]  
A.C. voltammetry, Pulse and Differential pulse polarography, square wave polarography, Voltammeter at solid electrode, Hydrodynamic voltammetry, Triangular wave voltammetry, Cyclic voltammetry, Fast linear ----- voltammetry, Problem.  
Ref.1. Pages – 707 – 713., & Pages – 777 – 793.
3. **ELECTROGRAVIMETRY AND COULOMETRY** [10]  
Electro-separations, Basic principles, Equipment for electrolytic separation, Electrogravimetry, Electrography, Electrolytic purification, Coulometric methods, Problems.  
Ref.1. Pages – 736 – 779, & 799 – 807.
4. **HIGH FREQUENCY TITRATIONS** [4]  
Introduction, Theory, Instrumentation, Applications, Advantages and disadvantages of HF titration's  
Ref. 1. Pages 445-453.
5. **AUTOMATED ANALYSIS** [6]  
Automated laboratory analysis, Computerisation, Automated laboratory apparatus continuous flow analyzer, Flow injections analyzer, Desecrate sample analyzer, Centrifugal force analyzer, Automatic titrator, Robots, Process control analyzer.  
Ref.1. Pages – Relevant Pages, Ref.2. Pages – 949-975.
6. **ORGANISATION OF ANALYTICAL CHEMISTRY IN INDUSTRIAL RESEARCH LABORATORY** [10]  
Introduction, Industrial research lab., Analytical chemistry in research. The Analytical division, Trends.  
i) Applications of analytical chemistry. Ref.4. Pages 55 –80.  
ii) Pharmaceutical lab. in industry.

#### REFERENCES :-

1. Instrumental methods of analysis (6<sup>th</sup> edition) H.H.Willard & L.L.Merritt, J.A.Dean, F.A.Settle.
2. Introduction to Instrumental Analysis R.D.Braun.
3. Instrumental methods of chemical analysis G.Chaitwal & S.Anand.
4. Treatise on analytical chemistry (Vol. One, Part-III) I.M.Kolthoff and P.J.Elwing.

### CH : 380 PHARMACEUTICAL ANALYSIS

- 1) **DEFINATION OF DRUG :-** [2]  
Introduction to drug act, Drug rules (Schedules), FLA,  
(Ref.1,2, & 3 Pages Relevant Pages )
- 2) **SOURCES OF IMPURITIES IN PHARMACEUTICAL CHEMICALS** [5]  
Raw materials, Method of manufacture, Reagents, Solvents, Atmospheric Contaminants, Microbial contaminants, Manufacturing and storage effect on drugs.  
(Ref.1,2, & 3 Pages Relevant Pages )
- 3) **STANDARDISATION OF FINISHED PRODUCTS AND THEIR CHARACTERISATION.** [5]  
(Ref.1,2, & 3 Pages Relevant Pages )

- 4) **OFFICIAL METHODS OF CONTROL** [6]  
 Monographs and their criteria, Preparation, Test procedures, limit tests, Disintegration tests, Dissolution test, Alkaloids assay, Raw material analysis, Aqueous and nonaqueous titration's.  
 (Ref.1,2, & 3 Pages Relevant Pages )
- 5) **INTRODUCTION TO PHARMACEUTICAL FORMULATIONS** [6]  
 Processes used in different pharmaceutical formulation, outline of pharmaceuticals.  
 (Ref.1,2, & 3 Pages Relevant Pages )
- 6) **EVALUATIONS, STANDARDISATION AND QUALITY CONTROL** [8]  
 Tablets, Capsules, Powders, Solutions, Suspensions, Emulsions, Aerosols, Creams, Ointments., Injections, and infusions, Eye preparations, and blood products.  
 (Ref.1,2, & 3 Pages Relevant Pages )
- 7) **STANDARD SPECIFICATIONS** [8]  
 Pharmacopoeia specifications, Stability studies and expiry date fixation.  
 (Ref.1,2, & 3 Pages Relevant Pages )
- 8) **CLASSIFICATIONS OF DRUG** [8]  
 An overview- chemical, Pharmacological and therapeutic classifications, Some examples of recent drugs.  
 (Ref.1,2, & 3 Pages Relevant Pages )

#### References

1. Pharmacopoeia of India
2. British Pharmacopoeia of India
3. United states Pharmacopoeia

### CH : 381 ANALYSIS OF ORGANICS AND MEDICINALS

1. **DETERMINATION OF HYDROCARBONS, CARBONYL COMPOUNDS, NITROGEN COMPOUNDS, AND SULPHUR COMPOUNDS** [10]
- a) Hydrocarbons – Carbon and Hydrogen by combustion method.
  - b) Carbonyl compounds - Estimation by oxidation, bisulphate addition, gravimetric DNP method and saponification method.
  - c) Nitrogen compounds-estimation by Kjeeldahl and Duma's methods, aromatic amines by diazotisation & nitrosation, reduction method for azo, hydrazo and nitro compounds by titanous chloride method.  
 Sulphur compounds- Oxygen flask method, bregel method. Mercaptans by silver sulphate method.
  - d) Numerical problem on above method.  
 Ref. 1. Pages – 366-372, 377-398, 462-470, 489-490, 497-501.  
 Ref. 2. British Pharmacopoeia of India
2. **ANALYSIS OF PETROLEUM AND PETROLEUM PRODUCTS** [4]
- a) Doctor test for petroleum.
  - b) Sulphur in petroleum products by colour indicator method.
  - c) Lead antiknock compounds in petrol by AAS.
3. **ANALYSIS OF POLYMERS AND PLASTICS** [8]
- a) Introduction to rubber products isoprene polymers.
  - b) Plastic identification by IR and GC method for ethylene plastics, styrene plastics, Vinyl chloride plastics and acrylic plastics.  
 Ref.2, Pages – 2055-2061, 2068-2075, 2080-2093, 2146-2150, 2160-2163.

4. ANALYSIS OF SURFACTANTS [4]  
 a) Tests for syndets  
 b) Analysis of organic builders in syndets.  
 Ref. 2, Pages 2289-2309.
5. ANALYSIS OF INSECTICIDES & PESTICIDES [4]  
 a) Analysis of BHC, 2,4-D, DDT, Endrin, Lindane & Malathion.  
 b) Analysis of Pesticide residues such as Organochloro and organophosphates.  
 Ref. 2, Relevant Pages, Ref. 3, Pages 1464-1477.
6. PHARMACEUTICALS, PHARMACOPOEA AND DRUGS REGULATIONS [8]  
 a) Impurities in pharmaceuticals and limit tests, General methods of assay of drugs.  
 b) General notices of I.P., Types of drugs and their monograms.  
 Drugs acts 1940, 1956.  
 Ref. 5, Pages – 1856-1857, 1862, 1865, 1871, 1880-1881.  
 Ref. 6, Pages – 1.1 to 1.13, 1.26 to 1.47, 4.1 to 4.7, 12.1 to 12.6, 1 to 6.
7. ANALYSIS OF MEDICINALS AND DRUGS [10]  
 a) Analysis of Medicinals such as aspirin, Sulpha drugs, Assay of drugs based on functional groups such as amino, -SH and acidic group.  
 b) Assay of Vitamin such as Vitamin A, Vitamin B, Vitamin B<sub>2</sub>, Vitamin B<sub>6</sub>, Vitamin B<sub>12</sub>, Vitamin C, Vitamin D, Vitamin F.  
 c) Enzyme assay methods – Ratio amino assay and ELISA method.  
 d) Bio assay method for antibiotics.  
 Ref. 1, Pages 412-413, 419-420, 425-427.  
 Ref. 2, Pages 2343-2352, 2358-2363.  
 Ref. 4, Pages 231 – 242, 278 – 288.  
 Ref. 5, Pages – A-147 to A-152.  
 Ref. 6, Pages – Forensic pharmacy of ethics.

#### References :-

1. Standard Methods of Chemical Analysis ( Vol. Two Part A ) - F. J. Welcher.
2. Standard Methods of Chemical Analysis ( Vol. Two Part B ) - F. J. Welcher.
3. Standard Methods of Chemical Analysis ( Vol. Three Part B ) - F. J. Welcher.
4. Analytical Bio-Chemistry. Holme & Peck.
5. British Pharmacopoeia.

### CH : 491, ABSORPTION AND EMISSION SPECTROSCOPIC METHODS OF ANALYSIS.

1. UV AND VISIBLE SPECTROMETRY: [10]  
 Photometry accuracy and precision, Double beam instruments, Scanning double beam instruments such as spectrophotometers, Dual wavelength.  
 Spectrophotometer, Analytical applications of UV and visible spectroscopy, Photometric titrations, Problems.  
 Ref. 1, Pages 261 to 298, Ref. 2, Pages 66 to 83.

2. **INFRA- RED SPECTROSCOPY:** [10]  
Principle, Instrumentation – Radiation sources, Detectors, FTIR , Hadmard transform Spectroscopy, Sample preparation, Structural co-relations, Qualitative and Quantitative analysis, Problems.  
Ref. 1, Pages 346 to 398, Ref. 2, Pages 178 to 210.
3. **PRINCIPLES AND ANALYTICAL APPLICATIONS OF FOLLOWING** [10]
  - i) X-ray diffraction and X-ray fluorescence.
  - ii) NMR and ESR
  - iii) Mass spectrometry and Mossbaur spectroscopy
 Ref. 1,2,3 Relevant Pages .
4. **PRINCIPLE, INSTRUMENTATION AND ANALYTICAL APPLICATIONS OF FLUORESCENCE AND PHOPHORESCENCE.** [6]  
Ref. 1,2,3 Relevant Pages .
5. **PRINCIPLE, INSTRUMENTATION AND ANALYTICAL APPLICATIONS OF FES AND AAS.** [8]  
Ref. 1,2,3 Relevant Pages .
6. **PRINCIPLE, INSTRUMENTATION AND ANALYTICAL APPLICATIONS OF ESCA** [4]  
Ref. 1,2,3 Relevant Pages .

#### References :-

1. Introduction to Instrumental Analysis. R.D.Braun.
2. Instrumental Methods of Analysis (6<sup>th</sup> edition) H.H.Willard & L.L.Merritt
3. Instrumental Methods of chemical Analysis(3<sup>rd</sup> edition) G.W.Ewing.

### CH : 492 SPECIAL ANALYTICAL METHODS & ANALYSIS OF COMPLEX MATERIALS.

1. **RADIOCHEMICAL METHODS OF ANALYSIS** [8]  
Measurement of Radio activity – Scintillation counter, sample preparation, mounting, Neutron Activation Analysis (NAA), Isotope Dilution Analysis (IDA), Problems,  
Ref. 1, Pages 289 to 315, Ref. 5, Pages 633 to 640.
2. **GAS VALUMETRIC METHODS OF ANALYSIS** [8]  
Apparatus employed in gas analysis – Orsat, Bunt and Hempel apparatus, Absorbents for various gases, Determination by explosion, Slow explosion and fractional combustion, Problems.  
Ref. 1, pages 1054 to 1087.
3. **THERMAL METHODS OF ANALYSIS** [8]  
Principle, Instrumentation and analytical applications of TGA,DTA,DSC and thermometric titration, Problems.  
Ref.1, Pages 637 to 643, 665 to 668, Ref.5, Pages 932 to 946.
4. **ANALYSIS OF MINERALS AND ORES SUCH AS** [8]  
Monazite, Bauxite, and Ilmenite.  
Ref. 3, Pages 1058 to 1072, 1094 to 1109.



5. ANALYSIS OF ALLOYS SUCH AS Brass, Bronze, Steel, and Silver Alloys. [8]
6. ANALYSIS OF FERTILIZER AND GLASSES Ref. 2, Pages 1183 to 1506, 2229 to 2258. [8]

#### References :-

1. Instrumental Methods of analysis (6<sup>th</sup> edition) - H.H. Willard & L.L. Merritt.
2. A text book of quantitative inorganic analysis (3<sup>rd</sup> edition) - A.I. Vogel.
3. Standard methods of chemical analysis ( Vol. Two Part B )- F. J. Welcher
4. Treatise on analytical chemistry (Series of volumes ) -I. M. Kolthoff & P.J. Elwing.
5. Introduction to instrumental methods of analysis - R.D. Braun

### CH : 480 ENVIRONMENTAL ANALYSIS

1. ENVIRONMENT :- [14]  
Characteristics, Classification, Metallic, and non-metallic pollutants, Physiological carcinogenic compounds.  
Ref. 1,2,3. Relevant Pages
2. CHEMISTRY OF AIR POLLUTANTS [08]  
Characteristics, Methods of analysis, Monitoring instruments.  
Ref. 1,2,3. Relevant Pages
3. POTABLE AND INDUSTRIAL WATER [12]  
Major and minor pollutants, Dissolve Oxygen, COD, BOD, Threshold odour number.  
Ref. 1,2,3. Relevant Pages
4. QUALITY OF INDUSTRIAL WASTE WATER [14]  
Analysis of organic and inorganic pollutants, Chemistry of odour and it's measurement, Control of radio active waste, Sewage and sludge analysis Treatment and disposal.  
Ref. 1,2,3. Relevant Pages

#### REFERENCES :-

1. Standard methods of water and waste water analysis. A.K. De.
2. Environmental Chemistry. S.M. Khopkar.
3. Environmental Chemical analysis M. S. Cress & Morr.

### CH : 481 BIOANALYSIS AND ANALYSIS OF FOOD

1. a) Human nutrition, Biological value of food. [10]  
b) Estimation of carbohydrates, Fats, Proteins, Amino acids.  
Ref. 1. Pages – 753 to 764.  
Ref. 3. Pages – 321 to 327, 329 to 336, 360 to 376, 388 to 398, 424 to 478.  
Ref. 4. Pages -- 152 to 154, 162, 164 to 168.
2. a) Food processing and Food Preservation. [12]  
b) Food legislation and public health.  
c) Single cell protein.

Ref. 5. Pages – 444 to 452, Ref. 6 . Pages – 817 to 342.  
 Ref. 7. Pages 1111 to 1114 , Ref. 8. Pages 817 to 820.  
 Ref. 9. Pages 36 to 69, Ref. 15. Pages 303 to 336.  
 Ref. 17. Pages 403 to 414.

3. Analysis of foods such as Milk, Flour, Honey, Jam, Jelly, Spices, Starches, Colouring matter, Beverges, Pesticide residues in food. [10]  
 Ref. 6. Pages 466 to 467, 497 to 500.  
 Ref. 10. Pages 58 to 72, 249 to 293, 306 to 313, 386 to 402, 407 to 413, 422 to 429, 499 to 508, 536 to 540, 542 to 547.  
 Ref. 11. Pages 03 to 04.
4. a) Analysis of Urine and blood serum. [8]  
 b) Detection of abnormal levels of constituents leading to diagnosis of diseases.  
 Ref. 7. Pages 1077 to 1083, 1088 to 1125.  
 Ref.12. Pages 21 to 30, 102 to 103, 111, 170 to 175.
5. FORENSIC ANALYSIS [8]
- a) Introduction.  
 b) Forensic examination of biological fluids, stains, semen, hair, other materials.  
 c) Forensic toxicology.  
 d) Techniques used in molecular probing – southern, northern, western, blotting, DNA fingerprinting.  
 Ref. 12. Pages 21 to 30, 102 to 103, 111, 170 to 175.  
 Ref. 13. Pages 724 to 730, Ref. 14. Pages Relevant Pages.  
 Ref. 16. pages 52 to 62, 262 to 263, 488 to 491.

#### REFERENCES :-

1. Biochemistry (1997 edition) - Lehinger
2. Physiological review of chemistry - Harper
3. Analytical Biochemistry (2<sup>nd</sup> edition) - Holme & Peck
4. A manual of laboratory techniques. – I. C. M. R. Hydrabad (1983)
5. Shrieves chemical process industries G. L .Austin ( 5<sup>th</sup> edition)
6. Association of officials analytical chemists (AOAC) -13<sup>th</sup> edition.1980.
7. Standard Methods of Chemical Analysis ( Vol. Three Part A )-F.J. Welcher
8. Microbiology Pelczar reid, Chand ( 1977 edition )
9. The prevention of food adulteration act. 1954 G.G.Mathur.
- 10 . Hand book of food analysis S.N.Mahindru
11. ISI – 1988, Hand book of food analysis - Part I
12. Medical laboratory technology - Dr. Ranik Good.
13. Practical Clinical Biochemistry - Harold Warely
14. Forensic pharmacy and ethics - V.D. Joshi & M. R. Varad
- 15 . Text book of Biotechnology - G. R. Chatwal
16. Elements of Biotechnology - L.K.Gupta
17. Biotechnology fundamentals and application – Purohit & Mathur.

## CH : A-1 ANALYTICAL CHEMISTRY PRACTICAL COURSE-I

N.B. :- Perform any 18 Experiments out of the followings.

- |     |   |      |                      |
|-----|---|------|----------------------|
| 1)  | Analysis of Nichrome alloy  | I)   | Cr by colorimetry    |
|     |   | II)  | Ni by gravimetry     |
| 2)  | Analysis of chalcopyrite Ore  | I)   | Cu by iodometry      |
|     |   | II)  | Fe by volumetry      |
|     |   | III) | Silica by gravimetry |
| 3)  | Analysis of zinc blend ore  | I)   | Zn by complexometry  |
|     |   | II)  | Fe by volumetry      |
| 4)  | Analysis of calcite ore   | I)   | Ca by complexometry  |
|     |   | II)  | Fe by colorimetry    |
| 5)  | Determination of COD value of given sample of polluted water  |      |                      |
| 6)  | Determination of BOD value of given sample of sewage water  |      |                      |
| 7)  | Separation and estimation of Fe and Al on cation exchanger resin  |      |                      |
| 8)  | Determination of iron in Portland cement sample.  |      |                      |
| 9)  | Determination of total chlorine in pesticide formulation  |      |                      |
| 10) | Determination of organic carbon in soil by walk ley and balck method.                                   |      |                      |
| 11) | Determination of copper in fungicide.   |      |                      |
| 12) | Determination of available chlorine in bleaching powder by Bunsen method.                               |      |                      |
| 13) | Determination of Barium in given sample by homogenous precipitation method.                             |      |                      |
| 14) | Estimation of sulphur in coal.  |      |                      |
| 15) | Estimation of Pencillin ( iodometrically )  |      |                      |
| 16) | Estimation of ascorbic acid by ceric ammonium sulphate method.  |      |                      |
| 17) | Estimation of endosulphan iodometrically.   |      |                      |
| 18) | Estimation of EDTA in detergent and shampoo.  |      |                      |
| 19) | Separation and identification of amino-acids from hydrolysates by two dimensional paper chromatography. |      |                      |
| 20) | Estimation of mixture of benzoic acid and salicylic acid in pharmaceutical preparation.                 |      |                      |

## CH : A-2 ANALYTICAL CHEMISTRY PRACTICAL COURSE-II

N.B. :- Perform any 18 Experiments out of the followings.

- 1) Determination of Na in given sample by Flame photometry method  
[ Calibration curve method ]
- 2) Determination of K in soil by Flame photometry method.[Li internal standard method. ]
- 3) Determination of Ca in egg shell by Flame photometry method.  
[ Standard addition method ]
- 4) Determination of Chloride by Turbidimetry.
- 5) Determination of Vitamin B<sub>2</sub> [ Riboflavin ] by flurometry.
- 6) Determination of p-nitrophenol by colorimetrically – standard addition method.
- 7) Determination of Water in organic sample by karl-fischer titration.
- 8) Estimation of O<sub>2</sub> and CO<sub>2</sub> in air by Orsat method.
- 9) Photometry titration of Fe (III) with sulphosalicylic acid.
- 10) Determination of strength of acetic acid in vinegar by conductometry titration.
- 11) Simultaneous spectrometry determination of Manganese and chromium in steel sample.
- 12) Determination of Asprin in drug tablet by pH metry titration with NaOH.
- 13) Determination of commercial washing soda by potentiometric titration method.
- 14) Determination of composition of complex by Job's continuous variation method.
- 15) Estimation of iron in pharmaceutical preparation by potentiometric titration.
- 16) Separation and determination of Co & Ni using basic anion exchanger resin Dovex 1 x 8.
- 17) Non aqueous titration method for estimation of
  - a) isoniazide
  - b) Sodium benzoate.

- 18) Quantitative analysis of iron, calcium, and phosphorus in Milk powder  
( Fe – Colorimetrically, Calcium-complexometrically phosphorus-Colorimetrically )
- 19) Analysis of lindane in B.GH.C. by polarography.
- 20) Casein isolation from Milk by isoelectric precipitation ( Yield expected )

### CH : A-3 ANALYTICAL CHEMISTRY PRACTICAL COURSE-III

N.B. :- Perform any 18 Experiments out of the followings.

- 1) Complete pharmacopoeal assay of aspirin.
- 2) Identification and estimation of surplus drug by TLC in ointment.
- 3) Estimation of blood protein by Lowery method.
- 4) Estimation of Benzoic acid in ointment by titrimetry
- 5) Estimation of Urea in blood/ Urine sample.
- 6) Estimation of Cholesterol in egg yolk or blood serum.
- 7) Separation and identification of plasma proteins by paper electrophoresis method.
- 8) Determination of blood Glucose by Folin – Wu method.
- 9) Estimation of sulphadiazine in sulpha tablet by amperometric titration method.
- 10) Estimation of Glucose and Fructose in honey by Lane and Eynone method.
- 11) Estimation of Vitamin A in food product by carr-price method.
- 12) Estimation of Vitamin C in Fruit Juice by iodometry
- 13) Estimation of lactose in Milk by iodometry.
- 14) Estimation of amino acids in protin hydrolysate by Sorenson formal titration method.
- 15) Estimation of Pectin as Ca-Pectate colorimetrically/volumetrically.
- 16) Estimation of Zinc in face powder by gravimetry.
- 17) Determination of available phosphorus in soil Olesen's colorimetric method.
- 18) Determination of saccharin in beverages.
- 19) Determination of anti-oxidant in oil and fat.
- 20) Determination of Fluoride in tooth paste calorimetrically with alizarinS.

OR

### CH : A-3 A Short Research Project.

#### References For Practicals.

- Ref. 1. A text book of qualitative inorganic analysis ( 3<sup>rd</sup> edition)-A.I.Vogel
- Ref. 2. Standard methods of chemical analysis ( A series of volumes )-F. J. Welcher
- Ref. 3. Treatise on analytical chemistry ( A series of volumes )-I. M. Kolthoff & P. J. Elwing
- Ref. 4. Association of official analytical chemistry ( AOAC )-13<sup>th</sup> edition. 1980.
- Ref. 5. Instrumental methods analysis ( 6<sup>th</sup> edition )-H. H. Willard & L. L. Merritt
- Ref. 6. Pharmacopoeas of India, British & United States.
- Ref. 7. Hand book of food analysis -S. N. Mahindru.
- Ref. 8. Analytical Biochemistry -Holme – Peak
- Ref. 9. Post graduate chemistry Practical Part I -Patel, Gadre & Turkhia.

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**M.Sc. PART-II SEMESTER III & IV**  
**Syllabus in Physical Chemistry from July, 2003.**  
**PROPOSED SYLLABUS**  
**COURSE STRUCTURE**

1. Each theory course should be covered in 5 periods each of 60 minutes per week. 4 periods for lectures & one period for tutorials, seminars etc.
2. Each practical course will require 6 hours of laboratory work per week and course will be extended over two semesters and the candidate will be examined at the end of year.
3. There should not be more than 10 students in a batch of M.Sc. Practical course.
4. For Project work the batch will be of not more than five students.
5. The distribution of courses for two semesters will be as follows.

**SEMESTER-III**

- 1] CH : 310 Quantum Chemistry and statistical Thermodynamics  
CH : 311 Nuclear and Radiation Chemistry.  
CH : 312 Polymer Chemistry Paper - I  
CH : 313 Solid State Chemistry and Surface Chemistry.

**SEMESTER-IV**

- 2] CH : 410 Molecular Structure.  
CH : 411 Electrochemistry and Phase rule.  
CH : 412 Polymer Chemistry Paper - II

**PRACTICAL COURSES**

- CH : P-2 : Physical Chemistry Practical Course-II  
CH : P-3 : Physical Chemistry Practical Course-III  
CH : P-4 : Physical Chemistry Practical Course-IV

OR

- CH : P-4 : A short Research Project.

**CH : 310 Quantum Chemistry and Statistical Thermodynamics**  
**Section-I**

**Quantum Chemistry**

- [1] OPERATORS :- [8]  
Operators, Eigen values and Eigen-functions operators and quantum mechanics.  
Hermitian operators  
Definition, examples, and Theorems, The three dimensional particle, schrodinger's equation, The particle in a three dimensional box. Degeneracy, Average values, Acceptable wave functions. The postulates of quantum mechanics.
- [2] THE VARIATION METHOD. [8]  
The variation theorem, extension of the variation method, Determinants, Simultaneous Linear equations, Linear variation functions.  
Semiempirical treatment of polyatomic molecules :- M.O. treatment to planer conjugated molecules, the free electron M.O. method. The Huckel M.O. method - Butadiene, conjugated polyenes, Benzene, Monocyclic conjugated polyenes. Napthalene, Delocalisation energy and Aromaticity,  $\pi$  electron charges and bond orders.

**[3] PERTURBATION THEORY .****[8]**

Perturbed and unperturbed systems, Non degenerate perturbation theory, perturbation treatment of the helium atom, ground state variation treatments of the ground state of perturbation Theory for degenerate energy levels, simplification of the elatero equation, perturbation treatment of the first excited states of helium, comparison of the variation and perturbation methods.

**REFERENCES: -**

1. Quantum Chemistry I. N. Levine, Allyn and Bacon.
2. Quantum Mechanics I.L .Powell and B.Crasemann Addison-Wesley (1961)
3. Quantum Chemistry – B.K .Sen. Tata Mc Graw Hill (1992)
4. Quantum Chemistry – R.K .Prasad. Wiley Eastern Ltd. (1992)
5. Quantum Chemistry – H. Eying, J. Walter and C. E. Kimboll, John Wiley and Sons (1944)
6. Quantum Mechanics in Chemistry – M Hanna John Wiley and Sons.
7. Introduction to Quantum Chemistry – A. K. Chandra Tata Mc. Graw Hill (1979)
8. Quantum Mechanics – L. Powling and E. B. Wilson Mc Graw Hill.
9. Quantum Chemistry of Matter. J. C. Slater Mc Graw Hill.
10. Quantum Chemistry of molecules and solids J. C. Slater Mc Graw Hill.
11. Elementary Quantum theory F. L. Pilar Mc Graw Hill (N.Y.).
12. D. A. Mc.Quarrie and J .D. Simon, Physical Chemistry- a molecular approach, viva books, New Delhi, 1998.

**Section-II****STATISTICAL THERMODYNAMICS :-****[8]**

1. Permutations, Probability distribution of molecules in energy states. Micro states and Micro configurations. Most probable distribution. Evaluation of Boltzmann parameters by Langrangeis method of undetermined multipliers, Boltzmann distribution function, Boltzmann constant, stirling approximation, entropy and probability.
2. Molecular Partition functions :-  
Statistical mechanisms of independent particles, independent and distinguishable (localised) molecules or particles, independent and indistinguishable (non localised) molecules or particles.  
Factorisation of the molecular partition function :-  
Evaluation of the independent molecular partition functions, translational, the vibrational rotational partition functions of mono, linear and non linear atomic and polyatomic ideal gases the electronic and nuclear partition functions.
3. APPLICATIONS OF STATISTICAL THERMODYNAMICS :- **[3]**  
Entropy of mixing ortho and para hydrogen, heat capacity of ideal gases heat capacity of Solids, Einstein Theory, Debye's Theory, calculation of equilibrium constant eg :- dissociation of iodine.
4. MAXWELL DISTRIBUTION LAW :- **[6]**  
Velocity distribution law, RMS velocity average velocity and most probable velocity energy distribution law, principles of equipartition of energy  
Fraction of molecules with energy greater than  $E^0_s$  the minimum energy. Bose Einstein, statistics, and Femi Dirac Statistics, comparison of B.E.F.D. and M.B.Statistics.

5. STATISTICAL MECHANICS OF ENSEMBLES :- [7]  
 Canonical and Grand canonical ensembles- meaning of ensemble, canonical ensembles. The thermodynamic function, properties of the canonical ensemble partition function. Grand canonical ensemble partition function systems with more than one component, micro canonical ensemble.

**REFERENCES: -**

1. Physical Chemistry : P.W.Aikins (ELBS) W.H.Freeman and Co. 3<sup>rd</sup> edition (1986)
2. Elements of statistical Thermodynamics, L.K.Nash, Addison Wiley 2<sup>nd</sup> edition (1972).
3. Thermodynamics for chemists. Glasstore affiliated East-West Press Pvt. (N.D.)
4. Advanced concepts in Physical Chemistry. E. D. Kawfmann Mc Graw Hill book. Co. (1966)
5. Statistical Thermodynamics ; M.C.Gupta. Wiley Eastern Ltd. (1990).
6. Introduction to Statistical Thermodynamics . M.Dole, Prentice Hall Inc.
7. Introduction to Statistical Thermodynamics T.L.Hall Addison Wiley.
8. Theoretical Chemistry S. Glass Stone – D Van. Nostard Co.

**CH : 311 Nuclear Chemistry and Radiation Chemistry**  
**Section-I**  
**NUCLEAR CHEMISTRY**

1. Nuclear structure, properties and models :- [2]  
 Nuclear spin, parity, magnetic moment and statistics. The liquid drop model, the shell model the fermigas model, the collective model.
2. Nuclear Reaction :- [4]  
 Types of nuclear reactions, conservation of nuclear reactions, Reaction cross-section. The compound nucleus theory, Experimental evidences of Bohr-theory, Experiments of Ghosnal and Alexander and Simon off.
3. Nuclear fission and fusion :- [4]  
 Discovery, process of nuclear fission, fission fragments and their mass, energy and charge distribution, fission cross sections, fission barriers and thresholds, nuclear fission symmetric and asymmetric fission.  
 Thermonuclear reactions, fusion reactions in the sun and stars.
4. Nuclear Reactors :- [4]  
 Nuclear fission as a source of energy the four factor formula. The classification of reactors, Reactor power, critical size of a thermal reactor, Research, power and the breeder reactors nuclear reactors in India.
5. Nuclear Radiation detectors :- [4]  
 Scintillation detectors, semiconductor detectors, neutron detectors, their applications.
6. Resonance fluorescence, line width and Doppler broadening, nuclear reanances fluorescence due to recoilless emission of gamma radiation chemical shift, quadrapole splitting, applications in the study of the compounds of tin and iron. [6]

## Section-II NUCLEAR CHEMISTRY

7. Techniques in nuclear chemistry. Targets for nuclear reaction studies, target chemistry, preparation of samples for activation measurement. [4]
8. Radiolysis of organic systems. Alkanes, Alkenes aromatic hydrocarbons alcohols. [4]
9. Effects of radiation on solids : Aromatic displacement, metal – alloys and semiconductors, radiolysis of oxy compounds, annealing of radiation damage, defects in ionic solids, colour centers, thermoluminescence. [8]
10. Isotope exchange reaction :- Kinetic of heterogeneous exchange reaction, hydrogen atom transfer and other atom transfer exchange reactions, heterogeneous exchange reaction. [8]

### REFERENCES: -

1. Essential of nuclear chemistry – H.J.Arnika Wiley Eastern Ltd. 3<sup>rd</sup> edition (1990)
2. Introduction to nuclear physics and chemistry B.G.Harvey Prentice Hall (1963).
3. Nuclear and Radiochemistry – G friendlander and J.W.Kennedy and J.M.Millar, John Wiley and Sons. 3<sup>rd</sup> edition (1973).
4. Introduction to radiation chemistry J.W.T.spinks and R.J.Woods, John Wiley and Sons
5. Fundamentals of radiation chemistry A.R.Denarao and G.G.Jayson, Butler worths.
6. Nuclear chemistry and It's applications (1972) M.Hassensky. Addison Wiley publishing company.
7. Nuclear chemistry M. Lefert, D.Van. Nostrand company ltd. London.
8. Nuclear Physics – I.Kaplan Addison Wiley Publishing Co.London.
9. Radio Isotope techniques R.T.Overman and H.M.Clark Mc Graw Hill book company Inc.
10. Source Book on Atomic Energy – S. Glasstone East. West press Pvt.New Delhi.
11. Isotopes in the atomic Age. H.J.Arnika Wiley Eastern Ltd. (1969)
12. The chemical basis of Radiation Biology – C.V.Sonntag, Taylor and Francis (1987)
13. Radiation chemistry of water and aqueous solutions A.G.Allen )(Van Nostrand, Princeton )
14. Principles of Radio chemistry H.A.C. McKay Butler worths London.
15. The mossbauer effect and it's applications to chemistry – V.I.Goldanskii D. Van Nostrand Com. Inc.
16. Electron and Nuclear counters. Theory and use – S. A. Korff D. Van. Nostrand Co.Ltd.
17. Radiochemistry – A. N. Nesmeyanov Mir Publication. Moscow.
18. Principles of mossbauer spectroscopy – T. C. Gibbs. John Wiley and Sons. Inc. (N.Y.)

## CH : 312 Polymer Chemistry - I Section-I

1. Basic concepts of Polymer Science :- [4]  
Nomenclature of polymers – vinyl polymers. Vinyl copolymers , nonvinyl polymers and non vinyl copolymers, Abbreviation Basis of classification Origin, thermal response, mode of formation, Line structure, application and Physical properties, tacticity and crystallinity Molecular forces and chemical bonding in polymers primary bond forces – ionic, covalent, co-ordinate and metallic bonds Secondary bond forces ionic, covalent, coordinate and metallic bonds secondary bond forces dipole induction and dispersion forces, hydrogen bond intermolecular forces and physical properties.
2. Thermodynamics of polymers - [6]  
Thermodynamics of simple liquid mixtures, ideal solutions, types of mixing, entropy and heat of mixing, heat and free energy of mixing, experimental results with polymer solutions, Dilute solutions – Flory krigbaum theory, corresponding state theories, scaling Concep-ts. Thermochemistry of chain polymerization enthalpies of polymerization, entropies and free energies of polymerization.



3. The condensation (step reaction) polymerization :- [4]  
Mechanism, Kinetics and statistics of linear stepwise polymerization, molecular weight control.
4. The addition (chain reaction) polymerization - [6]
- A) Free radical polymerization – free radical initiators, mechanism, kinetics, kinetic chain length, degree of polymerization, chain transfer reaction.
- B) Cationic polymerization – Mechanism kinetics.
- C) Anionic polymerization – Mechanism kinetics living polymer.
- D) Co-ordination polymerization - Ziegler – Natta catalysts mechanism, bimetallic and monometallic kinetics.
5. Co-polymerization - [4]  
Mechanism and kinetics of co-polymerization, monomer reactivity ratios, Types of co-polymerization, instantaneous composition of feed and polymer, determination of monomer, reactivity ratios, rate of co-polymerization.

### Section-II

6. Polymerization Processes - [4]  
Bulk polymerization, solution, suspension and emulsion polymerization. Salient features of different polymerization techniques.
7. Molecular weight of Polymers - [8]  
Average molecular weight, fractionation and molecular weight distribution – Fractional precipitation technique, partial dissolution technique, Gel permeation chromatographic technique.  
Methods of determination of average molecular weight :-  
End point analysis, ebulliometry, cryoscopy membrane osmometry vapour phase osmometry, light scattering and ultracentrifugation.
8. Analysis of Polymers :- [4]  
Physical and Chemical analysis, IR, NMR and EPR spectroscopy, Thermal analysis DTA, DSC and TGA.
9. Radiation Induced Polymerization :- [8]  
Kinetics and mechanism of polymerization in the liquid and solid phases, effect of irradiation on polymers, degradation, cross-linking and graft co-polymerization.

#### REFERENCES:-

1. Text book of Polymer Science – F.W.Billmeyer Jr. John Wiley and Sons. Inc. 3<sup>rd</sup> edition (1984)
2. Principles of Polymer Chemistry – P.J.Flory Cornell University Press Ithacs N.Y. (1953).
3. Principles of Polymer Systems – F.Radrigues Tata McGraw Hill 3<sup>rd</sup> edition (N.D.) (1987)
4. Polymer Chemistry – An introduction – R.B.Seymour and C.E.Carraher (Jr.) Marcel Dekker Inc. 2<sup>nd</sup> edition (N.D.)(1988)
5. Polymer Science – V.R. Gowariker, Vishwanathan Sreedhar, Wiley Eastern Ltd. N.Y.(1988).
6. Polymer Science and Technology of plastics and rubbers Premamoy Ghosh Tata McGraw Hill N.D.(1990)
7. Polymerization Chemistry – An introduction – M. P .Stevens Oxford University Press 2<sup>nd</sup> edition (1990).
8. Physical Chemistry of Polymers - Tagar A. Miv. Publication Moscow (1972)
9. Physico-Chemical aspects of high Polymer – Satya Prakash and S.P.Srivastava
10. Principles of Polymer Processing – Z. Toomor and C.O.Goges, John Wiley (1974).

## CH : 313 Solid State Chemistry And Surface Chemistry Section-I

- I Solid State Reactions** [4]  
General Principles, experimental Procedures, Co.Precipitation as a Precursor to solid state reactions, kinetics of solid state reactions.
- II Crystal Defects And – Stoichiometry** [6]  
Perfect and imperfect crystals, intrinsic and extrinsic defects – Point defects, line and plane defects, vacancies-Schottky defects and Frenkel defects. Thermodynamics of Schottky and Frenkel defect formation, colour centers, non-stoichiometry and defects.
- III Electronic Properties And Band Theory.** [14]  
Metals insulators and semiconductors, electronic structure of solids band theory band structure of metals, insulators and semiconductors. Intrinsic and extrinsic semiconductors, doping semiconductors, P-n junctions, super conductors.  
Optical properties :- Optical reflectance, photo-conduction Photo electric effects.  
Magnetic properties :- Classification of materials , Quantum Theory of paramagnetics, cooperative phenomena – magnetic domains, hysteresis

### REFERENCES: -

1. Introduction to solids – L.V. Azaroff Tata Mc Graw Hill (1977)
2. Solid State Chemistry – N. B. Hannay Prentice Hall Inc. New Delhi.(1967)
3. Introduction to solid state physics- C. Kittel, John Wiley & Sons.(1970)
4. Chemistry of solids- A.K.Galway and Hall Ltd.(1967)
5. Solid State Physics – A.J.Dekker, The Mac Millan Press Ltd.(1975)
6. Treatise solids state chemistry – Reactivity of solids edited by N.B.Hannay Vol.IV plenum press (1976)
7. Progress in semi conductors series volumes edited by Gibsen.
8. Solid state chemistry MTP international Review of science Vol.2. consultant editor Emelius and Roberts, Butter Worth .
9. Solid State Chemistry – Ram Prakash , Radha Prakashan New Delhi (1991)
10. Modern aspects of solid state chemistry C.N.R. Rao , Plenum Press London.
11. Solid State Chemistry – C.N.R. Rao, Dekkar N.Y.
12. Solid State Chemistry and its Applications, A.R.West. Plenum.
13. Principles of the Solid State H. V. Keer, Wiley Eastern.
14. Solid State Chemistry D.K.Chakrabarty, New Age, International.

## Section-II Surface Chemistry

- I Thermodynamics of liquid Interfaces :-** [7]  
One component System – Surface thermodynamics quantities for pure substances, the total surface energy.  
The structural and theoretical treatment of liquid interfaces Development of the thermodynamic treatment of the surface region, calculation of the surface energy and free energy of liquids.  
Thermodynamics of binary system. Determination of surface excess, quantities Gibbs Monolayers.

- II Surface films on liquid substances :- [6]  
 The spreading of one liquid on another experimental techniques for the study of monomolecular films. Measurement of surface potentials, surface viscosities state of monomolecular films Gaseous film The L1-G transition. The liquid exponential state, intermediate and L2 films the solid state .
- III Adsorption of Gases And vapours on Solids - [7]  
 The adsorption time.  
 The Langmuir adsorption isotherm experimental procedures.  
 The BET and related isotherm. The potential energy – The polanyi treatment  
 Comparison of the surface area from the various multilayers models.  
 Thermodynamics of adsorption the rate of adsorption. Critical comparison of the various models for adsorption.  
 Adsorption on porous solids-Molecular sieves, capillary condensation, micro pore analysis.
- IV Chemisorptions [4]  
 Chemisorption – The molecular views chemisorption isotherms , Kinetics of chemisorption.

#### REFERENCES:-

1. Physical Chemistry of surfaces A. W. Adamson John Wiley and Sons 5<sup>th</sup> edition. (1990)
2. Introduction to Colloid and Surface Chemistry. D. J. Shaw Butter worths 2<sup>nd</sup> edition 1970).
3. Adsorption and catalysis by solids. D. K. Chakrabarty Wiley Eastern Ltd. (1991)
4. Surface Chemistry – Theory and applications. J.J.Bikerman, Academic Press New York (1992)
5. Chemisorptions B. M.W. Trapnell and H. O .Hayward Butterworths London (1964).
6. Physical adsorption of gases – D. M. Young and A. D. Croweel, Butterworths London (1982).
7. Adsorption surface area and porosity S. I. Gregg and K. S. W. Sing Academic Press London (1978)
8. Zeolites and Molecular Sieves Structure. Chemistry and use D.W.Breck., Wiley Inter science (1974)
9. The properties and Applications of Elites – R.P.Townsend, Chemical Society Special Publication No.33 (1980)
10. Text book of physical chemistry – S. Glasstone McMillan India Ltd. 2<sup>nd</sup> edition (1986).
11. The surface chemistry of solids – S. J. Grog chafiman and Hall Ltd. London.
12. Diffusion in solids – P.G.Showmen McGraw Hill.
13. An Introduction to the principles of Surface Chemistry - A Aveyard and D.A.Hydon Cambrige University Press (1973).

### CH : 410 Molecular Structure Section-I

- 1 Nuclear Magnetic Resonance [8]  
 General theory, classical and quantum mechanical description, Spin-spin and spin lattice relaxation processes. Outlines of instrumental aspects, Requirements for high resolution NMR, Chemical shift, magnetic susceptibility corrections to chemical shift, spin-spin coupling-origin, coupling between groups of equivalent nuclei, first order analysis, signs of coupling constants, Interpretation of NMR spectra, Analysis of complex Ax, A2 and A3 cases, applications of NMR spectroscopy, chemical exchange.

2. **Electron Spin Resonance :-** [8]  
 Basic theory, line positions, line width and intensities, Hyperfine Splitting, g-value, factors affecting g-value, determination of g-values, ESR spectra of radicals in solution and their spin distribution, spectra of triplet state molecules paramagnetism and triplet state, Energy levels of triplet molecules, the naphthalene triplet applications of ESR spectroscopy.
3. **Mossbauer Spectroscopy :-** [8]  
 Basic principles, spectral parameters and spectrum display. Application of the technique to the studies of (1) bonding and structures of  $Fe^{+2}$  and  $Fe^{+3}$  compounds including those of intermediate spin. (2)  $Sn^{+2}$  and  $Sn^{+4}$  compounds nature of M-L bond, coordination number, structure and (3) detection of oxidation state and in equivalent MB atoms.

#### REFERENCES: -

1. High resolution Nuclear Magnetic Resonance J. A. Pople, W. G. Schneider and H. J. Bernstein Mc Graw Hill (1959)
2. The Physical principles of electron paramagnetic resonance G. E. Pake, T.L. Latte W. A. Benjamin (1973)
3. Spectra of Diatomic Molecules – G. Herzberg Van Nostrand.
4. High Resolution NMR E.D.Becker, Academic Press (1969)
5. An introduction to electron paramagnetic resonance M.Bersohn and J. C. Baird, W. A. Benjamin Inc.(1966)
6. Chemical Applications of Nuclear Magnetic Resonance Spectroscopy in paramagnetic Molecules.Ed.Mav.Horock Jr.(Holm Academic Press (1973) )
7. Nuclear Spectroscopy – Principles and applications Patel and Patel, Chemistry Department. Sardar Patel, University.
8. Molecular Structure – A spectroscopic approach- Singh & Agrawal.
9. Instrumental Methods of Chemical Analysis B.K.Sharma.
10. Elements of Magneto Chemistry – Datta & Shamal.

#### Section-II

4. **Electric Susceptibility :-** [12]  
 Basic concepts, Clausius – Mosotti equation, The molar refraction measurement of dielectric constant. The Debye equation, Estimation of dipole moment from solution data, Ionic character of diatomic molecules, vector character of dipole moments, Group moments and molecular structure. The limitations and extensions of Debye treatment of molar polarization. The dipole concentration, Onsager equation, Jitkar equation, water and hydrogen bonded liquids. Experimental determination of dipole moment. Application of dipole moment.
5. **Magnetic Susceptibility :-** [12]  
 Basic concepts, Diamagnetic Susceptibility Atomic and ionic susceptibilities Pascal constants and constitutive corrections, Paramagnetic Susceptibility, Langevin equation, Curie-Weiss Law, Van-Vleck's equation, Transition metal complexes – Valence Bond theory, Crystal field theory weak strong ligand field cases, Spin-orbit coupling on A, E and T terms, Ferro, ferry., and antiferromagnetism, measurement of magnetic susceptibility by Faraday and Gouy techniques, Applications of Magnetic Susceptibility.

## REFERENCES:-

1. Magnetic Susceptibility L. N. Mulay, Inter science publishing Co.(1968)
2. Introduction to Magneto Chemistry A. Earnshaw – Academic Press (1968)
3. Magnetic Chemistry P. W. Selwood Inter science publishing Co.2<sup>nd</sup> edition (1956)
4. Polar Molecules P. Debye (Dove)
5. Electrical & Optical aspects of Molecular behaviour M.Davis (Pergaman Press) (1965)
6. Elements of Magnetic Chemistry. Dutta R.L., Syamal A
7. Magentic Chemistry R.L.Carlin.
8. An approach to magnetic Chemistry R.C.Saxena & R.C.Gupta Kedar Nath Ram Nath Publishers, Meerut.
9. Physical Principles and applications of Magnetic Chemistry S.S.Bhatnagar & K.N.Mathur Mac.Millan & Co.Ltd.London.(1935)
10. Molecular Structure – A Spectroscopic Approach-Sing Agarwal
11. Instrumental Methods of Chemical Analysis – B.K.Sharma.

## CH : 411 Electro Chemistry and Phase Rule. Section-I

- 1 Ion-Solvent Interactions :- [4]  
Structural treatment of the ion-solvent interactions, structure of water, the ion-dipole model, heat of solvation, ion dipole theory of solvation, energetics of ion solvent interactions.
- 2 Ion-Ion Interactions :- [8]  
The Debye-Huckel theory, ionic cloud theory, charge density near the central ion Poissons equation, excess charge density, linearization of the Boltzman equation solution of the linearised P.B.equation. Ionic cloud around the central ion.  
Activity coefficients.  
Concept and significance of activity coefficients single ionic mean ionic activity coefficients, conversion of theoretical activity coefficients expressions.  
The trinputs and Limitations of the Debye Huckel theory of activity coefficients expressedd.  
D.H.expression and prediction of experimental values, finite size ions theoretical mean ionic activity coefficients in case of ionic clouds ion-size parameters, comparison of the finite ion size model with experiments, D.H.theory of ionic solutions, percentage of theory of ion-ion interactions.
- 3 Ion-Transport In solutions :- [6]  
ionic draft under chemical potential gradient Driving force diffusion, picks first law of steady state diffusion. Diffusion coefficient, ficks second law of non steady state diffusion.  
Diffusion on overall reviev's  
Ionic migrations :- Ionic movement under electric field, average value of drift velocity mobility of ions, the current density associated with the directed movement of ions in solution Einstein relation between absolute mobility and the diffusion coefficient, viscous force acting on an ions in solution, stokes-Einstein equations, Nernst-Einstein equation and their limitations.
- 4 Electrodictics :- [6]  
The basic electrodictics equation – The butler-volmer equation. Immersion of metal is electrolytic solution, the rate of charge transfer rotation under zero field. Consequence of electrode transfer at interface, electron transfer reaction, transfer rotation under electric field two way electron traffic across the interface the equation exchange current density, drift current density , the over potential, the basic electrodictics equation general and special cases exponential 'i' verses'n' law.

## CH : 411      Section-II

### Phase Rule :-

[24]

Phase equilibria :- The phase rule, phase component, one-component and two component systems, interpretation, Liquid-liquid phase diagrams, distillation, Liquid-Solid phase diagrams, reactions, steel, Zone-refining, Three component systems :- ( Ref.I. Chapter 10 Pages 287-309 ).

Problem solving on related topics.

### REFERENCES :-

1. modern Electrochemistry Vol. I JOM Bock-ris and A. K. N. Reddy A plenum/ Rosetta Ed. 3<sup>rd</sup> edition (1977).
2. An Introduction to Electrochemistry Vol.2. JOM Bock-ris and A. K. N. Reddy A plenum/ Rosetta Ed. 3<sup>rd</sup> edition (1977).
3. An Introduction to Electrochemistry – S. Glasstone Van Nostrand East-West (1965)
4. Electrolytic Solutions – R. A. Rabinson and R. H. Stokes Butter worths (London)
5. The principles of electrochemistry- Mac Innes, Duncan A Dover publication Inc.(N.Y.).
6. Chemistry in Non-aqueous Solvents – H. H. Sisler Chapman and Hall, London.
7. Non-aqueous solvents – L. F. Audrieth and J. Kleinberg, John Wiley and Sons Inc. New York.
8. Non-aqueous solvent systems by (Ed) T. C. Weddington Academic Press New York.
9. The Chemistry of Molten Salts – H. Bloom Benjamin Inc New York.
10. Theoretical electrochemistry – L. Antropov Mir. Publishers Moscow (1974).
11. Industrial electrochemistry – Derek Pletcher Chapman & Hall (N.Y.)
12. Fuel cells – A. Mc Oougall Mac Milan London (1976)

## CH : 412 Polymer Chemistry - II Section-I

### 1 Morphology of Polymer :-

[8]

Configurations of Polymer Chains :-

Configuration involving an asymmetric carbon atom, head to head, tail to tail configurations, configurations involving a carbon-carbon double bond, stereo regular configurations, crystal structures of polymers structural requirements for crystallinity, structures based on extended chains.

Crystallization and melting – crystallization kinetics determination of melting point thermodynamics of crystalline melting, heats and entropies of fusion, degree of crystallinity, specific volume, effect of crystallinity on the properties of polymers.

### 2 Rheology of Polymers :-

[8]

Visco flow – phenomenon of viscous flow, polymer melts flow measurements rotational and capillary viscometry experimental results- molecular weight and shear dependence, flow instabilities, temperature dependence of viscosity.

Rubber elasticity :- Kinetic theory of rubber elasticity thermodynamics of rubber elasticity – the ideal elastomer entropy elasticity, stress strain behaviour of elastomers a snyle model of an elastomeric network.

Visco elasticity :- the Boltzman super imposition principle time-temperature equivalence, experimental results. Stress relaxation, Models of visco elasticity behaviour – general mechanical models for an amorphous polymer treatment of experimental data, molecular structure and visco elasticity.

The glass transition and glassy state – measurement of glass transition temperature (T<sub>g</sub>), molecular interpretation, molecular motions below (T<sub>g</sub>).

3. **Crystalline melting point :-** [8]  
 Glass transition temperature and properties involving deformations. The crystalline melting points – Melting point of homologues series effect of flexibility and other steric factors-chain flexibility side chain substitution entropy and heat of fusion, effect of co-polymerization.  
 Glass transition temperature – Relation between T<sub>g</sub> and T<sub>m</sub> factors affecting the glass transition temperature – molecular weight and dilents, plasticisers, Chemical structure chain topology branching and cross linking (copolymerisation) experimental determination of T<sub>g</sub> importance of glass transition temperature properties involving large deformations – Melt properties, melt viscosity tensile strength and related properties, Toughness in rubber modified glassy plastics.

## Section-II

4. **Industrial Polymers :-** [8]  
 Preparation/Polymerization structure, properties and applications of  
 A) **Plastics :-** Polyethylene, Polypropylene, polystyrene, polymethyl methacrylate, polyvinyl acetate, polyvinyl alcohol polyvinyl chloride, polytetrafluoro ethylene, polyamide. Polyester and silicone polymers.  
 B) **Elastomers :-** Natural rubber polyisoprene styrene butadiene rubber Nitrile rubber, Butyl rubber, poly chloroprene, poly sulfido.  
 C) **Fibers :-** Acrylic fibers viscose rayon, cellulose acetate, polyamide, polystyrene.  
 D) **Resins –** ABS resin, phenolics, amino, unsaturated polyester epoxy alkyl, polyurethanes and ion exchange resins.
5. **Polymer Processing :-** [16]  
 a) **Plastic Technology :-** Forming methods – molding-compression injection ( thermoplastics and thermosetting ) blow reaction injection and rotational molding Extrusion co-extrusion film extrusion, pultrusion, calendaring, costing.  
 b) **Fiber Technology :-** Textile and fabric properties – Electrical mechanical fabric properties.  
 Spinning methods – melt, dry and wet spinning.  
 Fiber after treatments- Scouring, lubrication sizing dyeing and finishing.  
 c) **Elastomer Technology :-** Vulcanization chemistry of vulcanisation, physical aspects of Vulcanization.  
 Reinforcement – types of filler carbon blacks.  
 Elastomer properties and compounding – Mechanical properties oxidative ageing and compounding.  
 Properties involving small deformations – Effect of crystallinity, mechanical properties, solubility and related properties electrical and optical properties.  
 Effect of molecular weight – Solubility, electrical and optical properties.  
 Combined effect of crystallinity and molecular weight-mechanical properties.  
 Effect of Co-polymerization – Mechanical properties solubility.  
 Effect of coplasticization-Reinforcement and cross linking property requirements and polymer utilization – elastomers and fibers.

### REFERENCES:-

1. Text book of polymer science F.W. Billmeyer Jr. John Wiley and Sons Inc. 2<sup>nd</sup> edition 1984.
2. Principles of polymers chemistry – P.J.Flory Cornell University Press Ithacs (N.Y.) (1953)
3. Principles of Polymer Systems F.Radrigues Tata Mc. Graw Hill 3<sup>rd</sup> Edition (N.D.)(1987)

## CH : P-2 PHYSICAL CHEMISTRY PRACTICAL COURSE-II

- 1) Simultaneous determination of two ions by Polarography.
- 2) Polarographic titration of  $\text{Pb}(\text{NO}_3)_2$  by  $\text{Na}_2\text{SO}_4$ .
- 3) Conductometric titration of weak base with a strong acid in a non-aqueous solution.
- 4) Determination of the stability constant of a complex by spectrophotometry.
- 5) Estimation of K, Na and Ca in binary mixtures by using lithium as a internal standard by flame photometry.
- 6) Determination of dipole moment in solution.
- 7) Magnetic susceptibility measurement by faraday technique.
- 8) Kinetics of the reaction between 2,4 dinitrochlorobenzene and piperidine by potentiometry.
- 9) Study of the surface area and pore size of the catalyst by selective adsorption from solution.
- 10) To study the variation of solubility product with ionic strength using  $\text{KNO}_3$  and  $\text{Cd}(\text{NO}_3)_2$ .
- 11) To determine the molecular weight of a given polymer by turbidimetry.
- 12) Dead stop end point titration.
- 13) Determination of quantum yield by photolysis of iodoform, monochloro acetic acid, potassium persulphate etc.
- 14) To determine viscosity, Arrhenius-Nissan Constant and free energy of activation of flow.
- 15) Kinetics of iodination of aniline – pH effect and base catalysis.
- 16) Estimation of organic acid using depression of phenol, water UCST.

## CH : P-3 PHYSICAL CHEMISTRY PRACTICAL COURSE-III

- 1) To determine the velocity constant of the decomposition of benzene diazonium chloride.
- 2) Determinations of the dimerization constant of an organic acid in benzene.
- 3) To determine the stability constant of the complex formed between potassium oxalate and lead nitrate polarographically.
- 4) Determination of the molar absorption coefficient of 2 methyl, -2-nitropropane in solution by spectrophotometry.
- 5) Differential potentiometric titration.
- 6) Estimate the concentrations of  $\text{H}_2\text{SO}_4$ ,  $\text{CH}_3\text{COOH}$  and  $\text{CuSO}_4$  in a given solution by carrying out – conductometric titration.
- 7) Determination the molar refractions of ethyl acetate, propyl acetate and butyl acetate of the contribution of  $\text{CH}_2$  group.
- 8) Determine the critical micelle concentration of sodium lauryl sulphate from the study of the surface tension of aqueous solutions.
- 9) Molecular weight of a polymer by end group estimation.
- 10) Analysis of X-Ray diffraction pattern .
- 11) Analysis of electronic spectra of diatomic molecules.
- 12) Kinetics of photolysis of potassium persulphate monochloro acetic acid etc.
- 13) Determination of heat of ionization of Phenol/weak acid.
- 14) Determine Hammett constant of a given substituted benzoic acid by pH metry.
- 15) Heat of adsorption of acetic acid or oxalic acid on charcoal.
- 16) Determine viscosity of liquid at different temperatures and calculate enthalpy, entropy and free energy of activation of flow.

Each student should complete a minimum of 12 experiments with at least one experiment from each technique.



### CH : P-4 PHYSICAL CHEMISTRY PRACTICAL COURSE-IV

- 1) To determine the partial molar volume of DMSO/alcohol or salt solution in water by pionometer.
- 2) Latent heat of fusion by solubility- measurements at various temperatures.
- 3) To study the variation of surface tension with concentration of different salts for NaCl (0.5 to 3 M ) or sodium propionat ( 0.5 to 3 M ) or sodium dedacyl sulphate (2 to 20 M ) and interpret the results in the light of Gibbs adsorption equation.
- 4) Coulometric estimation of Arsenite by Bromine.
- 5) Conductometric titration of weak acid with a strong base non acuoous solution.
- 6) Studies of clock reaction – determination of energy of activation of reacton such as bromate – bromide reaction iodide – iodide reaction.
- 7) Analysis of Mossbauer spectra.
- 8) To determine speed of sound and compressibility of binary liquid mistures.
- 9) Coulemetric estimation arsenate by Bromine.
- 10) Determination of solubility diagram for a three component a system.
- 11) Amperometric titration.
- 12) Analysis of vibrational and electronic spectra of simple plyatomic molecules.
- 13) Computer programming and application to chemistry.
- 14) Conductometric titration p-toludine against H C L
- 15) Determination of ionization constant of bromophenol Blue.
- 16) Titration of FeSo4 against cerric sulphate and calculation formal redox potential of  $Fe^{2+} - Fe^{3+}$  and  $Co^{3+} - Co^{4+}$  system.

OR

### CH : P-4 PROJECT WORK

The students should carry out a small research project related to Physical Chemistry. This should make him familiar with literature survey, research methodologies etc.,

For examination , the student should present his project on Paper.

