M. Sc. Semester II
Inorganic Chemistry-CHE407

Unit 1- Chemical Bonding
The method of linear combination
VSEPR, Walsh diagrams (tri-and penta-atomic molecules), d_σ – p_π bonds, Bent rule and energetics of hybridization, some simple reactions of covalently bonded molecules.

Simple Huckel theory of linear conjugated systems, simple Huckel theory of the cyclic conjugated system and aromaticity, self consistent filed method, valence state ionization potentials, Pariser-Parr-Pople approximation.

Band theory of solids, Fermi level, electrical properties, insulators, semiconductors and superconductors (properties).

Unit 2- Application of symmetry
Application of symmetry to hybrid orbital, molecular orbitals, hybridization schemes for σ orbitals, π bonding and molecular orbital for ABn type of molecules.

Application of symmetry to molecular vibrations, interpretation of IR and Raman spectral data.

Unit 3-Organometallic Compounds
Role of organometallic compounds in catalytic reaction.

Unit 4 – Reaction Mechanism
Mechanism of substitution reaction in square planar complexes. Kinetics of substitution reaction of platinum (II) complexes
Effect of leaving group, effect of charge, steric effect, solvent effect, effect of nucleophile, effect of temperature and other effects.
Oxidation-Reduction reaction, electron transfer, tunnelling effect, Marcus –Hush theory, one and two electron transfer inner sphere and outer sphere, effect of ions on rate, electron transfer through extended bridges, unstable oxidation states, hydrated electron.
References

1. Introduction to Quantum Chemistry, A. K. Chandra, Tata MacGraw Hill
2. Quantum Chemistry, Ira N. Levine, Prentice Hall
4. D. A. McQuarrie Quantum Chemistry, OUP 1983
8. Coulson’s Valence, R. McWeeny, ELBS
17. Reaction Mechanism of Coordination Compounds, C. H. Langford and H. B. Gray
**M. Sc. Semester II- Practicals**
CHE411PR (Inorganic Chemistry)

Semester –II Practicals (Inorganic Chemistry) CHE411PR
1. Preparation and determination of purity of double and complex salts. At least ten preparations should be done.
2. Colourimetric estimation of any five out of Cu, Mn, NO$_2$, Ni, P, Fe, V, Ti, Cr, Co.

**References**

M.Sc. SEMESTER II
CHE408 Organic Chemistry

Unit-1

Spectroscopy

1) 13 CNMR : General considerations, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants.


3) Examples of mass spectral fragmentation of organic compounds, NMR, IR, UV with respect to their structure determination.

Unit - 2

(A) Photochemistry:


2) Photochemistry of carbonyl compounds: Representation of excited states of ketones, photoreduction Norrish type I & II reactions, Reactions of cyclic Ketone, oxetane formation (Paterno-Buchi reaction)

3) Di-π methane rearrangement, Dienone photochemistry, cis-trans isomerisation and photochemistry of conjugated olefins.

(B) Chemistry of Heterocycles

1) Nomenclature of heterocycles : Replacement and systematic nomenclature (Hantzsch-Widman system) for monocyclic, fused and bridged heterocycles. General chemical behavior of aromatic heterocycles.

2) Five-membered and benzo fused five member heterocycles : Oxazole, Isoxazole, Thiazole, Pyrazole, Imidazole, Benzothiazole and Benzimidazole.

3) Six membered and benzo fused six membered heterocycles : Pyrazine, Pyridazine, Pyrimidine, Cinnoline, Quinazoline, Quinoxaline, Phenoxyaline.
Unit - 3

Name reactions : General nature, method, mechanism and synthetic applications of the following reactions:
(i) Vilsmeier-Haack reaction
(ii) Mitsunobu reaction
(iii) Suzuki reaction
(iv) Buchwald Hartwig reaction (cross coupling)
(v) Sonogashira coupling
(vi) Stobbe condensation
(vii) Jones oxidation
(viii) Swern oxidation reaction
(ix) Michael addition
(x) Darzen’s glycidic ester synthesis
(xi) Mannich reaction
(xii) Dickmann reaction
(xiii) Birch reduction
(xiv) Witting reaction
(xv) Knoevenagel reaction

Unit-4
Reagents in organic synthesis: Mechanism selectivity and utility of following reagents:
(i) Gilman’s reagent-Lithium dimethylcuprate
(ii) Lithium diisopropylamide (LDA)
(iii) Dicyclohexyl carbodiimide (DCC)
(iv) 1,3 – Dithiane (Umpolung reagent)
(v) Dess- Martin periodinane
(vi) Bakers yeast
(vii) Diisobutyluminium hydride (DIBAL –H)
(viii) Sodium cyanoborohydride (NaBH3(CN))
(ix) Grignard reagents
(x) Sodium borohydride
(xi) DDQ
(xii) n-Butyl lithium
(xiii) Phase transfer catalysis : Quaternary ammonium and phosphonium salts, crown ethers.
M.Sc. SEMESTER II - Theory
CHE408 Organic Chemistry

References

1) Modern Synthetic Reactions, H.O.House, W.A. Benjamin.
M.Sc Semester – II (PRACTICALS)
CHE411PR Organic Chemistry

Mixture analysis: ternary mixture to be given. (S+S+S )or ( L+L+L ). Type
determination. Separation by physical and chemical methods. (both permitted in case of
liquids)

M.Sc Semester – II (PRACTICALS)
CHE411PR Organic Chemistry

References:
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
   Ahluwalia & S. Dhingra.
5. Comprehensive Practical Organic Chemistry : Preparations and Quantitative
   Analysis V K Ahluwalia & R. Aggarwal Universities Press.
6. An Advance Course in practical Chemistry, A K. Nad, B. Mahapatra and A.
   Ghoshal.
M.Sc. Semester II
CHE409 Physical Chemistry

Unit I  Statistical thermodynamics:
Concepts of distribution of molecules, thermodynamic probability, permutations and combinations, Boltzmann’s most probable distribution, partition function - translational, vibrational, rotational, electronic nuclear partition functions.

Unit II  Nuclear chemistry:
Nuclear properties-nuclear radius, coulombic and nuclear potential radius, nuclear spin and angular momentum, magnetic moment, nuclear binding energy, nuclear models-shell model, liquid drop model, Fermi gas model, collective model, radioactive decay, nuclear reactions, evaporation, spallation, fragmentation, fission and fusion reactions, accelerators, reaction cross section, use of radioisotopes as tracers.

Unit III  Polymer chemistry:
Kinetics and mechanism of polymer processes, criteria of polymer solubility, thermodynamics of polymer solutions, polymer characterization, molecular weight of polymer (number average and weight average), methods of molecular weight determination, properties of polymers and applications.

Unit IV  Electrochemistry:
Sign convention-American, European and IUPAC; Determination of dissociation constant of monobasic acids by conductometry, determination of dissociation constants of monobasic and polybasic acids by potentiometry.

The electrical double layer, the rate of charge transfer, polarization and overvoltage, basic principle of polarography, origin of different types of current; equation of polarographic wave, Ilkovic equation.
M. Sc. Semester II- References: Theory

(1) Textbook of physical chemistry – W.J.Moore
(2) Textbook of physical chemistry – Glasstone
(3) Textbook of physical chemistry – P.Atkins
(4) Advanced physical chemistry – Surdeep Raj
(5) Advanced physical chemistry – J.N.Gurtu, A.Gurtu
(6) Statistical thermodynamics – M.C.Gupta
(7) Polymer chemistry – Gowariker
(8) Polymer chemistry – Billmayer
(9) Principles of polymer science – Bahadur & Sastry
(10) Polymer science & technology – Fried
(11) Polymer chemistry- Malcolm P. Stevens
(12) Nuclear chemistry – Arniker
(13) Nuclear and radio chemistry – J.W. Kennedy, G.Friedlander
(14) Electrochemistry – Bockris and Reddy
M.Sc. Semester II Practicals
CHE412PR Physical Chemistry

I. Conductometry
1. Test of validity of Ostwald’s dilution law and determination of dissociation constant of weak electrolyte like CH₃COOH & ClCH₂COOH
2. Verification of Debye-Huckel-Onsager’s equation in case of strong electrolytes like HCl, KCl, NaCl.

II. Potentiometry
1. Titration of dibasic acid like malonic, oxalic, succinic acid with NaOH and find the dissociation constant of acid.
2. Precipitation titration → Titration of halids with AgNO₃.
3. Redox titration Ferrous ammonium sulfate – KMnO₄, K₂Cr₂O₇.

III. pHmetry
1. Determination of dissociation constant of weak acid like acetic and monochloroacetic acid

IV. Adsorption and kinetics
1. Adsorption of acetic acid on activated charcoal
2. Determination of order of reaction between K₂S₂O₈ and KI by a fractional change method.

V. Distribution method
1. Determination of the formula of the complex formed between cupric ion and ammonia by distribution method.
M.Sc. Semester II- Practicals
CHE412PR - Physical Chemistry

References:
1. Practical physical chemistry – J.B. Yadav
2. Practicals in physical chemistry – P.S. Sindhu
3. Experimental physical chemistry – R.C. Das, B. Behera
4. Experiments in physical chemistry - P.H. Parsania, F. Karia
UNIT-1
Sample Preparation Techniques
Liquid-liquid extraction/solvent extraction-partition coefficient, distribution ratio and percent extraction. Solvent extraction of metal ions-ion association complexes and metal chelates, multiple batch extraction, Craig’s counter-current distribution. Accelerated and Microwave assisted extraction, protein precipitation and solid phase extraction (SPE).

UNIT-2
Chromatographic Methods
Principles of chromatography, classification of chromatographic techniques based on mechanism of retention, configuration, mobile and stationary phase. Efficiency of separation- plate theory (theoretical plate concept) and rate theory (Van Deemter equation). Principles and applications of Paper chromatography, thin layer chromatography, HPTLC and Ion exchange chromatography. Counter-current chromatography for isolation of natural products.

UNIT-3
pH metry and Conductometry
pH measurement with glass electrode, working of glass electrode, mechanism of pH measurement, calibration of glass electrode, errors in pH measurement. Electrical conductance in solutions of electrolytes, measurement of conductance, conductometric titrations- acid-base, precipitation and complex formation titrations.

UNIT-4
Potentiometry and Ion-selective electrodes
M.Sc. Semester II
CHE410 Analytical Chemistry-Theory

Reference Books

M.Sc. Semester II- Practicals
Analytical Chemistry- CHE412PR

1. Determination of saponification value of oil.
2. Determination of iodine value of oil.
3. Determination of acid value of oil.
4. Determination of dissolved oxygen.
5. Determination of chemical oxygen demand.
6. Determination of iron in iron tablets.
7. Simultaneous estimation of chromium (III) and iron (III) by EDTA titration.
8. Simultaneous estimation of calcium (II) and zinc (II) by EDTA titration.
9. Simultaneous estimation of lead (II) and magnesium (II) by EDTA titration.
10. Separation of amino acids by TLC.
11. Separation of drugs by TLC.
12. Separation of dyes by TLC.

References