Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur (Autonomous)

Syllabus

For

Master of Science

M. Sc. Part - I Chemistry

(Semester I, II)

Under Choice Based Credit System

Syllabus with effect from the June, 2018

(Subject to modifications in the future)

Vivekanand College, Kolhapur (Autonomous)
Department of Chemistry
M. Sc. Chemistry Syllabus
Implemented from 2018-19
(Specialization: Organic Chemistry)

YEAR OF IMPLIMENTATION: New Syllabus will be implemented from June 2018.

- Total No. of Semester – 4
  (Two semesters per year)
- Total No. of Papers – 16
- Total No. of Practical course – 08
- No. of papers (theory) per semester – 04
- No. of practicals course per semester – 2
- Maximum marks per paper (Practical)- 100
- Maximum Marks per Paper (Theory)- 100 (Internal evaluation 20 + External evaluation 80)
- **Total Theory Marks: 1600**
- **Total Practical Marks: 800**
- **Total = 2400**

Course Structure

M. Sc. Part - I (Sem – I)

Paper CP-1131 A: Inorganic Chemistry – I

Paper CP-1132 A: Organic Chemistry-I

Paper CP-1133 A: Physical Chemistry-I

Paper CP-1134 A: Analytical Chemistry –I

Practical Course: V (CC –1135A) and VI (CC –1136A)

M. Sc. Part - I (Sem – II)

Paper CP-1137B: Inorganic Chemistry – II

Paper CP-1138B: Organic Chemistry-II

Paper CP-1139B: Physical Chemistry-II

Paper CP-1140B: Analytical Chemistry –II

Practical Course: V (CC –1141B) and VI (CC –1142B)

Vivekanand College, Kolhapur (Autonomous)
M. Sc. Part - I (Chemistry)
CBCS Syllabus with effect from June - 2018
Semester - I
Paper CP-1131 A: Inorganic Chemistry – I
Theory: 60hrs (Credits - 4)

On completion of the course, student will be able to:

CO1: Learn the symmetry elements and symmetry operations of various inorganic compounds.

CO2: Understand the spatial arrangement and nature of bonding in case of main group compounds.

CO3: Acquire the knowledge of bio inorganic chemistry and transition elements.

CO4: Study the electronic, electric and optical behaviour of Inorganic materials.

UNIT-I

Group theory and Symmetry concept [15]

Symmetry elements and symmetry operations, Centre of symmetry (i), Axis of symmetry (C_n), Plane of symmetry (σ_v, σ_h, σ_d), Rotation reflection axis of symmetry (S_n), Identity(E). point groups, classifications of point groups, Identification of point group of : H_2O, NH_3, CO_2, BF_3, C_2H_4, PCl_3, PCl_5, $[PtCl_4]^{--}$, cis and trans $[PtCl_2(NH_3)_2]$, $[CoCl_2(NH_3)_4]$, $[FeF_6]$, H_2, HCl, CO, BeF_2, $C_2H_2Cl_2$, C_6H_6, Group multiplication tables, matrix representation of symmetry elements. Reducible and irreducible representation, character of representation, character of matrix, Properties of irreducible representations, Great orthogonality theorem (without proof) and its importance, construction of character table of C_{2v} & C_{3v} point group. Mulliken symbolism rules for irreducible representations. Standard reduction formula, direct product and uses.

UNIT-II

a) Stereochemistry and Bonding in main group compounds [08]

VSEPR theory and drawbacks, bond length, bond angles, bond energies and resonance, $P\pi-P\pi$ and $P\pi-d\pi$ bonds, Bent rule, walsh diagram, Back bonding, some simple reactions of covalently bonded molecules (atomic inversion, Berry pseudo rotation, nucleophilic displacement and free radical reaction).

b) Metal ligand equilibria in solution [07]

Definition of stability constant, step wise and overall formation constant and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect, ternary complexes and factors affecting their stabilities, stability of metal complexes of crown ether, Determination of stability constant for binary complexes using pH-metric (Bjerrums method) and spectrophotometric (Job's and mole ratio) techniques.

Unit-III

a) Chemistry of transition elements [10]

General characteristic and properties of transition elements, co-ordination chemistry of transition metal ions, stereochemistry of coordination compounds, crystal field theory, crystal field splitting of d orbital's for octahedral, tetrahedral, square planar and square pyramidal complexes, crystal field stabilisation energy (CFSE), factors affecting the crystal field parameters, strong and weak field complexes, spectrochemical series, Jahn- Teller effect, Interpretation of electronic spectra through d-d spectra and charge transfer spectra, nephelauxetic series, metal clusters, sandwich compounds, metal carbonyls.

b) Bioinorganic Chemistry [05]

Role of metal ions in biological processes, structure and properties of metalloproteins in electron transport processes, cytochromes, ferrodoxins and iron sulphur proteins, metal ion transport and storage: Ionophores and ion pumps, transferrin and ferritin, Biological nitrogen fixation, PS-I, PS -II, Oxygen uptake proteins, metal complexes in medicines.

UNIT-IV

Electronic, Electric and Optical behaviour of Inorganic materials [15]

Metals, Insulators and Semiconductors, Electronic structure of solid, band theory, band structure of metals, insulators and semiconductors, Intrinsic and extrinsic semiconductors, doping of semiconductors and conduction mechanism, the band gap, temperature dependence of conductivity, carrier density and carrier mobility in semiconductors, synthesis and purification of semiconducting materials, single crystal growth, zone refining, fractional crystallization, semiconductor devices, rectifier transistors, optical devices, photoconductors, photovoltaic cells, solar batteries.

Reference books

1. F. Wells, Structural Inorganic Chemistry – 5th edition (1984)
2. J H Huheey, Inorganic Chemisry - Principles, structure and reactivity, Harper and Row Publisher, Inc. New York (1972)
3. J. D. Lee, Concise Inorganic Chemistry, Elbs with Chapman and Hall, London
4. A. R. West, Plenum, Solid State Chemistry and its applications
5. N. B. Hanney, Solid State Physics
6. H. V. Keer, Principles of Solid State
7. S. O. Pillai, Solid State Physics
8. W. D. Callister, Wiley, Material Science and Engineering: An Introduction
9. R. Raghwan, First Course in Material Science
10. R. W. Cahan, The coming of Material Science
11. A. R. West, Basic Solid State Chemistry, 2nd edition
12. U. Schubest and N. Husing, Synthesis of Inorganic Materials, Wiley VCH (2000)
13. M. C. Day and J. Selbin, Theoretical Inorganic Chemistry, Reinhold, EWAP
14. A. H. Hanney, Solid State Chemistry, A. H. Publications
15. O. A. Phiops, Metals and Metabolism
16. Cullen Dolphin and James, Biological aspects of Inorganic Chemistry
17. Williams, An Introduction to Bioinorganic Chemistry
18. M. N. Hughes, Inorganic Chemistry of Biological Processes
19. Ochi, Bioinorganic Chemistry
20. John Wulff, The structure an properties of materials.
21. L. V. Azoroff, J. J. Brophy, Electronic processes in materials, Mc Craw Hill
22. F. A. Cotton, R. G. Wilkinson. Advanced Inorganic chemistry
23. Willam L. Jooly, Modern Inorganic Chemistry
24. Manas Chanda, Atomic Structure and Chemical bonding
25. N. N. Greenwood and A. Earnshaw, Chemistry of elements,. Pergamon
26. Chakraburty, Soild State Chemistry, New Age International
27. S. J. Lippard, J.M . Berg, Principles of bioinorganic Chemistry, University Scienc e Books
28. G. L. Eichhron, Inorganic Biochemistry, Vol I and II, Elesevier
29. Progress Inorganic chemistry , Vol 18 and 38, J. J. Loppard, Wiley
30. Fundamental concepts of Inorganic Chemistry, (Vol I to VII) A.K. Das and M. Das, CBS Publ

Paper CP-1132 A: Organic Chemistry-I
Theory: 60hrs (Credits - 4)

On completion of the course, student will be able to:

CO1: Understand the structure and reactivity of various reactive intermediates as well as stereochemistry of nucleophilic substitution reactions.

CO2: Learn the stereochemistry in nucleophilic substitution reactions in aliphatic compounds.

CO3: Identify the Electrophilic substitution reactions with respect to aromatic, introduction of benzenoid and non benzenoid aromatic compounds.

CO4: Grasp knowledge of new reactions with respect to its stereochemistry and applications.

CO5: Study the specificity of elimination reactions.

CO6: Assimilate stereochemical aspects of chiral compounds containing heteroatoms and introduction to allenes and spiranes.

UNIT-I

a) Reaction Mechanism: Structure and Reactivity [8]

Generation, structure, stability and reactivity of carbocations and carbanions, free radicals, arynes, carbenes, *N*-heterocylcic carbene, nitrenes and Nitrogen, sulphur and phosphorus ylides.

b) Aliphatic Nucleophilic substitutions [7]

The SN^2, SN^1 and SN^i reactions with respects to mechanism and stereochemistry. Nucleophilic substitutions at an allylic, aliphatic trigonal, benzylic, aryl and vinylic carbons. Reactivity effect of substrate structure, effect of attacking nucleophiles, leaving groups and reaction medium. SN reactions at bridge head carbon, competition between SN^1 and SN^2 Ambident nucleophiles, Neighbouring Group Participation.

UNIT-II

a) Aromatic Electrophilic Substitutions [8]

Introduction, the arenium ion mechanism, orientation and reactivity in Nitration, Sulphonation, Friedel-Crafts and Halogenation in aromatic systems, energy profile diagrams. The ortho/para ratio,

ipso attack, concept of aromaticity, orientation in their ring systems. Diazo-coupling, Vilsmeir Haak reaction, Von Richter rearrangement. Nucleophilic aromatic substitution reactions SN^1, SN^2.

b) Non benzenoid aromatic Compounds **[7]**

Aromaticity in Non- benzenoids compounds Annulenes and heteroannulenes, fullerence C_{60}, tropone, tropolone, azulene, fulvene, tropylium salts, ferrocene.

UNIT-III

a) Elimination Reactions **[8]**

The E1, E2 and E1cB mechanisms. Orientation in Elimination reactions. Hofmann versus Saytzeff elimination, Pyrolytic syn-elimination, competition between substitution and elimination reactions, Reactivity: effects of substrate structures, attacking base, the leaving group, the nature of medium on elimination reactions. Pyrolytic elimination reactions.

b) Study of following reactions **[7]**

Schmidt, Curtius, Lossen, Prins, Orton, Hofmann-Martius, Mitsunobu and Baylis-Hillmann reaction, Arndt-Eistert, Biginelli, Duff, Darzen.

UNIT-IV

[15]

Stereochemistry

Prochiral relationship, homotopic, enantiotopic and disteriotopic groups and faces. Recemic modifications and their resolution, Geometrical isomerism, R, S and E, Z nomenclature, Threo and Erythro isomers. Allenes and spiranes, Stereochemistry of the compounds containing Nitrogen, Sulphur and phosphorous. Conformational analysis: Cyclohexane derivatives, stability and reactivity, Conformational analysis of Mono and disubstituted cyclohexanes.

Reference books

1. A guide book to mechanism in Organic chemistry (Orient-Longmens) - Peter Sykes
2. Organic Reaction Mechanism (Benjamin) R. Breslow
3. Mechanism and Structure in Organic chemistry (Holt Reinh.)B. S. Gould.
4. Organic Chemistry (McGraw-Hill) Hendrikson, Cram and Hammond.
5. Basic principles of Organic Chemistry (Benjamin) J. D.Roberts and M. C. Caserio.
6. Reactive Intermediates in Organic Chemistry (John Wiley) N. S. Issacs.
7. Stereochemistry of Carbon compounds. (McGraw-Hill)E.L.Eliel

8. Organic Stereochemistry (McGraw-Hill) by Hallas.
9. Organic Reaction Mechanism (McGraw-Hill) R. K. Bansal.
10. Organic Chemistry- R. T. Morrison and R. N. Boyd,(Prentice Hall.)
11. Modern Organic Reactions (Benjumin) H. O. House.
12. Principle of organic synthesis- R.O.C. Norman and J. M. Coxon. (ELBS)
13. Reaction Mechanism in Organic Chemistry- S. M. Mukharji and S. P. Singh.
14. Stereochemistry of Organic compounds D. Nasipuri.
15. Advanced Organic Chemistry (McGraw-Hill) J. March.
16. Introduction to stereochemistry (Benjumin) K. Mislow.
17. Stereochemistry by P. S. Kalsi (New Age International)
18. Organic Chemistry- Clayden, Greeves, Warren.
19. Reaction and rearrangement- S. N. Sanyal.
20. Organic Reaction Mechanism- V. K. Ahluwalia.
21. Advanced Organic Chemistry- Jagdamba Singh.

Paper CP-1133 A: Physical Chemistry-I
Theory: 60hrs (Credits - 4)

On completion of the course, student will be able to:

CO1: Inculcate phenomenon of Molecular spectroscopy.

CO2: Study the aspects of polymers and rubber.

CO3: Develop the concept of Colloids and surface phenomena.

CO4: Learn new concepts in thermodynamics and related properties.

UNIT-I: Molecular Spectroscopy [15]

Rotation spectra: Classification of molecules based on moment of inertia, rigid rotor, most intense line, isotopic effect on the rotational spectra, non-rigid rotator, diatomic molecules, linear triatomic molecules, symmetric top molecules, stark effect.

Infra red spectroscopy: Diatomic molecule, selection rule, anharmonicity, Morse potential, justifying the form of Morse potential, combinations of overtones, and hot bands in polyatomic molecules.

Vibrational rotational Spectra: fine structure in diatomic molecules, break down of the Born Oppenheimer approximation, effect due to nuclear spin, parallel and perpendicular vibrations. Numerical problems.

UNIT-II: Chemistry of Polymers

A) Polymers [10]

Introduction, Classification and Mechanism of polymerization (Chain and Step), molecular weight & size of polymer molecules, average molecular weight- Number, weight and viscosity average, methods of determining molecular weights (Osmometry, viscometry, light scattering, diffusion and ultracentrifugation), Degree of polymerization and molecular weight, polydispersity and molecular weight distribution in polymers, practical significance of polymer molecular weight, Glass transition temperature, determination of glass transition temperature and affecting factors, plasticizers. Polymer processing techniques, conducting polymers-classification and applications, Flory-Huggins Theory. Numerical problems.

B) Rubber [5]

Introduction-concentration and coagulation of Latex-classification, Types of Rubber-modification of natural rubber, terminology, mixing mechanism and types of mixing and processing.

UNIT-III: Colloids and surface phenomena [15]

Colloidal Systems-Sols, Lyophilic and lyophobic sols, properties of sols, coagulation. Sols of surface active reagents, surface tension and surfactants, electrical phenomena at interfaces including electrokinetic effects, micelles, reverse micelles, solubilization. Thermodynamics of micellisation, critical micelle concentration, factors affecting critical micelle concentration (cmc), experimental methods of cmc determination, Micellar catalysis. Adsorption, adsorption isotherms, methods for determining surface structure and composition, BET equation, surface area determination, Gibbs adsorption equation and its verification. Application of photoelectron spectroscopy, ESCA and Auger spectroscopy to the study of surfaces. Numerical Problems.

UNIT-IV: Thermodynamics [15]

Introduction, revision of basic concepts: Entropy and third law of thermodynamics. Methods of determining the practical absolute entropies. Entropies of phase transition. Maxwell relations and its applications, thermodynamic equation of state. Ideal and non-ideal solutions, Thermodynamics of nonelectrolyte solutions. Raoult's law. Duhem-Margules equation and its applications to vapor pressure curves (Binary liquid mixture). Gibbs-Duhem equation and its applications to study of partial molar quantities. chemical potential, variation of chemical potential with temperature & pressure. Henry's law. Excess and mixing thermodynamic properties. Equilibrium constants and general conditions of equilibrium in terms of thermodynamic potentials. Numerical Problems.

Reference books

1. Physical Chemistry – P. W. Atkins, Oxford University press, 8th edition, 2006.
2. Text book of Physical Chemistry – S. Glasstone.
3. Principles of Physical Chemistry – Marron and Pruton.
4. Physical Chemistry – G. M. Barrow, Tata-McGraw Hill, Vth edition, 2003.
5. Thermodynamics for Chemists – S. Glasstone, D. Van Nostrand , 1965.
6. Thermodynamics: A Core Course- R. C. Srivastava, S. K. Saha and A. K. Jain, Prentice-Hall of India, IInd edition, 2004.
7. Polymer Science – V. R. Gowarikar
8. Physical chemistry of surfaces – A. W. Adamson, 4th Ed. John Wiley, 1982.
9. Introduction to Colloid and Surface Chemistry – D. Shaw, Butterworth

Heinemann, 1992.

10. Surface Activity: Principles, Phenomena and Applications (Polymers, Interfaces and Biomaterials) – K. Tsujii, 1st Ed. Academic Press, 1998.
11. Thermodynamics of Biochemical Reactions – R.A. Alberty, Wiley-Interscience, 2003..
12. Fundamentals of Spectroscopy by C. N. Banwell
13. A Textbook of Polymer Chemistry- Dr. M. S. Bhatnagar.
14. Molecular Spectroscopy-Arun Das.
15. Physical Chemistry throughout problems- Dogra and Dogra.

Paper CP-1134 A: Analytical Chemistry – I
Theory: 60hrs (Credits - 4)

On completion of the course, student will be able to:

CO1: Learn the Symmetry elements and symmetry operations of various inorganic compounds.

CO2: Adapt knowledge related to organometallic chemistry, transition elements, transition metal complexes

CO3: Study related to lanthanides and actinides and get familiar with spectroscopic term symbols, nuclear and radiochemistry

UNIT-I: Introduction to Quality Control and quality assurance [15]

Concepts and significance, Quality control and statistical techniques: Quality control charts, the X-quality control chart, the R-quality control chart and its interpretation, spiked sample control charts, use of blind samples in quality control, use of proficiency evaluations in quality control.

Quality in Analytical Chemistry: Quality systems in chemical laboratories, cost and benefits of quality system, types of quality standards for laboratories, total quality management, quality audits, and qualities reviews, responsibility of laboratory staff for quality and problems.

UNIT-II: Chromatographic methods [15]

General principle, classification of chromatographic methods, Nature of partition forces, Chromatographic behaviour of solutes, Column efficiency and resolution.

Thin layer chromatography: basic principle, coating materials, solvent-solvent system, analytical and preparative TLC, methods of detection, applications and advances in TLC including modern TLC techniques.

Column chromatography: Principle and theory, adsorption and partition methods, stationary and mobile phase, columns and preparation of the columns, solvent systems, normal phase, reverse phase, detection methods and applications. Possible hyphenations- Advantages and limitations.

Gas Chromatography: Basic Principle, Instrumentation, detectors, Applications, Advantage and disadvantages.

Ion exchange chromatography: Introduction and basic principles, instrumentation, types of exchangers, mechanism of ion exchange, exchange theories, methodology, applications.

UNIT-III: Electroanalytical Techniques [15]

Polarography: Introduction, Instrumentation, Ilkovic equation and its verification. Polarographic measurements, Dropping mercury electrode, Determination of half wave potential, qualitative and quantitative applications.

Amperometry: Basic principles, instrumentation, Amperometric titration curves, Amperometric indicators, procedure for Amperometric titrations, Evaluation of amperometry in research and analytical applications.

Voltametry: Voltammetric methods of analysis, basic principles, instrumentation, voltammetric measurements, voltametric techniques, current in voltammetry, shape of voltammograms, quantitative and qualitative aspects of voltammetry, quantitative applications, characterization applications, Evaluation of CV in research and analytical applications.

UNIT-IV

a) Introduction to Research Methodology [7]

Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs.

Digital: Web resources, E-journals, Journal access, Citation index, Impact factor, H-index, UGC infonet, Search engines: Scirus, Google Scholar, ChemIndustry, Wiki- Databases, ChemSpider, Science Direct, SciFinder, Scopus.

b) Nano materials [8]

Fundamentals of Nanoscience and Nanotechnology, Classification of nanomaterials into 0D, 1D, 2D and 3D, Relationship between dimension and shape of nanomaterials (Quantum dots, Quantum wires, Carbon nanotubes, Bucky balls, Fullerenes). Introduction to size effect on electronic and optical properties (Quantum confinement), possible hazards and health effects of nanomaterials, Preparative chemical methods of Nanomaterials: sol-gel, thermal, microwave, SILAR, chemical bath deposition, Applications in the field of semiconductors and solar cells.

Reference books

1. Analytical Chemistry: (J.W) G. D. Christain
2. Introduction to chromatography: Bobbit
3. Instrumental Methods of analysis (CBS) - H.H . Willard, L.L. Mirrit, J.A. Dean
4. Instrumental Methods of Analysis: Chatwal and Anand

5. Instrumental Methods of Inorganic Analysis (ELBS): A.I. Vogel
6. Chemical Instrumentation: A Systematic approach - H.A. Strobel
7. The principals of ion-selective electrodes and membrane transport: W.E. Morf
8. Physical Chemistry – P.W. Atkins
9. Principal of Instrumental Analysis- D. Skoog and D. West
10. Treatise on Analytical Chemistry: Vol Ito VII – I.M. Kolthoff
11. Computer, Fundamentals-P.K. Sinha
12. Programming in BASIC: E. Balaguruswamy
13. Computer programming made simples: J.Maynard.
14. Research methodology: C. R. Kothari

M. Sc. Part - I (Sem-I) Chemistry
Practical Course (CC – 1135A) and (CC – 1136A)

Inorganic Chemistry

1. **Ore analysis** – '2' ores (iron and pyrolusite ore)
2. **Alloy analysis** – '2' (Solder metal and stainless steel alloy: Two and three components)
3. **Inorganic Preparations and purity** – '4'

   i) Hexathiourea plumbus (II) nitrate

   ii) Nickel ammonium sulphate

   iii) Tris(acetylacetonato) manganese (III) complex

   iv) Hexammine cobalt (III) chloride

   v) Prussian blue

Reference books

1. A text book of Quantitative Inorganic Analysis – A. I. Vogel
2. Experimental Inorganic Chemistry - W. G. Palmer
3. The analysis of minerals and ores of the rarer elements – W. R. Schoeller and A.R. Powell, Charles, Griffin and Company Limited

Organic Chemistry

A) Preparations

(One stage preparations involving various types of reactions)

1. Oxidation: Adipic acid by chromic acid oxidation of Cyclohexanol.
2. Aldol condensation: Dibenzal acetone from Benzaldehyde.
3. Preparation of Barbituric or Thiobarbituric acid form Diethyl malonate
4. Preparation of Benzocaine Drug from p-amino benzoic acid
5. Preparation of Coumarins from phenol and ethyl acetoacetate
6. Study of diazotization reaction during preparation of dye
7. Aromatic Electrophilic substitutions: Synthesis of p-Nitroaniline and p-Bromoaniline.
8. Preparation of Cinnamic acid by Perkin's reaction.
9. Knoevenagel condensation reaction
10. Synthesis of Heterocyclic compounds

B) Estimations

1. Estimation of unsaturation.
2. Estimation of formalin.
3. Colorimetric Estimation of Dyes
4. Estimation of Amino acids

(Any suitable Expt. may be added.)

Reference books

1. A text book of practical organic chemistry- A. I. Vogel.
2. Practical organic chemistry- Mann and Saunders.
3. A handbook of quantitative and qualitative analysis- H. T. Clarke.
4. Organic Synthesis Collective Volumes by Blat.

Physical Chemistry

Students are expected to perform 15-20 experiments of three and half hours duration.

Experiments are to be set up in the following techniques.

1. **Potentiometry**
   - Determination of solubility and solubility product of silver halides,
   - Determination of binary mixture of weak and strong acid etc.
2. **Conductometry**
   - Determination of mixture of acids and relative strength of weak acids.
   - Determination of solubility of lead sulphate.
   - Determination of CMC and ΔG of sodium dodecyl sulphate.
3. **Refractometry**
   - Determination of molecular radius of molecule of organic compound.
4. **pH- metry**
   - Determination of dissociation constant of dibasic acid.
5. **Chemical Kinetics**
   - Kinetics of reaction between bromate and iodide.
6. **Viscosity**
   - Determination of molecular weight of polymers
7. **Adsorption**
   - Study of adsorption of acetic acid on charcoal. (New experiments may also be added)

Reference books

1. Findlay's Practical Chemistry – Revised by J.A. Kitchner (Vedition)
2. Text Book of Quantitative inorganic analysis : A.I. Vogel.
3. Experimental Physical Chemistry : R.C.Das and B. Behera
4. Practical Physical Chemistry : B. Viswanathan and P.S. Raghavan
5. Experimental Physical Chemistry :V.D. Athawale and Parul Mathur.
6. Systematic Experimental Physical Chemistry :S.W. Rajbhoj and T.K. Chondhekar

Analytical Chemistry

Section-I: Physical Chemistry

1. To verify Beer-Lambert's Law for potassium permanganate solution and hence to determine the molar extinction coefficient and unknown concentration of given sample colorimetrically
2. To determine the solubility of calcium oxalate in presence of KCl (Ionic Strength Effect)
3. To determine the solubility of calciuum oxalate in presence of HCl (H+ ion Effect)

(Any other experiments may be added)

Section-II: Organic Chemistry

1. Analysis of Pharmaceutical tablets.
2. To verify the Beer-Lamberts Law and determine the concentration of given dye solution colorimetrically.
3. To estimate the amount of D-glucose in given solution colorimetrically.
4. To determine the acid value of given oil
5. Estimation of Sulphur from fungicide.

(Any other experiments may be added)

Section-III: Inorganic Chemistry

1. Determination of sodium from the fertilizer sample using cation exchange chromatographically.
2. Determination of calcium from given drug sample.
3. Determination of hardness of water sample
4. Separation and estimation of chloride and bromide on anion exchanger.
5. Composition of iron thiocyanate complex by Jobs method spectrophotometrically

6. Study the absorption spectra of $KMnO_4$ and $K_2Cr_2O_7$ by spectrometry

(Any other experiments may be added)

Vivekanand College, Kolhapur (Autonomous)
M. Sc. Part - I (Chemistry)
CBCS Syllabus with effect from June - 2018
Semester - II
Paper CP-1137 B: Inorganic Chemistry – II
Theory: 60hrs (Credits - 4)

On completion of the course, student will be able to:

CO1:	Learn the features of non – transition elements.
CO2:	Adapt knowledge related to organometallic chemistry, transition elements, transition metal complexes
CO3:	Study related to lanthanides and actinides and
CO4:	Get familiar with spectroscopic term symbols, nuclear and radiochemistry

UNIT-I

[15]

Chemistry of non – Transition elements

General discussion on the properties of the non – transition elements, special features of individual elements, synthesis, properties and structure of halides and oxides of the non – transition elements, Polymorphism in carbon, phosphorous and sulphur, Synthesis, properties and structure of boranes, carboranes, silicates, carbides, phosphazenes, sulphur – nitrogen compounds, peroxo compounds of boron, carbon,sulphur, structure and bonding in oxyacids of nitrogen, phosphorous, sulphur and halogens, interhalogens, pseudohalides.

UNIT-II

a) Organometallic Chemistry of transition elements

[08]

Ligand hapticity, electron count for different types of organometallic compounds, 18 and 16 electron rule exceptions, synthesis, structure and bonding, organometallic reagents in organic synthesis and in homogeneous catalytic reactions (Hydrogenation, hydroformylation, isomerisation and polymerisation), pi metal complexes.

b) Reaction mechanism of transition metal complexes

[07]

Classification of inorganic reactions, ligand substitution reaction and their mechanisms of octahedral complexes, Acid hydrolysis, factors affecting the acid hydrolysis, Base hydrolysis, square planar complexes, trans effect, Electron transfer reaction: mechanism of inner and outer sphere electron transfer reactions in octahedral complexes.

UNIT-III

Studies and applications of Lanthanides and Actinides [15]

Occurrence, properties of f-block elements, colour, oxidation state, Spectral and magnetic properties, lanthanide contraction, use of lanthanide compounds as shift reagents, compounds of lanthanides, photoluminescence properties of lanthanide compounds, Modern methods of separation of lanthanides and actinides, Organometallic chemistry of lanthanides and actinides, applications of lanthanide and actinide compounds in Industries.

UNIT-IV

a) Spectroscopic term symbols [08]

Terms, Inter-electronics repulsion, spin orbit coupling, ground terms, determination of terms symbol of d^1 to d^5 Configuration / complexes, Energy ordering of terms, microstates, Weak and stronger field approach, Orgel diagram of d^1 to d^9 configuration in an octahedral and tetrahedral environments, Correlation diagram of d^1, d^2, d^8 and d^9 configuration in octahedral and tetrahedral environments, non crossing rule.

b) Nuclear and radiochemistry [07]

Nuclear stability and nuclear binding energy, radioactivity and radioactive decay, radioactive equilibrium, classification of nuclear reactions, Q value, nuclear reaction cross-sections, nuclear fission, nuclear fusion, applications of radioactivity.

Reference books

1. A. F. Wells, Structural Inorganic Chemistry – 5th edition (1984)
2. J H Huheey, Inorganic Chemistry - Principles, structure and reactivity, Harper and Row Publisher, Inc. New York (1972)
3. J. D. Lee, Concise inorganic Chemistry, Elbs with Chapman and Hall, London
4. M. C. Day and J. Selbin, Theoretical Inorganic Chemistry, Reinhold, EWAP
5. Jones, Elementary coordination Chemistry
6. Martell, Coordination Chemistry
7. T. S. Swain and D. S. T. Black, organometallic Chemistry
8. John Wulff, structure and properties of materials, vol – 4, electronic properties, Wiley Eastern
9. L. V. Azoroff, J. J. Brophy, Electronic processes in materials, Mc Craw Hill
10. F. A. Cotton, R. G. Wilkinson. Advanced Inorganic chemistry

11. Willam L. Jooly, Modern Inorganic Chemistry
12. Manaș Chanda, Atomic Structure and Chemical bonding
13. P. L. Pauson, Organometallic Chemistry
14. H. S. Sisler, Chemistry in non – aqueous solvents, Reinhold Publishing Corporation, USA, 4th edition (1965)
15. H. J. Arnikar, Essentials of Nclear Chemistry
16. Friedlander, Kennedy and Miller, Nuclear and Radiochemistry
17. Fundamental Concepts of Inorganic Chemistry (Vol I to VII), A.K. Das and M. Das, CBS Publishers.
18. Inorganic Chemistry, H.E. House, Elsevier Publishers.

Paper CP-1138 B: Organic Chemistry – II
Theory: 60hrs (Credits - 4)

On completion of the course, student will be able to:

CO1: Assimilate the reaction mechanism with various name reactions, C- alkylation and acylation.

CO2: Learn oxidation, hydroboration and enamines.

CO3: Study reduction reactions with help of various reducing agents and functional group protection.

CO4: Get familiar with the concept of retrosynthetic analysis and organometallic chemistry w.r.t. organic synthesis

UNIT-I

a) Study of following reactions [10]

Mechanism of condensation reaction involving enolates, Dieckmann, Wagner-Meerwein, Robinson annulation, Reimer-Tieman, Chichibabin, Pummerer, Payne rearrangment, Simon-Smith, Ulmann, Mc-Murry, Dakin.

b) Alkylation and Acylation [05]

Introduction, Types of alkylation and alkylating agents: C-Alkylation and Acylation of active methylene compounds and their applications.

UNIT-II

a) Oxidation [10]

Oxidation of alcohol to aldehyde, ketone or acid: Jones reagent, Swern oxidation, Collins reagent, Fetizones reagent, PCC, PDC, IBX, Activated MnO_2, Chromyl chloride (Etard reaction), TEMPO, NMO, Moffatt oxidation

b) Hydroboration [03]

Mechanism and Synthetic Applications

c) Enamines

Formation and reactivity of enamines [02]

UNIT-III

a) Reductions

[08]

Study of following reductions- Catalytic hydrogenation using homogeneous and heterogeneous catalysts. Study of following reactions: Wolff-Kishner, Birch, DIBAL-H, Sodium borohydride, Lithium Aluminium hydride (LAH) and Sodium in alcohol, Fe in HCl.

b) Protection of functional group

[07]

Principle of protection of alcohol, amine, carbonyl and carboxyl groups.

UNIT-IV

a) Study of Organometallic compounds

[08]

Organo-lithium, organo cobalt, Ce, Ti, Use of lithium dialkyl cuprate, their addition to carbonyl and unsaturated carbonyl compounds.

b) Methodologies in organic synthesis

[07]

Ideas of synthones and retrones, Functional group transformations and inter conversions of simple functionalities.

Reference Books

1. Modern synthetic reactions-(Benjamin) H. O. House.
2. Reagents in organic synthesis-(John Wiley) Fieser and Fieser
3. Principles of organic synthesis-(Methuen) R. O. C. Norman
4. Hydroboration- S. C. Brown.
5. Advances in Organometallic Chemistry- (A.P.) F. C. A. Stone and R. West.
6. Organic Chemistry (Longman) Vol. I & Vol. II- Finar
7. Oxidation by-(Marcel Dekker) Augustin
8. Advanced Organic chemistry 2nd Ed. R R. Carey and R. J. Sundburg.
9. Tetrahydron reports in organic chemistry- Vol.1, No. 8.
10. Organic Synthesis-(Prentice Hall) R. E. Ireland.
11. Homogeneous Hydrogenation-(J. K.) B. R. James.
12. Comprehensive Organic Chemistry- (Pargamon) Barton and Ollis.
13. Organic reactions- various volumes- R. Adams.
14. Some modern methods of Organic synthesis-(Cambridge) W. Carruthares.

Paper CP-1139 B: Physical Chemistry – II
Theory: 60hrs (Credits - 4)

On completion of the course, student will be able to:

CO1: Acquire knowledge related to atomic structure of many electron systems.

CO2: Get familiar with basics of resonance energy transfer and fluorescence quenching.

CO3: Apply electrochemistry basics to determination of activity and activity coefficients of electrolytes.

CO4: Understand the kinetics approach for simultaneous reactions.

UNIT-I: Quantum Chemistry [15]

Introduction: Operators and related theorems, algebra of operators, commutator, linear operators, uncertainty principle, postulate of quantum mechanics, Normalization and orthogonality, Eigen functions and Eigen values. Selection rules, Linear and angular momentum, eigen function and eigen values of angular momentum operator, Ladder operator, addition of angular momenta. Spin angular momenta, symmetric and antisymmetric wavefunctions, Pauli Exclusion Principle, spectroscopic term symbols (molecular), Slatter determinant, Huckel theory for conjugated linear hydrocarbons.

UNIT-II: Photochemistry [15]

Absorption of light and nature of electronic spectra, electronic transition, Frank-Condon principle, selection rules, photo-dissociation, pre-dissociation, Photo physical phenomena: Electronic structure of molecules, molecular orbital, electronically excited singlet states, designation based on multiplicity rule, life time of electronically excited state, construction of Jablonski diagram, electronic transitions and intensity of absorption bands, photo-physical pathways of excited molecular system (radiative and nonradiative), prompt fluorescence, delayed fluorescence, and phosphorescence, fluorescence quenching: concentration quenching, quenching by excimer and exciplex emission, fluorescence resonance energy transfer between photo-excited donor and acceptor systems. Stern-Volmer relation, critical energy transfer distances, energy transfer efficiency, examples and analytical significance, bimolecular collisional V quenching and Stern-Volmer equation. Photochemistry of environment: Greenhouse effect, Numerical problems.

UNIT-III: Electrochemistry [15]

Types of electrodes, Activity and Activity coefficients: forms of activity coefficients and their interrelationship, Determination of activity coefficients of an electrolyte using concentration cells, instability constant of silver ammonia complex. Acid and alkaline storage batteries, Abnormal ionic conductance of hydroxyl and hydrogen ions.

Electrokinetic phenomena: Electrical double leyer, theories of double layer-Helmholtz-Perrin theory, Gouy and Chapman theory, Stern theory. electro-capillary phenomena, electro-capillary curve. Electro-osmosis, electrophoreses. Streaming and Sedimentation potentials. Zeta potentials and its determination by electrophoresis, influence of ions on Zeta potential. Numerical problems.

UNIT-IV: Chemical Kinetics [15]

Introduction to basic concepts, Experimental methods of following kinetics of a reaction, chemical and physical (measurement of pressure, volume, EMF, conductance, diffusion current and absorbance) methods and examples. Steady state approximation and study of reaction between NO_2 and F_2, decomposition of ozone, and nitrogen pentoxide. Ionic reaction: Primary and secondary salt effect,

Catalysis: Classification of catalysis, mathematical expression of autocatalytic reactions, Michaelis–Menten enzyme catalysis, Homogeneous catalysis: acid and base catalyzed reactions, Heterogeneous catalysis: Adsorption of gas on a surface and its kinetics, Catalyzed hydrogen-deuterium exchange reaction. Numerical problems.

Reference books

1. Introductory Quantum Chemistry - A. K. Chandra. Tata McGraw-Hill. 1988.
2. Physical Chemistry: A molecular Approach – Donald A. McQuarrie and John D. Simon, Viva Books, New Delhi, 1998.
3. Quantum Chemistry – Donald A. McQuarrie, Viva Books, New Delhi, 2003.
4. Physical Chemistry – P. W. Atkins, Oxford University press, VIth edition, 1998.
5. Quantum Chemistry - W. Kauzmann, Academic press.
6. Theoretical Chemistry: An introduction to quantum mechanics, statistical mechanics, and molecular spectra for chemists - S. Glasstone, D. Van Nostrand Company, Inc., 1944.
7. Quantum Chemistry - R.K. Prasad, New Age International, New Delhi.
8. Physical Chemistry – R.S. Berry, S.A. Rice, J. Ross, 2nd Ed., Oxford University Press, New York, 2000.

9. Photochemistry – J. G. Calverts and J. N. Pitts, John-Wiley & Sons
10. Fundamentals of Photochemistry- K. K. Rohatgi-Mukharjii, Wiley Eastern
11. Introduction to Photochemistry-Wells
12. Photochemistry of solutions-C. A. Parker, Elsevier
13. An Introduction to Electrochemistry by S. Glasstone
14. Modern Electrochemistry Vol. I & II by J. O. M. Bockris and A.K.N. Reddy.
15. Electrolytic Solutions by R. A. Robinson and R. H. Strokes, 1959
16. Chemical Kinetics-K. J. Laidler, Pearson Education,2004
17. Kinetics and Mechanism - A. A. Frost and R. G. Pearson.
18. Electrochemistry- S. Glasstone, D. Van Nostrand , 1965
19. Advanced Physical Chemistry- Gurdeep Raj, Goel Publishing House
20. Basic chemical Kinetics- G. L. Agarwal, Tata-McGraw Hill
21. Physical Chemistry – G. M. Barrow, Tata-McGraw Hill, Vth edition, 2003.

Paper CP-1140 B: Analytical Chemistry – II
Theory: 60hrs (Credits - 4)

On completion of the course, student will be able to:

CO1: Grasp the fundamentals of molecular spectroscopy.

CO2: Apply basics of spectroscopy in structure determination of organic compounds

CO3: Use of heat energy in structure determination.

CO4: Get familiar with modern techniques such as AAS, ICPS.

UNIT-I

a) Introduction to Spectroscopy (03)

Introduction, region of electromagnetic radiations, definitions and units of wavelength, frequency, energy, amplitude, wave number and their relations, Interactions of radiation with matter, rotational, vibrational, electronic energy levels, types of spectroscopy methods.

b) Electronic spectroscopy (05)

Diatomic molecules, selection rules, breakdown of selection rules, Franck-Condon factors, Dissociation energies, Photoelectron spectroscopy of diatomic (N_2) and simple polyatomic molecules (H_2O, Formaldehyde), Adiabatic and vertical ionization energies, Koopman's theorem. Numerical problems.

c) Raman spectroscopy (07)

Rayleigh and Raman scattering, quantum and classical theories of Raman Effect, pure rotational Raman spectra of linear and symmetric top molecules, Raman activity of vibrations, rule of mutual exclusion, vibrational Raman spectra, and rotational fine structure.

UNIT-II

a) Nuclear Magnetic Resonance (NMR) (08)

Introduction, principles, Magnetic and non magnetic nuclei, precessional motion, Larmor frequency, absorption of radio frequency. Instrumentation (FT-NMR). Sample preparation, shielding and deshielding effects, chemical shift, internal standards, factors influencing chemical shift, solvents used, peak area and protonratio, anisotropic effect, spin-spin coupling, coupling constant, applications to simple structural problems

b) Mass spectroscopy (MS) **(07)**

Introduction, Principle, Instrumentation, working of mass spectrometer (double beam). Determination of molecular formula, Formation of different types of ions, Mclafferty rearrangements, metastable ions or peaks, The nitrogen rule, Mass spectrum of alkanes, alkenes, alkynes, cycloalkanes, cycloalkenes, cycloalkynes, and applications.

UNIT-III [15]

Thermal Analysis

Introdcution to thermal analysis, types of thermal analysis, significance of thermal analysis in Analytical Chemistry, effect of heat on materials, chemical decomposition, phase transformation etc. and general thermal analysis applications, advantages and disadvantages.

a) Thermogravimetry analysis (TGA): principle, instrumentation, working, types of TGA, factors influencing TGA, curve to show nature of decomposition reactions, the product and qualities of compounds expelled, TGA in controlled atmosphere, TGA curves, analysis, research and analytical implications of TGA.

b) Differential thermal analysis (DTA) and differential scanning calorimetry (DSC), instrumentation, methodology, application and research implications. Thermometric titrations method and applications

Problems: Simple problems based on TGA, DTA and DSC.

UNIT-IV Atomic absorption and Inductively coupled plasma (ICP) Spectroscopy

Atomic Absorption Spectroscopy (AAS) [10]

Introduction, Principal, difference between AAS and FES, Advantages of AAS over FES, advantages and disadvantages of AAS, Instrumentation, Single and double beam AAS, detection limit and sensitivity, Interferences, applications. Graphite furnace atomic absorption spectroscopy, general description, advantages and disadvantages. Flame photometry, Cold Vapor Mercury, Hydride Generation, Spark emission, challenges and limitations.

Inductively Coupled Plasma Spectroscopy [5]

Introduction, Nebulisation Torch, Plasma, Instrumentation, Interferences, and Applications.

Problems: Simple problems based on AAS and ICP

Reference Books

1. Instrumental Methods of analysis- Willard, Merrit, Dean and Settle.
2. Spectroscopic identification of organic compounds- R.M. Silverstein and G.C. Bassler
3. Spectroscopic methods in organic chemistry- D.H. Williams and I. Fleming
4. Absorption spectroscopy of organic molecules- V.M. Parikh
5. Applications of spectroscopic techniques in Organic chemistry- P. S. Kalsi
6. A Text book of Qualitative Inorganic Analysis- A. I. Vogel
7. Physical Methods in Inorganic Chemistry (DWAP)- R. Drago
8. Fundamentals of Analytical Chemistry – D.A. Skoog and D. M. West (Holt Rinehart and Winston Inc.)
9. Principles of instrumental analysis, Holler, Skoog, Crouch. Cengage learning India Pvt. Ltd.
10. Instrumental methods of chemical analysis, H. Kaur, Pragati Prakashan.
11. Organic Spectroscopy by Pavia

M. Sc. Part - I (Sem-II) Chemistry
Practical Course (CC – 1141B) and (CC – 1142B)

Inorganic Chemistry

1. Ore analysis – '2' ores (Dolomite and bauxite ore)
2. Alloy analysis – '2' (Brass and Monel metal alloy: Two and three components)
3. Inorganic Preparations and purity –'4'
   - i) Potassium dioxalato dihydroxo mangnate (IV)
   - ii) Ammonium trioxalato chromate
   - iii) Nitropentammine cobalt (III) chloride
   - iv) Potassium hexathiocyanato chromate

Reference Books

1. A text book of Quantitative Inorganic Analysis – A. I. Vogel
2. Experimental Inorganic Chemistry - W. G. Palmer
3. The analysis of minerals and ores of the rarer elements – W. R. Schoeller vand A. R. Powell, Charles, Griffin and Company Limited

Organic Chemistry

1. Qualitative analysis:
   Separation and identification of the two component mixtures using Chemical and physical methods.
2. Thin layer chromatography (TLC).
3. Steam distillation techniques.
   (Any other suitable experiments may be added).

Reference Books

1. A text book of practical organic chemistry- A. I. Vogel.
2. Practical organic chemistry- Mann and Saunders.
3. A handbook of quantitative and qualitative analysis- H. T. Clarke.
4. Organic Synthesis Collective Volumes by Blat.

Physical Chemistry

Students are expected to perform 15-20 experiments of three and half-hours duration.

Experiments are to be set up in the following techniques.

Potentiometry

1. Determination formal redox potential of system (Fe^{2+}, Fe^{3+})
2. Determination of binary mixture of halides.
3. Dissociation constant of acetic acid.

Conductometry

4. Titration of ternary acid mixture of acids.
5. Verification of Onsagar Equation for 1:1 type strong electrolyte.
6. Determination of ΔG, ΔH, ΔS of silver benzoate by solubility product method.

Refractometry

7. Determination of atomic refractions of H, C and Cl atoms.
8. Determination of composition of mixture of liquids.

Chemical kinetics

9. Kinetics of iodination of acetone in presence of strong acid

Phase Equilibrium

10. To construct phase diagrams for ternary system.

Viscosity

11. Determination of radius of sucrose molecules.

(New experiments may be also be added)

Reference Books

1. Findlay's Practical Chemistry – Revised by J.A. Kitchner (Vedition)
2. Text Book of Quantitative inorganic analysis: A.I. Vogel.
3. Experimental Physical Chemistry: By F. Daniels and J. Williams
4. Experimental Physical Chemistry: R.C Das and B. Behera
5. Practical Physical Chemistry: B. Viswanathan and P. S. Raghavan

Analytical Chemistry

Section-I: Physical Chemistry

1. To estimate the amount of NH_4Cl colorimetrically using Nesseler's Reagent.
2. Determine the solubility of lead iodide in presence of varying concentration of Salt KCl.
3. Determine the solubility of lead iodide in presence of varying concentration of Salt KNO_3

(Any other experiments may be added)

Section-II: Organic Chemistry

1. Analysis of pharmaceutical tablets: Ibuprofen / Isoniazide
2. Colorimetric estimation of drugs.
3. Preparation of pesticides.
4. Column and thin layer chromatography

(Any other experiments may be added)

Section-III: Inorganic Chemistry

1. To determine the amount of copper in brass metal alloy colorimetrically.
2. Estimation of oxygen in H_2O_2.
3. Determination of alkalinity and salinity in water sample.
4. Separation and estimation of Iron and aluminium on a cation exchanger.
5. Composition of iron sulphosalicylic acid complex by Jobs method Spectrophotometrically
6. Preparation of Fe_2O_3 or Ag nanoparticles by chemical method

(Any other experiments may be added)

Reference Books

1. A Text book of quantitative Inorganic Analysis – A. I. Vogel
2. Standards methods of Chemical Analysis-F. J. Welcher.
3. Experimental Inorganic Chemistry – W. G. Palmer.
4. Manual on Water and Waste Water Analysis, NEERI- Nagpur D.S. Ramteke and C. A. Moghe
5. Inorganic synthesis- King.
6. Synthetic Inorganic Chemistry-W.L.Jolly
7. EDTA Titrations –F. Laschka

VIVEKANAND COLLEGE KOLHAPUR (Autonomous) ESTD JUNE 1964

CO-ORDINATOR
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(EMPOWERED AUTONOMOUS)