UNIVERSITY OF MYSORE
DEPARTMENT OF STUDIES IN CHEMISTRY
Post-graduate Degree Programme in Chemistry
M. Sc. Degree in Chemistry – I - IV Semesters
Choice Based Credit Based Continuous Assessment Semester System – 2012 - 2013
Scheme of Revised Syllabi and examination of M.Sc. degree in chemistry under CBCBCASS University of Mysore.

FIRST SEMESTER

THEORY

Core Papers	Paper Title	Contact Hours/week & Credits	Total Marks / Paper	Assessment Weightage		Semester End Exam. Duration (hrs) & Assessment Weightage
				C1 Test	C2 test	
Chem-HC-A-T-1.1	Statistical evaluation of analytical data and titrimetric analysis	2Session (2 h) & 2	100	25 %	25 %	2 ½ h and 50 %
Chem-HC-I-T-1.2	Concepts and Models of Inorganic Chemistry	2Session (2 h) & 2	100	25 %	25 %	2 ½ h and 50 %
Chem-HC-O-T-1.3	Stereochemistry and Reaction Mechanisms	2Session (2 h)& 2	100	25 %	25 %	2 ½ and 50 %
Chem-HC-P-T-1.4	Chemical Thermodynamics and Kinetics and Electrochemistry	2Session (2 h) & 2	100	25 %	25 %	2 ½ and 50 %

PRACTICALS

Core Papers	Paper Title	Contact Hours/week & Credits	Total Marks / Paper	Assessment Weightage		Semester End Exam. Duration (hrs) & Assessment Weightage
				C1 test	C2 test	
Chem-HC-A-P-1.1	Analytical Practicals – I	2 Session,4 h & 2	100	25 %	25 %	5 h and 50 %
Chem-HC-I-P-1.2	Inorganic Practicals – I	2Session, 4 h & 2	100	25 %	25 %	5 h and 50 %
Chem-HC-O-P-1.3	Organic Practicals – I	2Session, 4 h & 2	100	25 %	25 %	5 h and 50 %
Chem-HC-P-P-1.4	Physical Practicals – I	2Session, 4 h & 2	100	25 %	25 %	5 h and 50 %

SC PAPERS (FOR CHEMISTRY STUDENTS ONLY)

THEORY

Soft Core Papers	Paper Title	Contact Hours/week & Credits	Total Marks / Paper	Assessment Weightage		Semester End Exam. Duration (hrs) & Assessment Weightage
				C1 test	C2 test	
Chem-SC-T-1.1	Molecular spectroscopy– I	2Session (2,1 h), 3 h & 3	100	25 %	25 %	2 ½ h and 50 %
Chem-SC-T-1.2	Molecular spectroscopy– II	2Session (2,1 h), 3 h & 3	100	25 %	25 %	2 ½ h and 50 %

NOTE:

1. Chem-HC-A-T-1.1, Chem-HC-I-T-1.2, Chem-HC-O-T-1.3, Chem-HC-P-T-1.4 and practicals, Chem-HC-A-P-1.1, Chem-HC-I-P-1.2, Chem-HC-O-P-1.3, Chem-HC-P-P-1.4 are hard core papers and compulsory papers for every student.
2. Chem-SC-T-1.1 AND Chem-SC-T-1.2, are soft core papers and each student has to study both of them but a student taking Chem-SC-T-1.1 in the I semester will take Chem-SC-T-1.2 in the II semester or other way**.**
3. Each practical exam includes viva-voce.

SECOND SEMESTER

THEORY

Core Papers	Paper Title	Contact Hours/week & Credits	Total Marks / Paper	Assessment Weightage		Semester End Exam. Duration (hrs) & Assessment Weightage
				C1 Test	C2 test	
Chem-HC-A-T-2.1	Separation Techniques	2Session (2 h), & 2	100	25 %	25 %	2 ½ h and 50 %
Chem-HC-I-T-2.2	Coordination Chemistry	2Session (2 h), & 2	100	25 %	25 %	2 ½ h and 50 %
Chem-HC-O-T-2.3	Reagents in organic synthesis and organometallic chemistry	2Session (2 h), & 2	100	25 %	25 %	2 ½ and 50 %
Chem-HC-P-T-2.4	Quantum chemistry and advanced chemical kinetics	2Session (2 h), & 2	100	25 %	25 %	2 ½ and 50 %

PRACTICALS

Core Papers	Paper Title	Contact Hours/week & Credits	Total Marks / Paper	Assessment Weightage		Semester End Exam. Duration (hrs) & Assessment Weightage
				C1 test	C2 test	
Chem-HC-A-P-2.1	Analytical Practicals – II	2Session 4 h & 2	100	25 %	25 %	5 h and 50 %
Chem-HC-I-P-2.1	Inorganic Practicals – II	2Session 4 h & 2	100	25 %	25 %	5 h and 50 %
Chem-HC-O-P-2.3	Organic Practicals – II	2Session 4 h & 2	100	25 %	25 %	5 h and 50 %
Chem-HC-P-P-2.4	Physical Practicals – II	2Session 4 h & 2	100	25 %	25 %	5 h and 50 %

Note:

1. Chem-HC-A-T-2.1, Chem-HC-I-T-2.2, Chem-HC-O-T-2.3, Chem-HC-P-T-2.4 and practicals, Chem-HC-A-P-2.1, Chem-HC-I-P-2.2, Chem-HC-O-P-2.3, Chem-HC-P-P-2.4 are hard core papers and compulsory papers for every student.
2. Each practical exam includes viva-voce.

SC PAPERS (FOR CHEMISTRY STUDENTS ONLY)

NOTE: STUDENT WHO HAS TAKEN CHEM-SC-T-1.1 IN THE FIRST SEMESTER HAS TO TAKE CHEM-SC-T-1.2 IN THE SECOND SEMESTER AND VICE VERSA.

THIRD SEMESTER

THEORY

Core Papers	Paper Title	Contact Hours/week & Credits	Total Marks / Paper	Assessment Weightage		Semester End Exam. Duration (hrs) & Assessment Weightage
				C1 Test	C2 test	
Chem-HC-A-T-3.1	Instrumental methods of analysis	2Session (2 h), & 2	100	25 %	25 %	2 ½ h and 50 %
Chem-HC-I-T-3.2	Organometallic chemistry	2Session (2 h), & 2	100	25 %	25 %	2 ½ h and 50 %
Chem-HC-O-T-3.3	Heterocyclic chemistry, photochemistry and pericyclic reactions, molecular rearrangements and retrosynthesis	2Session (2 h), & 2	100	25 %	25 %	2 ½ and 50 %
Chem-HC-P-T-3.4	Nuclear, radiation, photo, polymer and Nano chemistry	2Session (2 h), & 2	100	25 %	25 %	2 ½ and 50 %

PRACTICALS

Core Papers	Paper Title	Contact Hours/week & Credits	Total Marks / Paper	Assessment Weightage		Semester End Exam. Duration (hrs) & Assessment Weightage
				C1 test	C2 test	
Chem-HC-A-P-3.1	Analytical Practicals – III	2Session 4 h & 2	100	25 %	25 %	5 h and 50 %
Chem-HC-I-P-3.2	Inorganic Practicals – III	2Session 4 h & 2	100	25 %	25 %	5 h and 50 %
Chem-HC-O-P-3.3	Organic Practicals – III	2Session 4 h & 2	100	25 %	25 %	5 h and 50 %
Chem-HC-P-P-3.4	Physical Practicals – III	2Session 4 h & 2	100	25 %	25 %	5 h and 50 %
Chem-HC-SR-3.5	Seminar	1 h duration & 1	25	-	-	-

Note:

1. Chem-HC-A-T-3.1, Chem-HC-I-T-3.2, Chem-HC-O-T-3.3, Chem-HC-P-T-3.4 and practicals, Chem-HC-A-P-3.1, Chem-HC-I-P-3.2, Chem-HC-O-P-3.3, Chem-HC-P-P-3.4 are hard core papers and compulsory papers for every student.
2. Student strength per seminar will not exceed 20 members or two times a practical batch.
3. Each practical exam includes viva-voce.

FOURTH SEMESTER

SC PAPERS (FOR CHEMISTRY STUDENTS ONLY)

THEORY

Soft Core Papers	Paper Title	Contact Hours/week & Credits	Total Marks / Paper	Assessment Weightage		Semester End Exam. Duration (hrs) & Assessment Weightage
				C1 test	C2 test	
Chem-SC-A-T-4.1	Miscellaneous methods of analysis	2Session (2,1 h),3 h & 3	100	25 %	25 %	2 ½ h and 50 %
Chem-SC-A-T-4.2	Applied analysis	2Session (2,1 h),3 h & 3	100	25 %	25 %	2 ½ h and 50 %
Chem-SC-I-T-4.3	Bioinorganic chemistry	2Session (2,1 h),3 h & 3	100	25 %	25 %	2 ½ h and 50 %
Chem-SC-I-T-4.4	Structural methods in inorganic chemistry	2Session (2,1 h),3 h & 3	100	25 %	25 %	2 ½ h and 50 %
Chem-SC-O-T-4.5	Synthetic organic chemistry	2Session (2,1 h),3 h & 3	100	25 %	25 %	2 ½ h and 50 %
Chem-SC-O-T-4.6	Natural products	2Session (2,1 h),3 h & 3	100	25 %	25 %	2 ½ h and 50 %
Chem-SC-P-T-4.7	Polymers, semiconductors and statistical thermodynamics	2Session (2,1 h),3 h & 3	100	25 %	25 %	2 ½ h and 50 %
Chem-SC-P-T-4.8	Pharmaco kinetics and biophysical chemistry	2Session (2,1 h),3 h & 3	100	25 %	25 %	2 ½ h and 50 %

PRACTICALS

Core Papers	Paper Title	Contact Hours/week & Credits	Total Marks / Paper	Assessment Weightage		Semester End Exam. Duration (hrs) & Assessment Weightage
				C1 test	C2 test	
Chem-SC-A-P-4.1	Analytical Practicals – IV	2Session 4 h & 2	100	25 %	25 %	5 h and 50 %
Chem-SC-A-P-4.2	Analytical Practicals – V	2Session 4 h & 2	100	25 %	25 %	5 h and 50 %
Chem-SC-I-P-4.3	Inorganic Practicals – IV	2Session 4 h & 2	100	25 %	25 %	5 h and 50 %
Chem-SC-I-P-4.4	Inorganic Practicals – V	2Session 4 h & 2	100	25 %	25 %	5 h and 50 %
Chem-SC-O-P-4.5	Organic practical-IV	4 h & 2	100	25 %	25 %	5 h and 50 %
Chem-SC-O-P-4.6	Organic practical-V	2Session 4 h & 2	100	25 %	25 %	5 h and 50 %
Chem-SC-P-P-4.7	Physical chemistry-IV	4 h & 2	100	25 %	25 %	5 h and 50 %
Chem-SC-P-P-4.8	Physical chemistry-V	2Session 4 h & 2	100	25 %	25 %	5 h and 50 %
Chem HC-D-4.1	Dissertation-project work	2Session 4+1 h & 3	100	25 %	25 %	Project Report evaluation and Viva-voce by internal and external examiners = 50 %

Note:

1. In the fourth semester, the students will be distributed equally among the four branches/specializations based on merit in the first two semesters plus admission merit and their choice. They have to select two elective theory papers and two elective practicals from the same branch/specialization. The Dissertation work has to be carried out on topics from the same branch/specializations under the supervision of same branch/specialization faculty members.
2. Chem HC-D-4.1 hard core and compulsory for every student.
3. Each practical exam includes viva-voce in all semesters.

OPEN ELECTIVE (FOR NON-CHEMISTRY STUDENTS ONLY)

THEORY

Open elective Papers	Paper Title	Contact Hours/week & Credits	Total Marks / Paper	Assessment Weightage		Semester End Exam. Duration (hrs) & Assessment Weightage
				I test	II test	
CHEM- OE-A-T-1	Analytical Chemistry	2Session 2 h & 2	100	25 %	25 %	2 ½ h and 50 %
CHEM- OE-I-T-2	Inorganic Chemistry	2Session 2 h & 2	100	25 %	25 %	2 ½ h and 50 %
CHEM- OE-O-T-3	Organic Chemistry	2Session 2 h & 2	100	25 %	25 %	2 ½ h and 50 %
CHEM- OE-P-T-4	Physical Chemistry	2Session 2 h & 2	100	25 %	25 %	2 ½ h and 50 %

NOTE:

1. Students of chemistry when registered for additional credits can chose more than one elective / soft core paper in IV semester. However, a minimum of 15 students have to register for additional credits for conducting such a paper.
2. Open elective / Cross border papers are for other than chemistry students and for conducting such a paper a minimum of ten students are required.

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FIRST SEMESTER

Chem-HC-A-T-1.1 **Statistical evaluation of analytical data and titrimetric analysis**

UNIT – I

Analytical Chemistry - Meaning and analytical prospective, scope and function: Analytical problems and their solutions, trends in analytical methods and procedures.

Language of analytical chemistry - Analysis, determination and measurement. Techniques, methods, procedures and protocols. Classifying analytical techniques. selecting an analytical method - accuracy, precision, sensitivity, selectivity, robustness and ruggedness. Scale of operation, equipment, time and cost. Making the final choice

Errors and treatment of analytical data: Limitations of analytical methods – Error: determinate and indeterminate errors, minimization of errors. Accuracy and precision, distribution of random errors, the normal error curve. Statistical treatment of finite samples - measures of central tendency and variability: mean, median, range, standard deviation and variance. Student's t-test, confidence interval of mean. Testing for significance - comparison of two means and two standard deviations. Comparison of an experimental mean and a true mean. Criteria for the rejection of an observation - Q-test. Propagation of errors: determinate errors and indeterminate errors.

Standardization and calibration: Comparison with standards - direct comparison and titrations. External standard calibration - the least squares methods, regression equation, regression coefficient. Internal standard methods and standard-addition methods. Figures of merit of analytical methods - sensitivity and detection limit, linear dynamic range.

UNIT – II

Obtaining and preparing samples for analysis: Importance of sampling, designing a sample plan-random, judgement, systematic-judgement, stratified and convenience sampling. Type of sample to collect - grab and composite samples. *Insitu* sampling. Size of sample and number of samples. Implementing the sampling plan - solutions, gases and solids. Bringing solid samples into solution - digestion and decomposing.

Titrimetric analysis: An overview of titrimetry. Principles of titrimetric analysis. Titration curves. Titrations based on acid-base reactions - titration curves for strong acid and strong base, weak acid and strong base and weak base and strong acid titrations. Selecting and evaluating the end point. Finding the end point by visual indicators, monitoring *p*H and temperature. Quantitative applications – selecting and standardizing a titrant, inorganic analysis - alkalinity, acidity and free CO_2 in water and waste waters, nitrogen, sulphur ammonium salts, nitrates and nitrites, carbonates and bicarbonates. Organic analysis - functional groups like carboxylic acid, sulphonic acid, amine, ester, hydroxyl, carbonyl. Air pollutants like SO_2. Quantitative calculations. Characterization applications - equivalent weights and equilibrium constants.

Acid-base titrations in non-aqueous media: Role of solvent in acid-base titrations, solvent systems, differentiating ability of a solvent, some selected solvents, titrants and standards, titration curves, effect of water, determining the equivalence point, typical applications - determination of carboxylic acids, phenols and amines.

UNIT – III

Precipitation titrations: Titration curves, feasibility of precipitation titrations, factors affecting shape - titrant and analyte concentration, completeness of the reaction, titrants and standards, indicators for precipitation titrations involving silver nitrate, the Volhard, the Mohr and the Fajan's methods, typical applications.

Complexometric titrations: Complex formation reactions, stability of complexes, stepwise formation constants, chelating agents, EDTA - acidic properties, complexes with metal ions, equilibrium calculations involving EDTA, conditional formation constants, derivation of EDTA titration curves, effect of other complexing agents, factors

affecting the shape of titration curves - completeness of reaction, indicators for EDTA titrations - theory of common indicators, titration methods employing EDTA - direct, back and displacement titrations, indirect determinations, titration of mixtures.

Redox titrations: Balancing redox equations, calculation of the equilibrium constant of redox reactions, calculating titration curves, detection of end point, visual indicators and potentiometric end point detection. Quantitative applications - adjusting the analyte's oxidation state, selecting and standardizing a titrant. Inorganic analysis - chlorine residuals, dissolved oxygen in water, water in non-aqueous solvents. Organic analysis - chemical oxygen demand (COD) in natural and waste waters, titrations of mercaptans and ascorbic acid with I_3^- and titration of organic compounds using periodate.

References:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 6th edition, 2004, John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993, Prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. Principles and Practice of Analytical Chemistry, F.W. Fifield and Kealey, 3rd edition, 2000, Blackwell Sci., Ltd. Malden, USA.
7. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.

FIRST SEMESTER

Chem-HC-A-P-1.1 **ANALYTICAL CHEMISTRY PRACTICALS-I**

1. Determination of total acidity of vinegar and wines by acid-base titration.
2. Determination of purity of a commercial boric acid sample, and Na_2CO_3 content of washing soda.
3. Analysis of chromate-dichromate mixture by acid-base titration.
4. Determination of replaceable hydrogen and relative molecular mass of a weak organic acid by titration with NaOH.
5. Determination of ephedrine and aspirin in their tablet preparations by residual acid-base titrimetry.
6. Determination of purity of aniline and assay of chlorpromazine tablets by non-aqueous acid-base titration.
7. Periodate determination of ethylene glycol and glycerol (Malprade reaction).
8. Determination of carbonate and bicarbonate in a mixture by *p*H-metric titration and comparison with visual acid-base titration.
9. Determination of purity of a commercial sample of mercuric oxide by acid-base titration.
10. Determination of the *p*H of hair shampoos and *p*H determination of an unknown soda ash.
11. Analysis of water/waste water for acidity by visual, *p*H metric and conductometric titrations.
12. Analysis of water/waste water for alkalinity by visual, *p*H metric and conductometric titrations.
13. Determination of carbonate and hydroxide-analysis of a commercial washing soda by visual and *p*H-titrimetry.
14. Determination of ammonia in house-hold cleaners by visual and conductometric titration.
15. Potentiometric determination of the equivalent weight and Ka for a pure unknown weak acid.
16. Spectrophotometric determination of creatinine and phosphorus in urine.

17. Flame emission spectrometric determination of sodium and potassium in river/lake water.

18. Spectrophotometric determination of *p*Ka of an acid-base indicator.

19. Determination of percentage purity of phenol by bromatometry.

References:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 6th edition, 2004, John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993, Prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.

FIRST SEMESTER

Chem-HC-I-T-1.2 CONCEPTS AND MODELS OF INORGANIC CHEMISTRY

UNIT – I

Structures and energetics of ionic crystals: Introduction, Ionic radii, Factors affecting the ionic radii, Radius ratio rules, Crystal systems, Bravais lattice (fluorite, rutile, β-crystobalite and cadmium iodide), Perovskite and spinel structures, Properties and thermodynamics of ionic solids, Lattice energy (NaCl, MgO, etc), Born-Haber cycle, Born-Lande equation., Kapustinskii equation, Point defects, Applications of lattice energy,

Structures and energetics of inorganic molecules: Introduction, Hybridized orbitals, VSEPR model for polyatomic molecules, MO treatment of homo- and heteronuclear diatomic molecules, MO treatment for polyatomic molecules (CO_3^{2-}, NO_3^-, NO_2^-, CO_2, N_3^- etc), Walsh diagram for triatomic molecules.

UNIT – II

Modern concept of acids and bases: Lux-Flood and Usanovich concepts, Solvent system and leveling effect, HSAB concept.

Non-aqueous solvents: Classification of solvents, Properties of solvents (dielectric constant, viscosity etc), Protic solvents (HF, anhydrous H_2SO_4 and glacial acetic acid) aprotic solvents (BrF_3 and N_2O_4), Solutions of metals in liquid ammonia, Hydrated electron. Superacids.

Supercritical fluids: Properties of supercritical fluids and their uses as solvents. Supercritical fluids as media for inorganic chemistry

Molecular hydrides: Nomenclature and classification, Synthesis, properties and structure of diborane and higher boranes, Wade's rules, Carboranes and metallocarboranes, Borazines

UNIT – III

Chemistry of main group elements: Polymorphism of carbon, sulphur and phosphorous, Phosphazines, Oxyacids of nitrogen, phosphorous,sulphur and halogens, Sulphur-nitrogen compounds.

Silicates: Classification and structure, Isomorphous replacement, Pyroxenes, Layered and vitrified silicates, Zeolites and molecular sieves, Condensed phosphate, Polyhalides.

References

1. Basic Inorganic Chemistry – 3rd edition. F.A. Cotton, G. Wilkinson and P.L. Gaus, John Wiley and Sons (2002).
2. Inorganic Chemistry, 3rd edition. James E. Huheey, Harper and Row Publishers (1983).
3. Inorganic Chemistry, 3rd edition. G.L. Miessler and D.A. Tarr, Pearson Education (2004).
4. Inorganic Chemistry, 2nd edition. D.F. Shriver, P.W. Atkins and C.H. Langford, Oxford University Press (1994).
5. Inorganic Chemistry, 2nd edition. C.E. Housecroft and A.G. Sharpe, Pearson Education Ltd. (2005).
6. Introduction to Modern Inorganic Chemistry, K.M. Mackay and R.A. Mackay, Blackie Publication (1989).
7. Concepts and Models of Inorganic Chemistry 3rd edition. B.E. Douglas, D.H. McDaniel and Alexander, Wiley (2001).
8. Modern Inorganic Chemistry, William Jolly, TMH.
9. Chemistry of Elements, M. M. Greenwood and Earnshaw, Elsevier.

FIRST SEMESTER

Chem-HC-I-P-1.2 INORGANIC CHEMISTRY PRACTICALS-I

1. Determination of iron in haematite using cerium(IV) solution (0.02M) as the titrant, and gravimetric estimation of insoluble residue.
2. Estimation of calcium and magnesium carbonates in dolomite using EDTA titration, and gravimetric analysis of insoluble residue.
3. Determination of manganese dioxide in pyrolusite using permanganate titration.
4. Quantitative analysis of copper-nickel in alloy/mixture:
    i. Copper volumetrically using KIO_3.
    ii. Nickel gravimetrically using DMG
5. Determination of lead and tin in a mixture: Analysis of solder using EDTA titration.
6. Quantitative analysis of chloride and iodide in a mixture:
    i. Iodide volumetrically using KIO_3
    ii. Total halide gravimetrically
7. Gravimetric analysis of molybdenum with 8-hydroxyquinoline.
8. Spectrophotometric determinations of:
    a. Titanium using hydrogen peroxide
    b. Chromium using diphenyl carbazide in industrial effluents
    c. Iron using thiocyanate/1,10-phenanthroline method in commercial samples
    d. Nickel using dimethylglyoxime in steel solution
9. Micro-titrimetric estimation of :
    a) Iron using cerium(IV)
    b) Calcium and magnesium using EDTA
10. Quantitative estimation of copper(II), calcium(II) and chloride in a mixture.
11. Circular paper chromatographic separation of: (Demonstration)
    a. Iron and nickel
    b. Copper and nickel

References

1. Vogel's Text Book of Quantitative Chemical Analysis – 5th edition, J. Basset, R.C. Denney, G.H. Jeffery and J. Mendhom.
2. A Text Book of Quantitative Inorganic Analysis by A.I. Vogel, 3rd edition.
3. Spectrophotometric Determination of Elements by Z. Marczenko.

FIRST SEMESTER

Chem-HC-O-T-1.3 **STEREOCHEMISTRY AND REACTION MECHANISMS**

UNIT – I: STEREOCHEMISTRY

Stereoisomerism: Projection formulae [flywedge, Fischer, Newman and sawhorse], enantiomers, diasteroisomers, mesomers, racemic mixture and their resolution, configurational notations of simple molecules, *DL* and *RS* configurational notations.

Stereoselectivity: Meaning and examples of stereoselective reactions, diastereoselective reactions, stereospecific reactions, regioselective, regiospecific reactions, enantioselective reactions and enantiospecific reactions.

Optical isomerism: Conditions for optical isomerism: Elements of symmetry-plane of symmetry centre of symmetry, alternating axis of xymmetry (rotation-reflection symmetry). Optical isomerism due to chiral centers and molecular dissymmetry, allenes and biphenyls, criteria for optical purity.

Geometrical isomerism: Due to C=C, C=N and N=N bonds, E, Z conventions, determination of configuration by physical and chemical methods. Geometrical isomerism in cyclic systems.

Conformational analysis: Elementary account of conformational equilibria of ethane, butane and cyclohexane. Conformation of cyclic compounds such as cyclopentane, cyclohexane, cyclohexanone derivatives and decalins. Conformational analysis of 1,2-, 1,3- and 1,4-disubstituted cyclohexane derivatives and *D*-Glucose, Effect of conformation on the course andrate of reactions.

UNIT – II: REACTION MECHANISM-I

Structure and reactivity: Brief discussion on effects of hydrogen bonding, resonance, inductive and hyperconjugation on strengths of acids and bases.

Methods of determining organic reaction mechanism: Thermodynamic and kinetic requirements for reactions, kinetic and thermodynamic control. Hammonds postulates and Curtin-Hammett principle.

Identification of products. Formation, structure, stability, detection and reactions of carbocations (classical and non-classical), carbanions, free radicals, carbenes, nitrenes, nitrile oxides, nitrile imines, nitrile ylides and arynes. Determination of reaction intermediates, isotope labeling and effects of cross over experiments. Mechanism of ester hydrolysis. Kinetic and stereochemical evidence, solvent effect. Linear free energy relationship-Hammet equation and Taft treatment.

UNIT – III: REACTION MECHANISM-II

Basics of organic reactions: Meaning and importance of reaction mechanism, classification and examples for each class.

Aliphatic substitution reaction:

Nucleophilic substitution reactions: Kinetics, mechanism and stereochemical factors affecting the rate of $S_N1, S_N2, S_Ni, S_N1', S_N2'$ and S_Ni' reactions, Neighbouring group participation.

Electrophilic substitution reactions:

Aromatic substitution reactions:

Nucleophilic substitution reactions: S_N1, S_N2 and benzyne mechanism, Bucherer reaction.

Electrophilic substitution reactions: Mechanism of nitration, halogenation, sulphonation, Friedel-Crafts alkylation and acylation, Mannich reaction, chloromethylation, Vilsmeier-Haack reaction.

Mechanism of Addition reactions: Addition to C-C multiple bonds involving electrophiles, nucleophiles. Markownikoff's rule and anti-Markownikoff's rule.

Additions to carbonyl compounds: Addition of water, alcohol, bisulphate, HCN and amino compounds.

Mechanism of hydrolysis of carboxylic acid derivatives: Hydrolysis of esters, amides and acid chlorides.

Elimination reactions: Mechanism and stereochemistry of eliminations - E_1, E_2, E_1cB. *cis* elimination, Hofmann and Saytzeff eliminations, competition between elimination and substitution, decarboxylation reactions. Chugaev reaction.

References:

1. Organic Chemistry by Morrison and Boyd.
2. H. Pine, Hendrickson, Cram and Hammond, Organic Chemistry, Mc Graw Hill, New York, 1987.
3. I.L. Finar, Organic Chemistry, ELBS Longmann, Vol. I & II, 1984.
4. E.L. Eliel and S.H. Wilen, Stereochemistry of Organic Compounds, John Wiley and Sons, New York. 1994.
5. Basic Principles of Organic Chemistry by Roberts & Caserio
6. N.S. Issacs, Reactive Intermediates in Organic Chemistry, John Wiley and Sons, New York.1974.
7. R.K. Bansal, Organic Reaction Mechanism, Wiley Eastern Limited, New Delhi, 1993.

8. J. March, Advanced Organic Chemistry, Wiley Interscience, 1994.
9. A Guide Book to Mechanism in Organic Chemistry by Petersykes
10. Stereochemistry and Mechanism through Solved Problems by P.S. Kalsi.
11. Text book of Organic Chemistry by P.S. Kalsi.
12. F.A. Carey and Sundberg, Advanced Organic Chemistry – Part A & B, 3rd edition, Plenum Press, New York, 1990.
13. S.K. Ghosh, Advanced General Organic Chemistry, Book and Alleied (P) Ltd, 1998.
14. Organic chemistry, Gram Solomons.

FIRST SEMESTER

Chem-HC-O-P-1.3 ORGANIC CHEMISTRY PRACTICALS-I

1. Preparation of *p*-nitro aniline from acetanilide.
2. Preparation of n-butyl bromide from n-butanol.
3. Preparation of *p*-nitroiodobenzene from paranitroaniline.
4. Preparation of aniline from nitrobenzene.
5. Preparation of ß-*D*-glucose penta acetate.
6. Preparation of phenoxy acetic acid.
7. Preparation of cyclohexanone from cyclohexanol.
8. Preparation of chalcone.
9. Preparation of *S*-benzylthiouronium chloride.
10. Diels-Alder reaction of anthracene and maleic anhydride.
11. Preparation of m-nitrobenzoic acid from methyl benzoate.

References:

1. Manual of Organic Chemistry - Dey and Seetharaman.
2. Modern Experimental Organic Chemistry by John H. Miller and E.F. Neugil, p 289.
3. An Introduction to Practical Organic Chemistry - Robert, Wingrove etc.
4. A Text Book of Practical Organic Chemistry – A.I. Vogel, Vol.III
5. Practical Organic Chemistry - Mann & Saunders
6. Semimicro Qualitative Organic Analysis by Cheronis, Entrikin and Hodnet .
7. R.K. Bansal, Laboratory Manual of Organic Chemistry, New Age International (P) Ltd. London, 3rd edition, 1996.

FIRST SEMESTER

Chem-HC-P-T-1.4 Chemical Thermodynamiccs, Kinetics and Electrochemistry

UNIT – I :

Chemical Thermodynamics : A brief resume of laws of thermodynamics (combined form of 1st and 2nd laws), entropy as a measure of unavailable energy, Concept of fugacity and free energy, entropy and free energy changes and spontaneity of processes. Variation of free energy with T & P, Maxwell's relations, thermodynamics equations of state,

limitations of Van't Hoff`s equation, Nernst heat theorem & its applications.Third law of thermodynamics, determination.of third law of entropies.
Application of thermodynamics : Entropy and free energy of mixing, partial molar quantities, partial molar volume and free energy (chemical potential), their significance and determinations (slope and intercept methods). Gibbs-Duhem and Duham-Margules equations.

Thermodynamics of non-ideal solutions -Activity, activity coefficient-effect of temperature and pressure, determination by vapour pressure, cryoscopic and conductivity methods
Thermodynamics of ideal solutions - deductions of laws of Raoult ebullioscopy, cryoscopy and osmotic pressure. Quantitative treatment of Le-Chatelier principle.

Phase Rule:Application to 3-component systems. An introduction to 4-component system.

UNIT- II :
Chemical Kinetics: Determination of order of reactions, **c**omplex reactions- parallel, consecutive and reversible reactions. Chain reactions - Branched chain reactions- general rate expression, explosion limits. Oscillatory reactions.

Theories of reaction rates: Collision theory and its limitations, Activated complex theory (postulates -derivation) and its applications to reactions in solution. Energy of activation, other activation parameters-determinations and their significance. Lindemann theory of unimolecular rections. Qualitative account of its modifications (no derivation).

Potential energy surfaces – Features & construction of them. Theoretical calculation of Ea.

Kinetic Isotope Effect: Theory of kinetic isotope effect - normal and inverse isotope effect, primary isotope effect, secondary isotope effect, solvent isotope effect.

Fast reactions- Study of fast reactions by continuous and stopped flow techniques, relaxation methods (T-jump and P-jump methods), flash photolysis, pulse and shock tube methods.

Reactions in solution: Ionic reactions - salt and solvent effects. Effect of pressure on the rates of reactions.

UNIT-III :
Electrochemistry of solutions: Ionic atmosphere, factor effecting conductance, Debye-Huckel-Onsager equation of conductivity and its validity. Walden`s rule and its application. Debye-Huckel theory - concept of Ionic strength, Debye-Huckel limiting law (DHL), its modification for appreciable concentrations.

A brief survey of Helmholtz-Perrin, Guoy-Chapmaan and Stern electrical double layer (no derivation).
Determination of transference number by emf and Hittorf's methods. Liquid junction potential. True and apparent transference numbers (TrN). Abnormal TrN, effect of temperature on TrN.

Irrversible electrode process: Introduction, reversible and irreversible electrodes, reversible and irreversible cells. Polarization, over voltage - ohmic over voltage, concentration over voltage activation over voltage, experimental determination of over voltage. Equations for concentration over potential, diffusion current – stationary current, potential curves, thickness of diffusion layer, diffusion controlled current – potential curves at a dropping mercury electrode, polarography, half wave potential, application in qualitative and quantitative analysis. Energy barrier and electrode kinetics, Butler-Volmer equation, Tafel equation. Hydrogen over voltage and Oxygen over voltage. Effect of temperature, current density and *p*H on over voltage.

REFERENCES :

1. Physical Chemistry, 5th Ed., - Atkins (ELBS) 1995.
2. Physical chemistry – G. M. Barrow (McGraw Hill, Int. St. Ed) 1988.
3. Fundamentals of Physical Chemistry – Maron and Lando (Collier Macmillan) 1974.
4. Thermodynamics for Chemists - S. Glasstone (East-west) 1973.
5. Themodynamics - Rajaram and Kuriokose (East-West) 1986.
6. Chemical Kinetics - K.J.Laidler (Harper and Row) 1987.
7. Principles and Applications of Electrochemistry–Crow (Chapman hall, London) 1988
8. Thermodynamics for Chemists by S. Glasstone, Affiliated East-West, New Delhi, (1965).
9. Chemical Thermodynamics by I.M. Klotz, W.A. Benzamin Inc. New York (1964).
10. Basic Physical Chemistry by W.J. Moore, Prentice Hall, New Delhi (1986).
11. Text Book of Physical Chemistry by Samuel Glasstone, MacMillan Indian 2nd ed. (1974).
12. Theoretical Chemistry by S. Glasstone.
13. Elements of Physical Chemistry by Lewis and Glasstone.
14. Chemical Kinetics by Frost and Pearson.
15. Kinetics and Mechanism of Chemical Transformation by J. Rajaram and J.C. Kuriacose.
16. Chemical Kinetics by L.K. Jain.

17. Kinetics in Analytical Chemistry by H.B. Mark and G.A. Rechnitz, Wiley Interscience Publishers, John Wiley and Sons, New York.
18. Introduction to Electrochemistry by S. Glasstone.
19. Advances in Photochemistry - Rohatgi Mukherjee.
20. Principle and Applications of Photochemistry by R.P. Wayne, Elsevier, New York, (1970).
21. Treatise on Electrochemistry, G. Kortum, 2 nd ed. Elsevier, London (1965)

FIRST SEMESTER

Chem-HC-P-P-1.4 **PHYSICAL PRACTICALS - I**

1. Study of kinetics of hydrolysis of an ester using HCl/H_2SO_4 at two different temperatures,
determination of rate constants and energy of activation.
2. Study of kinetics of reaction between $K_2S_2O_8$ and KI, first order, determination of rate constants at two different temperatures and E_a.
3. Conductometric titration of a mixture of HCl and CH_3COOH against NaOH.
4. Conductometric titration of a mixture of HCl, CH_3COOH and $CuSO_4$ against NaOH.
5. Potentiometric titration of KI vs $KMnO_4$ solution.
6. Determination of dissociation constant of a weak acid by potentiometric method.
7. Potentiometric titration of $AgNO_3$ vs KCl.
8. To obtain the absorption spectra of coloured complexes, verification of Beer's law and estimation of metal ions in solution using a spectrophotometer.
9. Spectrophotometric titration of $FeSO_4$ against $KMnO_4$.
10. Determination of heat of solution of benzoic acid by variable temperature method (graphical method).
11. Thermometric titration of hydrochloric acid with a NaOH.
12. Determination of molecular weight of a compound using Bekmann's cryoscopic method
using benzene or/and water as solvent.
13. Potentiometric titrations of (a) Fe(II) vs V(V).
14. Kinetics of photodegradation of indigocarmine (IC) using TiO_2 as photocatalyst and study the effect of [TiO_2] and [IC] on the rate of photo degradation.
15. Conductometry –To determine the degree of hydrolysis and hydrolysis constant of aniline
hydrochloride.
16. Conductometric titration of potassium iodide with mercuric perchlorate.
17. Determination of the molecular weight of a polymer material by viscosity measurements
(cellulose acetate/methyl acrylate).

FIRST SEMESTER
CHEM-SC-T-1.1 MOLECULAR SPECTROSCOPY- I

UNIT – I : Symmetry and Group Theory

Definitions of group, subgroup, relation between orders of a finite group and its subgroup. Conjugacy relation and classes, symmetry elements and symmetry operations, Schonflies symbols, Matrix representations of symmetry operations, products of symmetry operations, some properties of matrices and vectors, classification of molecules into point groups. Reducible and irreducible representations. The Great Orthogonality theorem (without proof), character tables. The direct product. Applications of group theory - Molecular vibrations, group theoretical selection rules for electronic transitions, for infra red and Raman spectra. Hybrid orbitals and Molecular orbitals, transformation properties of atomic orbitals.

Microwave Spectroscopy- The rotation and classification of molecules, rotation spectra of diatomic and polyatomic molecules. Rigid and non-rigid rotator models. Determination of bond lengths, isotope effect on rotation spectra. Stark effect, nuclear and electron spin interaction. Microwave Spectrometer.

Vibrational Spectroscopy: Vibration spectra of diatomic molecules - linear harmonic oscillator, vibrational energies, zero point energy, force constants & bond strengths; anharmonicity of molecular vibrations- Morse PE diagram, selection rules, fundamental, overtones and hot bands. Vibrations of polyatomic molecules- normal modes of vibrations & nature of molecular vibrations (Ex-CO_2 & H_2O).

UNIT-II

Vibration-rotation spectra of diatomic and polyatomic molecules, selection rules, PQR branches. IR Spectrophotometer-Instrumentation, sample handling techniques, FTIR Spectroscopy. Far IR region - metal-ligand vibrations, normal co-ordinate analysis.

Raman Spectroscopy: Classical and quantum theories of Raman effect, concept of polarizability and polarizability ellipsoid. Rotational and vibrational Raman spectra, selection rules, Raman activity of vibrations, vibrational - rotational Raman spectra, selection rules, mutual exclusion principle, polarization of Raman lines. An introduction to Laser Raman Spectroscopy. Raman Spectrometer – instrumentation. Applications of IR and Raman spectroscopy in elucidation of molecular structure (Ex - H_2O, N_2O & CO_2 molecules). An introduction to Resonance Raman Spectroscopy.

Application of infrared spectroscopy in the structural study-identity by fingerprinting and identification of functional groups. Characteristic vibrational frequencies of common functional groups (alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines). Study of vibrational frequencies of carbonyl compounds (ketones,

aldehydes, esters, amides and acids). Factors affecting band positions and intensities such as effect of hydrogen bonding, phase and solvent on vibrational frequencies, overtones, combination bands and Fermi resonance.

UNIT – III

UV-VIS Spectroscopy (outer shell electronic spectroscopy): Quantitative aspects of Absorption -Beer's law. Terminology associated with absorption measurements. Limitation of the law: Real, chemical, instrumental and personal. Theory of molecular absorption. Vibration, rotation, fine structure of electronic spectra. Types of absorption bands: n toπ^*, $\pi$to π^*, n to σ^* , $\sigma$to σ^*,

C-T & ligand field. Empirical rules for predicting the wavelength of maximum absorption: Olefins, conjugated dienes, cyclic trienes and polyenes -α, β-unsaturated aldehydes

and ketones - benzene and substituted benzene rings. Basic components of instrumentation, single and double beam designs. Applications: Qualitative and quantitative analysis of binary mixtures, measurement of dissociation constants of acids and bases, determination of molecular weight, photometric titrations, determination of stoichiometry and stability of the complexes and kinetic studies.

Photoelectron spectroscopy: Basic principles, valence &core binding energies, shifts in energies due to chemical forces, Photoelectron spectra of simple molecules, Auger transitions, measurement techniques. Applications.

Polarimetry: Plane polarized light, instrumentation, acid-catalyzed muta rotation of glucose, inversing of cane sugar-relative strengths of acids. Optical rotatory dispersion &circular dichroism–introduction, selection rules, deduction of absolute configuration, octant rule for ketones and cotton effect.

REFERENCES:

1. Fundamentals of Molecular Spectroscopy, Banwell & McCash (Tata McGraw

Hill)2001.

2. Organic Spectroscopy-3rd ed.-W.Kemp (Pagrave Publishers, New York), 1991.
3. Spectrometric Identification of Organic Compounds - Silverstein, Bassler&Monnill (Wiley) 1981.

FIRST SEMESTER

CHEM-SC-T-1.2 **MOLECULAR SPECTROSCOPY-II**

UNIT - I :

NMR Spectroscopy: Magnetic properties of nuclei (magnetic moment, g factor, nuclear spin), effect of external magnetic field on spinning nuclei, Larmor precession frequency, resonance conditions, population of nuclear magnetic energy levels, relaxation processes, relaxation time, line width and other factors affecting line width.

Chemical Shift: Standards employed in NMR, factors influencing chemical shift: electronegativity, shielding and deshielding, vander Walls deshielding magnetic anisotropy, H-bonding, diamagnetic and paramagnetic anisotropies, spin-spin coupling, chemical shift values and correlation for protons bonded to carbon and other nuclei, Instrumentation.

Chemical shift equivalence and magnetic equivalence, proton exreactions, effects of chiral centre, stereochemistry-hindered rotation, karplus curve-variation of coupling constants with dihedral angle.

Complex NMR Spectra: Simplification of complex spectra-isotopic substitution, increased magnetic field strength, double resonance and lanthanide shift reagents;, Nuclear Overhauser Effect (NOE), variable temperature probe, FT-NMR Spectroscopy and advantages.

^{13}C-NMR Spectroscopy: Comparison of 1H-NMR and 13C-NMR, multiplicity-Proton decoupling-Noise decoupling-Off resonance decoupling-Selective proton decoupling-Chemical shift, application of CMR.

NMR of ^{19}F, ^{31}P, ^{11}B and ^{15}N

Applications of NMR: Structural diagnosis, conformational nalysis, keto-enol tautomerism, Hbonding.

Two dimensional NMR Spectroscopy: COSY, NOESY, INDOR, SPI, DEPT Spectra, CIDNP

technique, MRI.

UNIT – II

Electron Spin Resonance Spectroscopy: Basic principles, hyperfine couplings, the 'g' values, factors affecting 'g' values, isotropic and anisotropic hyperfine coupling constants, Zero Field splitting and Kramer's degeneracy. Measurement techniques and Applications to simple inorganic and organic free radicals and to inorganic complexes.

NQR Spectroscopy: Quadrupolar nuclei, electric field gradient, nuclear quadrupole coupling constants, energies of quadrupolar transitions, effect of magnetic field. Applications.

Mössbauer spectroscopy: The Mössbauer effect, chemical isomer shifts, quadrupole interactions, measurement techniques and spectrum display, application to the study of Fe^{2+} and Fe^{3+} compounds, Sn^{2+} and Sn^{4+} compounds(nature of M-L bond, coordination number and structure), detection of oxidation states and inequivalent Mössbauer atoms.

UNIT – III

Mass Spectrometry: Basic principles, Instrumentation -Mass spectrometer, interpretation of mass spectra, resolution, exact masses of nucleides, molecular ions, meta-stable ions and isotope ions. Fragmentation processes-representation of fragmentation, basic fragmentation types and rules. Factors influencing fragmentations and reaction pathways. McLafferty rearrangement. Fragmentations (fragmentation of organic compounds with respect to their structure determination) associated with functional groups- alkanes, alkenes, cycloalkanes, aromatic hydrocarbons, halides, alcohols, phenols, ethers, acetals, ketals, aldehydes, ketones, quinines, carboxylic acids, esters, amides, acid chlorides, nitrocompounds, amines & nitrogen heterocycles. Fragmentation patterns of carbohydrates, terpenoids, alkaloids, steroids, peptides & proteins-some representative examples, ion analysis, ion abundance, retro Diels-Alder fragmentation. Application in structure elucidiation and evaluation of heats of sublimation & ionization potential. Nitrogen rule. High resolution mass spectroscopy.
Composite problems involving the applications of UV, IR, ^{1}H and ^{13}C NMR and mass spectroscopic techniques. Structural elucidation of organic molecules.

REFERENCES:

1. Fundamentals of Molecular Spectroscopy, Banwell & McCash (Tata McGraw Hill)2001.

2. Organic Spectroscopy-3rd Ed.-W.Kemp(Pagrave Publishers, New York), 1991.

3. Spectrometric Identification of Organic Compounds - Silverstein,Bassler & Monnill (Wiley)1981.

4. Applications of Absorption Spectroscopy of Organic Compounds-Dyer (Prentice Hall, NY) 1965.

5. Spectroscopy of Organic Compounds-3rd Ed.-P.S.Kalsi (New Age, New Delhi) 2000.

6. E.A.V.Ebsworth, D.W.H.Ranklin and S.Cradock: Structural Methods in Inorganic Chemistry, Blackwell Scientific, 1991.

7. R.S.Drago: Physical Methods for Chemists, Saunders College Publishing, 1992.

8. D.N.Satyanarayana: ElectronicAbsorption Spectroscopy and Related Techniques,

9. G.Aruldhas, Molecular Structure and Spectroscopy, Prentice Hall, 2001

10. J. A. Iggo: NMR Spectroscopy in Inorganic Chemistry, Oxford University Press, 1999.

11. C.N.R.Rao and J.R. Ferraro: Spectroscopy in Inorganic Chemistry, Vol I&II(Academic)1970

12. Analytical Chemistry-Open Learning : Mass spectrometry.

13. Spectroscopic Methods in Organic Chemistry - Williams and Fleming, TMH.

14. Spectroscopy, B. P. Straughan and S. Salker, John Wiley and Sons Inc., New Yourk, Vol.2, 1976.

15. Application of Absorption Spectroscopy of Organic Compounds, John R. Dyer, Prentice/Hall of India Private Limited, New Delhi, 1974.
16. Organic Spectroscopy, V. R. Dani, Tata MeGraw-Hall Publishing Company Limited, New
Delhi. 1995.
17. Interpretation of Carbon-13 NMR Spectra, F.W. Wehrli and T. Wirthin, Heyden, London,
1976.
18. NMR spectroscopy-Powai

SECOND SEMESTER

Chem-HC-A-T-2.1 **SEPARATION TECHNIQUES**

UNIT – I

Chromatography: Definition, principles and mechanism of separation, classification of chromatographic techniques. General descriptions of column chromatography - frontal analysis, displacement analysis and elution analysis. General theory of column chromatography: characterizing a chromatogram - retention time, retention volume and baseline width. Chromatographic resolution, capacity factor, column selectivity. Column efficiency - band broadening - rate theory and plate theory. Peak capacity, non ideal behavior. Optimizing chromatographic separations using capacity factor, column selectivity and column efficiency - Van Deemter equation, and its modern versions, Golay equation and Huber-Knox equations.

Gas chromatography (GC): Principles, instrumentation - mobile phase, chromatographic columns, stationary phases, sample introduction, temperature control, and detectors for gas chromatography. Quantitative and qualitative applications.

High performance liquid chromatography (HPLC): Principles, instrumentation - columns (analytical and guard columns), stationary phases, mobile phases, choosing a mobile phase, isocratic *vs* gradient elution, HPLC plumbing, sample introduction. Detectors for HPLC - spectroscopic, electrochemical and others, quantitative applications.

UNIT – II

Ion exchange chromatography (IEC): Definitions, requirements for ion-exchange resin, synthesis and types of ion-exchange resins, principle, basic features of ion-exchange reactions, resin-properties-ion-exchange capacity, resin selectivity and factors affecting the selectivity, applications of IEC in preparative, purification and recovery processes. IEC with eluent suppressor columns. Single Column Ion Chromatography.

Size-exclusion chromatography: Theory and principle of size-exclusion chromatography, experimental techniques of gel-filtration chromatography (GFC) and gel-permeation chromatography (GPC), materials for packing - factors governing column efficiency, methodology and applications.

Thin layer chromatography: Principle, apparatus and methodology, applications, HPTLC

Affinity chromatography: Definitions, separation-mechanism-matrices, matrix activation, role of spacer arms and applications.

Supercritical fluid chromatography (SFC): Properties of supercritical fluids, instrumentation and operating variables, comparison of SFC with other types of chromatography, applications.

Supercritical fluid extraction: Advantages of supercritical fluid extraction, instrumentation, supercritical fluid choice, off-line and on-line extractions, typical applications of supercritical fluid extraction.

UNIT – III

Electrophoretic methods - Electrophoresis & Capillary Electrophoresis**:** Theory **-** electrophoretic mobility, electroosmotic mobility, electroosmotic flow velocity, total mobility, migration time, efficiency, selectivity and resolution. Instrumentation - capillary tubes, hydrodynamic and electrokinetic methods of sample injection, applying electric field and detectors. Capillary electrophoresis methods - capillary zone electrophoresis, micellar electrokinetic capillary chromatography, capillary gel electrophoresis and capillary electrochromatography.

Solvent extraction: Theory - Nernst partition law, efficiency and selectivity of extraction.

Extraction systems: Extraction of covalent neutral molecules, extraction of uncharged metal chelates and synergic extraction, extraction of ion-association complexes - non chelated complexes, chelated complexes and oxonium systems. Use of salting out agents. Methods of extraction - batch and continuous extractions. applications.

Solid Phase Extraction (SPE): Principles, apparatus and instrumentation. Solid phase sorbents, extraction formats - Automated solid phase extraction. Solid phase micro extraction (SPME). Applications of SPE and SPME.

References:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 6th edition, 2004 John Wiley & Sons, Inc. India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 Prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003 Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. Introduction to Instrumental Analysis, Robert. D. Braun, Pharm. Med. Prem. India, 1987.
7. Instrumental Method of Analysis, W.M. Dean and Settle, 7th edition, 1986, CBS Publishers, New Delhi.
8. Instant Notes of Analytical Chemistry, Kealey and Haines, Viva Books Pvt. Ltd., 2002.
9. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.
10. Principles and Practice of Analytical Chemistry, F. W. Fifield and Kealey, 5th edition, 2000, Blackwell Sci., Ltd. Malden, USA.

SECOND SEMESTER

Chem-HC-A-P-2.1 ANALYTICAL CHEMISTRY PRACTICALS-II

1. Determination of percentage of chloride in a sample by precipitation titration - Mohr, Volhard and Fajan's methods.
2. Determination of silver in an alloy and Na_2CO_3 in soda ash by Volhard method.
3. Mercurimetric determination of blood or urinary chloride.
4. Determination of total hardness, calcium and magnesium hardness and carbonate and bicarbonate hardness of water by complexation titration using EDTA.
5. Determination of calcium in calcium gluconate/calcium carbonate tablets/injections and of calcium in milk powder by EDTA titration.
6. Analysis of commercial hypochlorite and peroxide solution by iodometric titration.
7. Determination of copper in an ore/an alloy by iodometry and tin in stibnite by iodimetry.
8. Determination of ascorbic acid in vitamin C tablets by titrations with $KBrO_3$ and of vitamin C in citrus fruit juice by iodimetric titration.
9. Determination of iron in razor blade by visual and potentiometric titration using sodium metavanadate.
10. Determination of iron in pharmaceuticals by visual and potentiometric titration using cerium(IV) sulphate.
11. Determination of nickel in steel by synergic extraction and boron in river water/sewage using ferroin.
12. Determination of total cation concentration of tap water by ion-exchange chromatography.
13. Determination of magnesium in milk of magnesium tablets by ion-exchange chromatography.
14. Cation exchange chromatographic separation of cadmium and zinc and their estimation by EDTA titration.
15. Gas chromatographic determination of ethanol in beverages.
16. Determination of aspirin, phenacetin and caffeine in a mixture by HPLC.

17. Solvent extraction of zinc and its spectrophotometric determination.

18. Anion exchange chromatographic separation of zinc and magnesium followed by EDTA titration of the metals.

19. Separation and determination of chloride and bromide on an anion exchanger.

20. Thin layer chromatographic separation of amino acids.

References:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 6th edition, 2004 John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993, Prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.

SECOND SEMESTER

Chem-HC-I-T-2.2 COORDINATION CHEMISTRY

UNIT – I

Preparation of coordination compounds: Introduction, Preparative methods - simple addition reactions, substitution reactions, oxidation-reduction reactions, thermal dissociation reactions, reactions of coordinated ligands, the trans-effect, other methods. **Stability constants of coordination compounds:** Introduction, Trends in stepwise and overall stability constants, Factors influencing the stability of complexes, Irving-William series, Macrocyclic effect, Theoretical aspects of determination of stability constants by spectrophotometric, pH and polarographic methods.

Crystal field theory: Salient features of CFT, d-orbital splitting in octahedral, tetrahedral, square planar and tetragonal fields, Strong and weak field complexes, Jahn-Teller distortions, Factors affecting10 Dq, Evidences for metal-ligand covalency, Ligand Field Theory. Geometries of complexes of coordination number 4 to10.

UNIT – II

Molecular Orbital Theory: MO theory of octahedral, tetrahedral and square planar complexes with sigma (and pi) bonding, Dq from MO energy diagrams.

Electronic spectra: Introduction, selection rules and intensities, Electronic spectra of octahedral and tetrahedral complexes, Term symbols for d^n ions, d-d transitions, Orgel and Tanabe-Sugano diagrams, Charge-transfer spectra, Spectrochemical and Nephelauxetic series, Factors affecting 10 Dq, Calculation 10 Dq and Racah parameter(B).

Magnetic properties: Introduction, Diamagnetism, Paramaganetism, Ferromagnetism, Antiferromagnetism and Ferrimagnetism, Magnetic susceptibility and its measurements (Gouy and Faraday methods), Spin and orbital contributions to the magnetic moment, Effect of temperature, Spin-cross over systems.

UNIT - III

Reaction and Mechanisms: Introduction, Substitution reactions - Inert and labile compounds, mechanisms of substitution,

Kinetic consequences of Reaction pathways - Dissociation, interchange and association, Experimental evidence in octahedral substitution - Dissociation, associative mechanisms, the conjugate base mechanism, the kinetic chelate effect.

Stereochemistry of reactions- Substitution in *trans* and *cis* complexes, Isomerization of chelate rings.

Substitution reactions of square-planar complexes - Kinetics and stereochemistry of square-planar substitutions, Evidence for associative reactions, Explanations of the *trans* effect.

Electron-transfer processes: Inner-sphere and outer-sphere mechanism.

Metal-metal bonding: Factors favoring M-M bonding, Wade-Mingo-Lauher rules, Polynuclear metal clusters (bi through hexa.)

References

1. Physical Inorganic Chemistry - A Coordination Chemistry Approach- S.F.A. Kettle, Spektrum, Oxford, (1996).
2. Inorganic Chemistry - 2nd edition, C.E. Housecroft and A.G. Sharpe, Pearson Education Ltd., (2005).

3. Inorganic Chemistry - 3rd edition, G.L. Miessler and D.A. Tarr, Pearson Education, (2004).
4. Inorganic Chemistry - 2nd edition, D.F. Shriver, P.W. Atkins and C.H. Langford, Oxford University Press, (1994).
5. Inorganic Chemistry- 3rd edition, James E. Huheey, Harper and Row Publishers, (1983).
6. Basic Inorganic Chemistry- 3rd edition, F.A. Cotton, G. Wilkinson and P.L. Gaus, John Wiley and Sons, (2002).
7. Concise Coordination Chemistry, R.Gopalan and Ramalingam.

SECOND SEMESTER

Chem-HC-I-P-2.2 INORGANIC CHEMISTRY PRACTICALS-II

Semimicro qualitative analysis of mixtures containing **TWO** anions and **TWO** cations (excluding sodium, potassium and ammonium cations) and **ONE** of the following less common cations: W, Mo, Ce, Th, Ti, Zr, V, U and Li.

References

1. Vogel's Qualitative Inorganic Analysis – Svelha.
2. Macro and Semimicro Inorganic Qualitative Analysis by A.I. Vogel.
3. Semimicro Qualitative Analysis by F.J. Welcher and R.B. Halin.
4. Quantitative Chemical Analysis by Daniel C. Harris, 7th edition, (2006).

SECOND SEMESTER

Chem-HC-O-T-2.3 REAGENTS IN ORGANIC SYNTHESIS AND ORGANOMETALLIC CHEMISTRY

UNIT – I: OXIDATION AND REDUCTION

Oxidation: Oxidation with chromium and manganese reagents (CrO_3, $K_2Cr_2O_7$, PCC, PDC, Sarret reagent, Jones reagent, MnO_2, $KMnO_4$), oxygen (singlet and triplet), ozone, peroxides and peracids, lead tetraacetate, periodic acid, OsO_4, SeO_2, NBS, chloramine-T, Sommelet oxidation, Oppenauer oxidation, Fenton's reagent, Sharpless epoxidation.

Reductions: Catalytic hydrogenation (homogeneous and heterogeneous) – catalysts (Pt, Pd, Ra-C, Ni, Ru, Rh), solvents and reduction of functional groups, catalytic hydrogen transfer reactions. Wilkinson catalyst, $LiAlH_4$, $NaBH_4$, DIBAL-H, Sodium cyanoborohydride, dissolving metal reactions (Birch reduction). Leukart reaction

(reductive amination), diborane as reducing agent, Meerwein-Ponndorf-Verley reduction, Wolff-Kishner reduction, Clemensen reduction, tributyl tinhydride, stannous chloride, Bakers yeast,

Organoboron compounds: Introduction and preparations. Hydroboration and its applications. Reactions of organoboranes: isomerization reactions, oxidation, protonolysis, carbonylation, cyanidation. Reaction of nonallylic boron stabilized carbanions: alkylation reactions, acylation reaction, Reactions with aldehydes or ketones (*E* and *Z*-alkenes).

Palladium reagents: Suzuki coupling, Heck reaction, Negishi reaction.

UNIT – II: REAGENTS AND REACTIONS IN ORGANIC SYNTHESIS

Reagents in organic synthesis: Use of following reagents in organic synthesis and functional group transformations: Lithium diisopropylamide (LDA), Gilmann reagent, dicyclohexyl carbodimide (DCC), dichlorodicyanoquinone (DDQ), Silane reagents-trialkylsilyl halides, trimethylsilyl cyanide, trimethyl silane, TBDMS, phase transfer catalyst, crown ethers, cyclodextrins, Ziegler-Natta catalyst, diazomethane, Woodward and Prevost hydroxylation, Stark enamine reaction, phosphorous ylides - Wittig and related reactions, sulphur ylides – reactions with aldehydes and ketones, 1,3-dithiane anions - Umpolung reaction, Peterson reaction.

Functional group transformations: Nitro to keto group (Neff reaction), alcohol to aldehyde.

UNIT – III: CHEMISTRY OF ORGANOMETALLIC COMPOUNDS

Chemistry of organometallic compounds: Synthesis and reactions of organolithium (n-BuLi, PhLi}, organocadmium, organomagnesium (Grignard reagent), organomanganese, organoselenium and organotellurium.

Organoaluminium reagents: Preparation, site selective and stereoselctive additions of nucleophiles mediated by organoaluminum reagents, reaction with acid chlorides, allyl vinyl ethers, 1,2-addition to imines and application in the synthesis of natural products.

Organocopper reagents: Gilman reagent, preparation, reactions with aldehydes, ketones and imines. Application in the synthesis of brevicomin,

Organozinc reagents: Preparation - oxidative addition and transmetallation, addition reactions of alkyl, aryl, allylic and propargylic zinc reagents, diastereoselective and enantioselective addition reaction with aldehydes, Reformatsky reaction.

Organosamarium reagents: Reactions promoted by samarium diiodide and dicyclopentadienyl samarium – Barbier type reaction, Reformatsky type reactions, ketyl-alkene coupling reactions, pinacolic coupling reactions, acyl anion reactions.

Organotin reagents: tributyltin hydride, Barton decarboxylation reaction, Barton deoxygenation reaction, Stille coupling, Stille-Kelley coupling reactions, Barton McCombie reaction, Keck stereoselective allylation and other applications.

References:

1. H. Pine, Hendrickson, Cram and Hammond, Organic Chemistry, Mac Grow Hill, New York, 1987.
2. Organic Chemistry - Morrison and Boyd
3. Organic Chemistry- Crabtree
4. Organic Chemistry- Clayden
5. I.L. Finar, Organic Chemistry, ELBS Longmann, Vol. 1 & II, 1984.
6. J. March, Advanced Organic Chemistry, Wiley Interscience, 1994.
7. E.S. Gould, Mechanism and Structure in Organic Chemistry, Halt, Rinhart & Winston, New York, 1964.
8. F.A. Carey and Sundberg. Advanced Organic Chemistry – Part A & B, 3rd edition, Plenum Press, New York. 1990.
9. Principles of Organic Synthesis - ROC Norman and Coxon.
10. S.K. Ghosh, Advanced General Organic Chemistry, Book and Allied (P) Ltd. 1998.

SECOND SEMESTER

Chem-HC-O-P-2.3 ORGANIC CHEMISTRY PRACTICALS-II

Qualitative analysis: Separation of binary mixtures, identification of functional groups and preparation of suitable solid derivatives.

References:

1. Manual of Organic Chemistry - Dey and Seetharaman.
2. Modern Experimental Organic Chemistry by John H. Miller and E.F. Neugil, p 289.
3. An Introduction to Practical Organic Chemistry - Robert, Wingrove etc.
4. A Text Book of Practical Organic Chemistry – A.I. Vogel, Vol.III
5. Practical Organic Chemistry - Mann & Saunders
6. Semimicro Qualitative Organic Analysis by Cheronis, Entrikin and Hodnet .
7. R.K. Bansal, Laboratory Manual of Organic Chemistry, New Age International (P) Ltd. London, 3rd edition, 1996.

SECOND SEMESTER

Chem-HC-P-T-2.4 **Quantum Chemistry and Advanced Chemical Kinetics**

UNIT - I : Quantum Chemistry

A brief resume of black body radiation, and atomic spectra-Bohr's theory of hydrogen atom. Photoelectric and Compton effects, de-Broglie concept, uncertainty principle, operators (algebra of operators, commutative and non-commutative operators, linear operator, Laplacian operator, Hermitian operator-Hamiltonian operator, turn over rule. Wave equation for stretched strings, Schrodinger wave equation for particles, Eigen values and Eigen functions, postulates of quantum mechanics. Application of Schrodinger equation to a free particle and to a particle trapped in a potential field (one dimension and three dimensions). Degeneracy, Wave equation for H-atom, separation and solution of R, ϕ and θ equations. Application of Schrodinger equation to rigid rotator and harmonic oscillator. Quantum numbers and their characteristics, orbital diagrams.

Approximate methods – Necessity of approximate methods, perturbation method, the theory of perturbation method – first order and second order correction, application to He-atom (first order correction only) – calculation of first ionization potential and binding energy.

UNIT–II:

Variation theorem: statement and proof . Application of variation method to He atom, the structure of many electron systems/atoms (secular equations & determinants), Spin-orbit interaction, antisymmetry and Pauli exclusion principle. Angular momenta (commutations, relations, operators), Term symbols, Russell-Saunders terms and coupling schemes, Slater orbitals and SCF method for many electron systems.

Molecular wave functions: Born-Oppenheimer approximations. Covalent bond –valence bond and molecular orbital approaches with comparisons. MO theory applied to homonuclear and heteronuclear diatomics by LCAO methods, correlation diagrams, non-crossing rule.

Theory of directed valence-hybridization and geometry of molecules in terms of molecular orbitals (bond angle, dihedral angle), localised and delocalised molecular orbitals.

Conjugated and aromatic molecules: Huckel molecular orbital (HMO) theory of linear conjugated systems (ethane & allyl systems) and aromatic molecules (benzene as an example). Calculation of delocalization energies, bond order & charge density.

UNIT-III :

Homogenous Catalysis: Acid-Base catalysis, specific acid and base catalysis. General acid and base catalysis. Oxidation of amino acids and carbohydrates in pressence of acid and base catalysis. Acidity functions - Bronstead, Hückel, Hammett and Bunnett hypothesis.

Enzyme kinetics: Effect of substrate concentration (Michaelis Menton equation), Effect of pH, effect of catalysts and inhibitors (substrate, zeolite, Cr^{3+}, Fe^{2+} ZnO, U.V light),

effect of temperature. A brief kinetic and mechanistic applications of glucose oxidase in the oxidation of glucose.

Linear Free Energy Relationship: Hammett equation, Taft equation, Okemoto Brown equation and its application to oxidation of amino acids and aromatic amines. Swain-Scott and Edward equation. Winstein - Grunwald relationship. Isokinetic relationship and significance of isokinetic temperature, Exner criterion.

Pharmaco kinetics: Pharma concentration time curve, protein binding and drugs, drug dissolution rate, pharmacokinetics applied to one-component open model (calculation of elimination rate constant & metabolism constant). Bioavailability.and factors affecting it.

Mechanisms of surface reactions- kinetic effects of surface heterogeneity & interactions – surface inhibition and activation energies –reactions between two adsorbed molecules – surface exchange reactions –unimolecular and bimolecular reactions.

Micelles: Surface active agents-micellisation, hydrophobic interactions, critical micellar concentration (CMC), factors affecting the CMC of surfactants. Micellar catalysis.

REFERENCES :

1. Introductory Quantum Chemistry – A.K.Chandra (Tata McGraw Hill) 1994.
2. Introduction to Physical Organic Chemistry, R. D. Gilliom, Madison – Wesley, USA (1970).
3. Quantum Chemistry – Eyring, Walter and Kimball. John Wiley and Sons, Inc., New York.
4. Quantum Chemistry –I.N. Levine. Pearson Education, New Delhi, (2000).
5. Theoretical Chemistry – S. Glasstone. East West Press, New Delhi, (1973).
6. Quantum Chemistry – R.K. Prasad, New Age International Publishers, (1996).
7. Valence Theory – Tedder, Murel and Kettle.
8. Quantum Chemistry – D.A. McQuarrie.
9. Physical Organic Chemistry, Reaction Rate and Equilibrium Mechanism – L. P. Hammett, McGraw HillBook, Co., (1970).
10. Biophysical Chemistry, Principle and Technique – A. Upadhyay, K. Upadhyay and N. Nath, Himalaya Publishing House, Bombay, (1998).

SECOND SEMESTER

Chem-HC-P-P-2.4 PHYSICAL PRACTICALS - II

1. Analysis of a binary mixture (Gylcerol & Water) by measurement of refractive index.
2. Determination of degree of association of benzoic acid in benzene by distribution method.
3. Binary analysis of two miscible liquids by viscometric method (Ethanol & Water)
4. To study the salt effects on kinetics of reaction between $K_2S_2O_8$ and KI.
5. Study of kinetics of reaction between CAT and indigocarmine spectrophotometrically and determination of rate constant.
6. Determination of energy of activation for the bromide-bromate reaction.
7. Conductometric titration of sodium sulphate against barium chloride.

8. Determination of equivalent conductance at infinite dilution of a strong electrolyte(NaOH)
and verification of Onsager equation.
9. Determination of dissociation constant of a weak electrolyte (HCOOH) by conductivity
method.
10. Potentiometric titration of a mixture of halides (KCl+KBr) against $AgNO_3$.
11. pH titration of (a) (CH_3COOH+HCl) Vs NaOH (b) $CuSO_4$ Vs NaOH and determination of
Ka.
12. Determination of redox potential of Fe^{2+} ions by potentiometric method.
13. Determination of partial molar volume of (a) NaCl-H_2O systems.
14. G.M. Counter –determination of G.M. plateau and dead time.
15. Verification of inverse square law using gamma emitter.
16. Kinetics of acid hydrolysis of an ester and study of effect of dielectric constant of the medium (using CH_3OH).
17. Conductometric titration of formic acid/oxalic acid against NaOH and NH_4OH.
18. Conductometric titration of orthophosphoric acid against NaOH.
19. Determine the concentration of KI by potentiometrically by caliberation method.

REFERENCES

1. Practical Physical Chemistry – A.J. Findlay.
2. Experimental Physical Chemistry –F. Daniels et al.
3. Selected Experiments in Physical Chemistry – Latham.
4. Experiments in Physical Chemistry – James and Prichard.
5. Experiments in Physical Chemistry – Shoemaker.
6. Advanced Physico-Chemical Experiments –J. Rose.
7. Practical Physical Chemistry –S.R. Palit.
8. Experiments in Physical Chemistry – Yadav, Geol Publishing House.
9. Experiments in Physical Chemistry – Palmer.
10. Experiments in Chemistry –D.V. Jahagirdar, Himalaya Publishing House, Bombay, (1994).
11. Experimental Physical Chemistry –Das. R.C. and Behera B, Tata Mc Graw Hill.

NOTE:

1. Student who has taken chem-SC-T-1.1 in the first semester has to take chem-SC-T-1.2 in the second semester and vice versa.

THIRD SEMESTER

Chem-HC-A-T-3.1 INSTRUMENTAL METHODS OF ANALYSIS

UNIT – I

Flame photometry and Atomic absorption spectrometry: Energy level diagrams - atomic absorption spectra. Flame characteristics. Flame atomizers and electrothermal atomization. Comparison of spectral interferences, chemical and physical interferences in FP and AAS. Use of organic solvents. Quantitative techniques - calibration curve procedure and the standard addition technique. Typical commercial instruments for FP and AAS, applications. Qualitative analysis and quantitative evaluations. Relative detectabilities of atomic absorption and flame emission spectrometry.

Molecular luminescence spectrometry: Theoretical basis for fluorescence and phosphorescence. Singlet and triplet excited states. Variables affecting luminescence - quantum efficiency, transition types, structure and structural rigidity, temperature and solvent effects, effect of *p*H, dissolved oxygen and concentration effect. Excitation spectra *vs* emission spectra. Fluorescence instrumentation - fluorometers and spectrofluorometers. Sensitivity and selectivity. Modification necessary to measure phosphorescence. General scope of applications of luminescence. Chemiluminescence spectrometry-Principles, instrumentations and applications.

Nephelometry and turbidometry: Principles, instrumentation and applications.

UNIT – II

Classification of electrochemical methods: Controlling and measuring current and potential potentiometers, galvanostats and potentiostats.

Potentiometric methods of analysis. Potentiometric electrochemical cells. The Nernst equation. Liquid junction potentials. Reference electrodes - SHE, calomel electrode and silver/silver chloride electrode. Metallic indicator electrodes - electrodes of first kind and second kind. Redox electrodes. Membrane electodes – membrane potential, selectivity of membranes. Glass ion selective electrodes. Crystalline solid state ion selective electrodes. Liquid-based ion selective electrodes. Gas sensing electrodes. Potentiometric biosensors. Quantitative applications. Activity *vs* concentration. Quantitative analysis using external

standards and the method of standard additions. Measurement of *p*H. Clinical and environmental applications.

Electrogravimetric analysis: Theory, apparatus, cell processes, deposition and separation, electrolytic separation of metals, applications.

Coulometric methods of analysis: General discussion, coulometry at controlled potential, apparatus and general technique, applications, coulometric titrations (amperometric coulometric) - principles, apparatus, comparison of coulometric titrations with conventional titrations, automatic coulometric titrations, applications.

Voltammetry: Fundamentals of voltammetry. Cyclic voltammetry**:** Principles and applications. Stripping analysis: Stripping voltammetry - basic principles, electrodes used for stripping analysis, apparatus for stripping analysis, applications, determination of lead in water voltammetry with micro electrodes.

UNIT – III

Thermal method of analysis: Introduction,

Thermogravimetric analysis (TGA): types of thermogravimetric analysis, principles. Factors affecting the results - heating rate, furnace, instrument control/data handling. Applications - purity and thermal stability, evaluation of correct drying temperature, analysis of complex mixture and determination of kinetic parameters of thermal degradation.

Differential thermal analysis (DTA): Theory - variables affecting the DTA curves. Differences between TGA and DTA. General principles. Instrumentation. Applications - analysis of the physical mixtures and thermal behaviour study. Determination of melting point, boiling point and decomposition point.

Differential scanning calorimetry (DSC): Basic principle. Differences between DTA and DSC. Instrumentation - power compensated DSC, Heat flux DSC. Applications - studies of thermal transitions and isothermal crystallization. Pharmaceutical industry for testing the purity of the samples.

Thermomechanical analysis. Dynamic mechanical analysis**.**

Enthalpimetric analysis: Thermometric titrimetry and direct injection enthalpimetry - principle, instrumentation, applications.

References:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th edition, 2001 John Wiley & Sons, Inc. India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 Prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003 Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. Instrumental Methods of Analysis by H.H. Willard, L.L. Merritt and J.A. Dean, 7th Edition, CBS Publishers, New Delhi, 1988.
7. Principles and Practice of Analytical Chemistry, F.W. Fifield and Kealey, 3rd edition, 2000, Blackwell Sci., Ltd. Malden, USA.
8. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.
9. Introduction to Instrumental Analysis, Braun, Pharm. Med. Press. India.
10. Instant Notes of Analytical Chemistry, Kealey and Haines, Viva Books Pvt. Ltd., New Delhi, 2002.

THIRD SEMESTER

Chem-HC-A-P-3.1 **ANALYTICAL CHEMISTRY PRACTICALS-III**

1. Determination of calcium in limestone by redox, acid-base and complexation titrations.
2. Determination of mercury in an algaecide by EDTA titration; and arsenic in ant control preparation by redox titration.
3. Analysis of a copper-nickel alloy sample for copper and nickel by EDTA titration using masking and selective demasking reactions.

4. Determination of zinc in a sample of foot powder and thallium in a sample of rodenticide by EDTA titration.
5. Determination of ascorbic acid in goose berry/bitter gourd by titrimetry and spectrophotometry using *N*-bromosuccinimide (NBS).
6. Analysis of a mixture of iron(II) and iron(III) by EDTA titration using *p*H control.
7. Potentiometric titration of a mixture of chloride and iodide.
8. Electrolytic determination of copper and lead in brass.
9. Polarographic determination of copper and zinc in brass.
10. Determination of sodium, potassium and calcium in mineral waters by atomic emission spectrometry.
11. Colorimetric analysis of procaine by diazotization and coupling reaction.
12. Determination of manganese in steel by extraction-free spectrophotometry and molybdenum in steel by extractive spectrophotometry.
13. Potentiometric determination of formula and stability constant of a silver-ammonia complex ion.
14. Conductometric titration of sodium acetate with HCl and NH_4Cl with NaOH.
15. Photometric and potentiometric titration of iron(III) with EDTA.
16. Photometric and potentiometric titration of copper with EDTA.
17. Polarographic determination of stability constant of lead oxalate complex.

References:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th edition, 2001 John Wiley & Sons, Inc. India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993, prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003 Pearson Education Pvt. Ltd., New Delhi.

5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. Pharmaceutical Drug Analysis by Ashutoshkar, New Age International Publishers, New Delhi, 2005.
7. Practical Pharmaceutical Chemistry, Ed. A. H. Geckett, J. B. Stenlake, 4th edition. Part I and II, CBS Publishers, New Delhi.
8. Quantitative Analysis of Drugs in Pharmaceutical Formulations, P. D. Sethi, 3rd edition, CBS Publishers & Distributors, New Delhi, 1997.

THIRD SEMESTER

Chem-HC-I-T-3.2 **ORGANOMETALLIC CHEMISTRY**

UNIT – I

Fundamental concepts: Introduction, Classification of organometallic compounds, Nomenclature, Effective atomic number rule, General methods of synthesis.

Organometallics of transition metals: Preparation, bonding and structures of manganese,iron, cobalt and nickel carbonyls, Preparation and structures of metal nitrosyls

Metallocenes: Preparation, structure and bonding of ferrocene and ruthenocene

Complexes of alkene, alkyne, arene and allyl ligands: Preparation, structure and bonding. Isolobal principles.

UNIT –II

Organometallics in Organic Synthesis: Preparation, properties and applications of organometallic compounds-Li, Mg, Zn, Cd, Sn and Hg.

Organotransition metal compounds: Organocuprates, Hydrozirconation, Transmetallation reactions by Organopalladium and Organonickel, Carbonylation by metal carbonylates, Decarbonylation, Carbene complexes and Metallacycles.

UNIT – III

Homogeneous catalysis: Alkene hydrogenation, hydroformylation, Wacker's process, Monsanto acetic acid process and L-DOPA synthesis, Alkene oligomerizations, Water-gas shift reactions.

Heterogeneous catalysis: Alkene polymerization: Ziegler-Natta catalysis, Fischer-Tropsch reaction, Mechanism

Zeolites as catalysts for organic transformation: Uses of ZSM - 5

Alkene metathesis, Hydroboration, Arylation or Vinylation of Olefins (Heck reaction).

Applications: Industrial and medicinal applications of organometallics**.**

References

1. Organometallic Chemistry, 2nd edition, R.C. Mehrothra and A. Singh, New Age International Publications (2006).
2. Fundamental Transition Metal Organometallic Chemistry - Charles M. Lukehart, Brooks, Cole Publishing Company (1985).
3. The Organometallic Chemistry of the Transition Metals, 4th edition, Robert H. Crabtree, Wiley Interscience, (2005).
4. Organometallics - A Concise Introdution, 2nd edition, Chistoph Elschenbroich and Albert salzer VCH, (1992).
5. Inorganic Chemistry, 2nd edition, C.E. Housecroft and A.G. Sharpe, Pearson Education Ltd., (2005).
6. Inorganic Chemistry- 3rd edition, G.L. Miessler and D.A. Tarr, Pearson Education, (2004).
7. Basic Organometallic Chemistry - B.D. Gupta and A.J. Elias, Universities Press (2010).

THIRD SEMESTER

Chem-HC-I-P-3.2 INORGANIC CHEMISTRY PRACTICALS-III

1. Determination of bismuth, cadmium and lead in a mixture: Analysis of a low melting alloy (Wood's alloy).
2. Simultaneous spectrophotometric determination of chromium and manganese in a steel solution.
3. Quantitative analysis of copper(II) and iron(II) in a mixture:
    i. Copper gravimetrically as CuSCN and
    ii. Iron volumetrically using cerium(IV) solution
4. Determination of chromium(III) and iron(III) in a mixture: Kinetic masking method.

5. Electrogravimetric determination of:
    a) Copper in copper sulphate
    b) Nickel in nickel suphate
    c) Copper and nickel in alloy solution
    d) Lead in lead nitrate.
6. Flame photometric determination of the following metal ions from different samples:

    a) sodium b) potassium c) calcium d) lithium and d) sodium and potassium in a mixture.
7. Polarographic estimation of cadmium and zinc.
8. Determination of iron as the 8-hydroxyquinolate by solvent extraction method.
9. Quantitative determination of nickel using dithizone and 1,10-phenanthroline by synergistic extraction.
10. Spectrophotometric determination of the *p*Ka value of methyl red.

References:

1. Advanced Physico-Chemical Experiments – J. Rose.
2. Instrumental Analysis Manual - Modern Experiments for Laboratory – G.G. Guilbault and L.G. Hargis.
3. A Text Book of Quantitative Inorganic Analysis – A.I. Vogel, 5th edition.
4. Experimental Inorganic Chemistry – G. Palmer.
5. Inorganic Synthesis – O. Glemser.
6. Experimental Inorganic/Physical Chemistry- Mounir A. Malati.
7. Quantitative Chemical Analysis – Daniel C. Harris, (2006) 7th edition.
8. Spectrophotometric Determination of Elements – Z. Marczenko

THIRD SEMESTER

Chem-HC-O-T-3.3 HETEROCYCLIC CHEMISTRY, PHOTOCHEMISTRY AND PERICYCLIC REACTIONS, MOLECULAR REARRANGEMENTS AND RETROSYNTHESIS

UNIT – I: HETEROCYCLIC COMPOUNDS

Heterocyclic chemistry: Nomenclature of heterocyclic compounds. Structure (no elucidation), reactivity, synthesis and reactions of furan, pyrrole, thiophene, indole, pyridine, quinoline, isoquinoline, pyrazole, imidazole, pyrone, coumarin, chromones, pyrimidines, purines. Structure and importance of quinine, proline as organic catalysts.

UNIT – II: PHOTOCHEMISTRY AND PERICYCLIC REACTIONS

Photochemistry: Light absorption and electronic transitions, Jablonski diagram, intersystem crossing, energy transfer, sensitizers, quenchers.

Photochemistry of olefins, conjugated dienes, aromatic compounds, ketones- Norrish type-I and Norrish type-II reactions, enones, Paterno-Buchi reaction, di-pi-rearrangements, photooxidations, photoreductions.

PERICYCLIC REACTIONS

Electrocyclic reactions: Stereochemistry, symmetry and Woodward-Hofmann rules for electrocyclic reactions, FMO theory of electrocyclic reactions, correlation diagram for butadiene to cyclobutene and hexatriene to cyclohexadiene systems.

Cycloaddition reactions: Classification, analysis by FMO and correlation diagram method.

Cycloaddition reactions: [2+2] and [4+2] cycloadditions- FMO and correlation diagram method Deils-Alder reaction, hetero Diels-Alder reaction and their applications.

Intra and intermolecular 1,3-dipolar cycloadditions: involving nitrile oxide, nitrile imine, nitrile ylide and their application in organic synthesis.

Sigmatropic reactions: Classification, stereochemistry and mechanisms. suprafacial and antarafacial shifts of H and carbon moieties. [3,3] and [5,5]- sigmatropic rearrangement, Claisen, Cope and aza-Cope rearrangement.

UNIT – III: MOLECULAR REARRANGEMENTS AND RETROSYNTHESIS

Molecular rearrangements: Introduction

Carbon to carbon migration: Pinacol-pinacolone, Wagner-Meerwein, Benzidine, benzylic acid, Favorskii, Fries rearrangement, dienophine rearrangement.

Carbon to nitrogen migration: Hofmann, Curtius, Lossen, Schmidt and Beckmann rearrangements.

Miscellaneous rearrangements: Wittig, Smiles, Bayer-Villeger rearrangement and Barton reaction.

Retrosynthesis: Introduction to disconnection approach: Basic principles and terminologies used in disconnection approach. One group C-X and two group C-X disconnections. Synthons and synthetic equivalents.

Retrosynthesis and synthesis of benzofurans, *p*-methoxy acetophenone, saccharine, α-bisabolene, nuciferal, tetralone, iboprofin.

References:

1. J. March, Advanced Organic Chemistry, Wiley Inter Science, 1994.

2. F.A. Carey and Sundberg, Advanced Organic Chemistry – Part A & B, 3rd edition, Plenum Press, New York, 1990.
3. Principles of Organic Synthesis ROC Norman and Coxon.
4. Comprehensive Organic Synthesis – B.M. Trost and I. Fleming series, Pergamon Press, New York, 1991.
5. S.K. Ghosh, Advanced General Organic Chemistry, Book and Allied (P) Ltd., 1998.
6. Heterocyclic Chemistry – Joule & Smith
7. Basic Principles of Heterocyclic Chemistry – L.A. Pacquette
8. Molecular reactions and Photochemistry-DePey Chapmann
9. Organic synthesis- Stuart Warren, Wiley interscience, 1982.

THIRD SEMESTER

Chem-HC-O-P-3.3 ORGANIC CHEMISTRY PRACTICALS-III

Isolation of natural products

1. Fractional crystallization: separation of mixture of naphthalene and biphenyl
2. Fractional distillation: Separation of mixture of hexane and toluene.
3. Thin layer chromatography: Separation of plant pigments
4. Column chromatography: Separation of mixture of *o* and *p*-nitro anilines
5. Isolation of piperine from pepper
6. Isolation of caffeine from tea
7. Isolation of azeleic acid from castor oil
8. Isolation of hesperidiene from orange peal
9. Isolation of cysteine from hair
10. Isolation and spectroscopic characterization of lycopene
11. Isolation of lipids from egg yolk
12. Extraction of nicotine from tobacco leaves.

References:

1. Manual of Organic Chemistry - Dey and Seetharaman.
2. Modern Experimental Organic Chemistry by John H. Miller and E.F. Neugil, p 289.
3. An Introduction to Practical Organic Chemistry - Robert, Wingrove etc.
4. A Text Book of Practical Organic Chemistry – A.I. Vogel, Vol.III
5. Practical Organic Chemistry - Mann & Saunders
6. Semimicro Qualitative Organic Analysis by Cheronis, Entrikin and Hodnet .
7. R.K. Bansal, Laboratory Manual of Organic Chemistry, New Age International (P) Ltd. London, 3rd edition, 1996.

THIRD SEMESTER

Chem-HC-P-T-3.4 Nuclear, Radiation, Photo-, Polymer and Nano Chemistry

UNIT - I :

Nuclear chemistry: Radioactive decay – General characteristics, decay kinetics, parent – daughter decay growth relationships, determination of half-lives, Nuclear stability – packing
fraction, binding energy, Brief survey of alpha, beta and gamma decays. Nuclear reactions –
Bethe's notation, types of nuclear reactions – specific nuclear reactions, photonuclear reactions,
Oppenheimer – Phillips process, spallation reactions. Definition of Curie and related calculations.. Szilard-Chalmers process. Geiger-Muller counters – G.M. Plateau, dead time, coincidence loss, determination of dead time.

Radiation chemistry: Introduction, units, interaction of electromagnetic radiation with matter, G-value, LET of radiation, dosimetry, Fricke dosimeter. Radiolysis - cysteine, and biphenyl. Radioisotopes as tracers, use of isotopic tracers in the elucidation of reaction mechanism, structure determination and solubility of sparingly soluble substances. ^{14}C dating, medical applications of isotopic tracers. Hazards in radiochemical work and radiation protection.

UNIT - II :

Photochemistry: Introduction to photochemistry, quantum yield and its determination, factors affecting quantum yield, Actinometry - Uranyloxalate and potassium ferrioxalate actinometers, acetone and diethylketone actinometers. Term symbols and significance. Photosensitization: by mercury, dissociation of H2. Photochemical kinetics of: Decomposition of CH3CHO, formation of HCl. Photodegradation: Photocatalyst – ZnO, TiO2, principle, application of ZnO/TiO2 in the photo degradation of dyes (IC), pesticides (DDT) and in industrial effluents. Effect of photo degradation on COD value.

Corrosion: Manifestations of corrosion, types of corrosion, basis of electrochemical corrosion, theories of corrosion. Local cell theory (Wagner and Traud theory), Current – potential relations (Evan diagram) in corrosion cells. Effect of *p*H, nature of metal and dissolved oxygen (principle of differential aeration) on corrosion. Corrosion inhibition and prevention by painting,phosphating and by using biomaterials, corrosion protection by anodic (passivation) and cathodic protection.

Polymers: Fundamentals of polymers - monomers, repeat units, degree of polymerization. Linear, branched and network polymers. Classification of polymers. Polymerization - condensation, addition, free radical, ionic, co-ordination polymerization and ring opening

polymerization. Molecular weight and size. Polydispersion. Average molecular weight concepts – number, weight and viscosity average molecular weight. Determination of molecular weights -viscosity method, osmotic pressure method, sedimentation and light scattering method.

UNIT - III:

Fundamentals of X-ray crystallography, law of interfacial angles, laws of symmetry, Miller indices, Bragg equation (no derivation), Experimental methods – powder and rotating crystal methods, indexing of powder and rotating crystal photographs. Atomic scattering factor, structure factor, Fourier synthesis and electron density diagrams. Electron diffraction of gases, experimental technique, Scattering-Intensity curves, Wierl equation (no derivation), Radial distribution method determination of bond lengths and bond angles.

Chemistry of Nanomaterials: Nano particles. Synthesis - Laser abalation, chemical vapour transportor (CVT) and sol-gel methods. Metal oxides nanoparticles with supercritical water and precursor method. Synthesis of metal oxides and its composite nanoparticles by solvothermal, hydrothermal and electrochemical methods. Carbon nanotube, carbon nanowires and its composites. Applications of nanomaterials in renewable energy. Inorganic and organic nanoporous aerogels. Heat capacity of solids: Einstein and Debye equations (With derivation).

References:

1. Nuclear Chemistry by Friedlander and Kennedy, John Wiley and Sons (1987).
2. Nuclear Physics and Chemistry by G. Harvey.
3. Essentials of Nuclear Chemistry by H.J. Arnikar, Eastern Wiley (1990).
4, Nuclear Chemistry by U.N. Dash, Sultan Chand and Sons (1991).
5. Source Book on Atomic Energy by S. Glasstone, 3rd edition Van Nonstrand (1967).
6. Nuclear Radiation Detection by Price. Nuclear Radiation Detectors by S.S. Kapoor and Ramamoorthy, Wiley Eastern (1986).
7. Fundamentals of Radiochemistry by D.D. Sood, A.V.R. Reddy and N. Ramamoorthy
8. Fundamentals of Photochemistry – Rohatgi and Mukherje (New Age Bangalore) 2000.
9. Introduction to electrochemistry by S. Glasstone.
10. Treatise on Electrochemistry, G. Kortum 2nd Edition, Elsevier, London (1965).
11. Text Book of Polymer Science, F.W. Billmeyer, Jr., John Wiley, London (1994).
12. Polymer Science. V. R. Gowrikar, N.V. Vishwanathan and J. Sreedhar, Wiley Eastern, New Delhi (1990).
13. Fundamentals of Polymer Science and Engineering. A. Kumar and S.K. Gupta, Tata –McGraw Hill New Delhi (1978).
14. Polymer Characterization, D. Campbell and J.R. White, Chapman and Hall, New York.

15. Fundamental Principles of Polymer Materials, R.L. Rosen, Wiley, New York.
16. Functional Monomers and Polymers by K. Takemoto, Y. Inaki and P.M. Ottenbrite, Marcel Dekker, Inc., New York, 1987.
17. Hand Book of Nanotechnology, Bharat Bhushan, Springer Publisher.
18. Nanotechnology, Richard Booker and Earl Boysen, Wiley.
19. Nanometerials, A.K. Bandopadhyay, New Age International, 2nd edition.
20. Nanotechnology - Importance and Applications, M. H. Fulekar, Ink International publishing.

THIRD SEMESTER

Chem-HC-P-P-3.4 PHYSICAL PRACTICALS -III

1. Kinetics of reaction between sodium formate and Iodine, determination of energy of activation.
2. To study the kinetics of saponification of ethyl acetate by conductivity method, determination the energy of activation.
3. To study the kinetics of reaction between acetone and iodine-determination of order of reaction w.r.t. iodine and acetone.
4. Conductometric titration of thorium nitrate with potassium tartarate.
5. Determination of mean ionic activity coefficient of a weak electrolyte (acetic acid) by conductometric measurements.
6. To study the acid catalysed kinetics of oxidation of glycine by chloramine-T (CAT)-determination of order of reaction w.r.t. [CAT] and [glycine].
7. Kinetics of decomposition of benzene diazonium chloride, determination of energy of activation and thermodynamic parameters.
8. Potentiometric titration of $Pb(NO_3)_2$ Vs EDTA.
9. Preparation of Ag/AgCl electrode and to determine the activity of 0.2M HCl.
10. Determination of ionic product of water and study the effect of temperature.
11. Determination of transport number of H^+ by e.m.f. method.
12. Photolysis of monochloro acetic acid.
13. To determine the eutectic point of a two component system (Naphthalene-m-dinitrobenzene system).
14. Conductometric method of determination of solubility of sparingly soluble salt.
15. Potentiometric titration of mixture of KCl+KBr+KI vs $AgNO_3$.
16. Study of phase diagram of a three component system (Eg: acetic acid-chloroform water and system).
17. Thermodynamics of a cell reaction –construction of an electrochemical cell, study the effect of temperature on the cell reaction and calculation of thermodynamic parameters.
18. Determination of hydroxyl radicals scavenging (antioxidant activity) by spectrophotometric method.
19. Study of pH effect (by inhibitors) on electrochemical dissolution of a metal.

REFERENCES

1. Practical Physical Chemistry – A.J. Findlay.

2. Experimental Physical Chemistry –F. Daniels et al.
3. Selected Experiments in Physical Chemistry – Latham.
4. Experiments in Physical Chemistry – James and Prichard.
5. Experiments in Physical Chemistry – Shoemaker.
6. Advanced Physico-Chemical Experiments –J. Rose.
7. Practical Physical Chemistry –S.R. Palit.
8. Experiments in Physical Chemistry – Yadav, Geol Publishing House.
9. Experiments in Physical Chemistry – Palmer.
10. Experiments in Chemistry –D.V. Jahagirdar, Himalaya Publishing House, Bombay, (1994).
11. Experimental Physical Chemistry –Das. R.C. and Behera B, Tata Mc Graw Hill

FOURTH SEMESTER

Chem-SC-A-T-4.1 MISCELLANEOUS METHODS OF ANALYSIS

Unit-I

Kinetic methods of analysis: Analytical uses of reaction rates relative, basis of reaction rate methods, rate laws-first and second order reactions relative rates of reactions, analytical utility of first or pseudo first order reactions, determination of reaction rates, types of kinetic methods–differential methods, integral methods, multicomponent analysis-neglect of reaction of slow-reacting component, logarithmic extrapolation method, reaction rate method, applications-catalyzed reactions, measurement methods for catalyzed reactions, micro determination of inorganic species like iodide, selenium, cobalt & mercury in complex materials, determination of organic species, non-catalytic reactions. Applications of enzyme-catalysed reactions for the analysis of substrates-stoichiometric and rate methods, determination of urea, uric acid, blood glucose, galactose and blood alcohol, determination of enzymes-LDH, GOT and GPT.

A brief outline of IR, UV, NMR, Mass spectroscopy as tools for kinetic study.

Unit-II

Radiochemical methods of analysis

Introduction: Radioactive isotopes, radioactive decay products. Decay processes- alpha decay. beta decay, gamma-ray emission and x-ray emission. Radioactive decay rates. Counting statistics.

Measurement of alpha particles, beta-particles and gamma radiations. Radiation detectors-gas ionisation, scintillation and semiconductor detectors. Pulse height analysis and autoradiograghy.

Neutron activation methods-neutrons and neutron sources, reactors, radioactive neutron sources and accelerators.

Interactions of neutrons with matter. Theory of activation methods and experimental considerations. Non-destructive methods and destructive methods. Applications of neutron activation-scope, accuracy and sensitivity, Isotopes dilution methods- Types, principles and applications.

Radiometric titrations. Radiorelease methods. Radioactive tracers. Principles and applications of radioimmunoassay.

Unit-III

Automated methods of analysis

An overview, definition, distinction between automatic and automated systems, advantages and disadvantages by automation, types of automated techniques. Non-discrete techniques, segmented flow methods and basic equipment, special techniques and devices, theoretical considerations and problems, applications. Single channel and multi channel auto analysers, BUN analyzers, automatic glucose analyzers and ammonia in water analyzers, COD analyzers, CFA in industry. Non-segmented flow methods: Flow injection analysis. Principles, types of dispersion, factors affecting dispersion, applications of small, medium and large dispersions. Stopped flow methods, flow injection titrations. Discrete methods: Centrifugal fast scan analyzer, automatic multipurpose analyzers, Automatic elemental analyzer, automated analyzer based on multi layer film-principles, film structure, instrumentation applications. Comparison of discrete and non-discrete methods. Advantages of flow injection measurements over continuous flow measurements.

References:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th ed., 2001 John Wiley & Sons, Inc, India
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition,1993 prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint.2003, Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. I nstrumental Methods of Analysis by H.H. Willard, L.L. Merritt and J.A. Dean, 7th Edition, (1988).
7. Principles of instrumental analysis. D.A. Skoog, D.M. West, Holler, Nieman
8. Introduction to instrumental methods of analysis. D. Braun.
9. Principles and practice of analytical chemistry. Fifield and Kealey.
10. Nuclear chemistry-Arnikar.
11. H.H.Bauer, G.D. Christien, and J.E.O'Reilly, eds., Instrumental analysis. Boston:Allyl and Bacon, 1978, Chapter 18, "Kinetic methods" by H.B. Mark, Jr.
12. R.A. Greinke and H.B.Mark, Jr., "Kinetic Aspects of Analytical Chemistry". Anal. chem., **46** (1974) 413 R.
13. H. L. Pardue, " A Comprehensive Classification of Kinetic Methods of Analysis used in Clinical Chemistry". Clin. Chem., **23**, (1977) 2189.
14. D. Perez-Bendito and M. Silva, Kinetic methods in analytical chemistry. New York: Wiley, 1988.
15. H.A. Mottola, Kinetic Aspects of Analytical Chemistry. New York: Wiley interscience, 1988.
16. H.U. Bergmeyer, Methods of Enzymatic Analysis, 3rd ed. New York: Wiley. A series of 12 volumes plus index volume, 1983-1987.

FOURTH SEMESTER

Chem-SC-A-P-4.1 ANALYTICAL CHEMISTRY PRACTICALS -IV

Applied analysis-I

1. Analyses of waste waters for DO and COD by titrimetry.
2. Analysis of a ground water sample for sulphate by titrimetry (EDTA) and turbidimetry.
3. Kinetic determination of urinary creatinine and purity of a commercial H_2O_2 sample.
4. Analysis of brackish water for chloride content by a**)** spectrophotometry (mercuric thiocyanate method), b) conductometry (silver nitrate) and c**)** potentiometry (silver nitrate).
5. Determination of fluoride in drinking water/ground water by spectrophotometry (alizarin red lake method).
6. Spectrophotometric determination of iron in natural waters using thiocyanate and 1,10-phenanthroline as reagents.
7. Analysis of waste water for
   a) nitrate by phenol disulphonic acid method.
   b) phosphate by molybdenum blue method
   c) ammonia-nitrogen by Nessler's method
   d) nitrite-nitrogen by NEDA method
   e) silica by molybdate method
8. Analysis of a soil sample for
   a) *pH*, conductance and total solids and dissolved solids.
   b) calcium carbonate and organic carbon by titrimetry.
   c) calcium and magnesium by EDTA titration.
9. Analysis of a soil sample for
   a) Available phosphorus by spectrophotometry.
   b) Nitrate-nitrogen/nitrite nitrogen/ammonia nitrogen by spectrophotometry.
   c) sodium and potassium by flame photometry.
   d) water-soluble silica by molybdate method by spectrophotometry.
   e) sulphur by colorimetric method.
10. Analysis of waste water for anionic detergents and phenol by spectrophotometry.

11. Kinetic based indirect spectrophotometric method for the simultaneous determination of MnO_4^- and $Cr_2O_7^{2-}$
12. Enzymatic determination of glucose in blood.
13. Analysis of potable /ground water for fluoride with ion selective electrode potentiometry.
14. Kinetic determination of urinary creatinine and purity of a commercial H_2O_2 sample.
15. Determination of chromium (III) and iron (III) in a mixture by kinetic masking methods.
16. Catalytic determination of traces of selenium in biological materials and iodide in blood serum.
17. Separation and identification of pesticide residues from the soil by TLC.

References

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th edition, 2001 John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993, Prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. Practical Clinical biochemistry methods and interpretations, R. Chawla, J.P. Bothers Medical Publishers (P) Ltd., 1995.
7. Laboratory manual in biochemistry, J. Jayaraman, New Age International Publishers, New Delhi, 1981.
8. Practical Clinical Biochemistry by Harold Varley and Arnold.Heinmann, 4th edition.
9. Experiments on Water Pollution, D.I. Williams and D. Anglesia, Wayland Publishers Ltd., England, 1978.
10. Experiments on Land Pollution, D.I. Williams and D. Anglesia, Wayland Publishers Ltd., England, 1978.
11. Experiments in Environmental Chemistry, P.D. Vowler and D.W. Counel, Pergamon Press, Oxford 1980.
12. Manual Soil Laboratory Testing, vol. I, K.H. Head, Pentech Press, London 1980.

FOURTH SEMESTER
Chem-SC-A-T-4.2 **APPLIED ANALYSIS**

Unit-I

Food analysis: Objectives of food analysis. Sampling procedures. Detection and determination of sugars and starch. Methods for protein determination. Oils and fats and their analysis-iodine value, saponification value and acid value. Rancidity-detection and determination (peroxide number). Tests for common edible oils. Analysis of foods for minerals-phosphorus, sodium, potassium and calcium. General methods for the determination of moisture, crude fibre and ash contents of food. Analysis of milk for fat and added water. Non-alcoholic beveragesdetermination of chicory and caffeine in coffee; caffeine and tannin in tea. Alcoholic beveragesmethanol in alcoholic drinks and chloral hydrate in toddy. Food additives-chemical preservatives. Inorganic preservatives-sulphur dioxide and sulphites, their detection and determination. Organic preservatives-benzoic acid and benzoates, their detection and determination. Flavouring agents-detection and determination of vanilla and vanillin. Coloring matters in foods-classification, certified colors, detection of water soluble dyes, color in citrus fruits, beet dye in tomato products, mineral color. Pesticide residues in foods-determination of chlorinated organic pesticides. Control food quality-codex alimentaries, Indianstandards.

Unit –II

Pharmaceutical analysis: Importance of quality control; drugs and pharmaceuticals. Sources of impurities in pharmaceutical chemicals. Analytical quality control in finished/final products. Common methods of assay. Analysis of common drugs; Analgesics-aspirin, paracetamol; Anthelmentics-mebendazole; Antiallergics-chlorpheneramine maleate; Antibioticspenicillin, chloromycetin; Anti-inflammatory agents-Oxyphenbutazone; Antimalarialsprimaquine phosphate; Antituberculosists-INH; Narcotics-nicotine, morphine; Expectorants- Benadryl; Sedative-diazepam; Vitamins-A. C, B1, B2, B6, niacin and folic acid. Estimation of drug residues in biological samples.

Unit-III

Newer Concepts in Analytical Chemistry: Metrology: Meaning, importance and newer concepts.

Traceability and Uncertainty: Concepts and definitions. Accuracy versus traceability Precision versus Uncertainty.

Green Chemistry: A New Chemical Philosophy. Basic concepts of twelve principles.

Green Analytical Chemistry: Real Time analysis for pollution prevention. Green Sampling Techniques.

Field Analytical Chemistry: Meaning, Importance and Advantages. Field Portable Instrumentation.

Process Analytical Chemistry: Meaning, Importance and Advantages. Process Analysis.

Green Analytical Tools: Chemical Sensors. Biochemical Sensors. Electronic Tongue. Electronic Nose.

References:

1. Food Analysis, A. G. Woodman, McGraw Hill. 1971.
2. Chemical Analysis of Foods, H. E. Cox and Pearson.
3. Analysis of Foods and Food Products, J. B. Jacob.
4. A First Course in Food Analysis, A. Y. Sathe, New Age Internationals (P) Ltd., Publishers, Bangalore, 1999.
5. Analytical Agricultural Chemistry, S. L. Chopra and J. S. Kanwar, Kalyani Publishers, New Delhi, 1999.
6. Pharmaceutical Analysis, Ed. T. Higuchi and E. B. Hanssen, John Wiley and Sons, New York, 1997.
7. Pharmaceutical Analysis-Modern Methods, Part A & B, Ed. James W. Hunson.
8. Quantitative Analysis of Drugs in Pharmaceutical Formulations, P. D. Sethi, 3rd Ed. CBS Publishers & Distributors, New Delhi, 1997.
9. Encyclopaedia of Analytical Chemistry. R.A. Meyers, Wiley, 18 volume set, 2000.
10. Green Chemistry: Theory and Practice , Paul T Anastas John C.Warner, Oxford University press, USA , 2000.

11. Introduction to Green Chemistry, Second edition. Albert Matlack, CRC Press: 2nd edition, 2010.
12. Green Chemistry: An Introductory Text. Mike Lancaster, Royal Society of Chemistry; Revised edition. 2010.
13. Ultrasound Technology in Green Chemistry, Sillapaa, Mika, Pham, Thuy-Duong, Shrestha, Reena Amathya. 1st Edition., 2011, Springer.
14. Handbook of Green chemistry and technology, James H. Clark, Duncan J. Macquarrie, John Wiley and sons, 25-Mar-2002.

FOURTH SEMESTER

Chem-SC-A-P-4.2 ANALYTICAL PRACTICALS-V

Applied analysis-II

1. Determination of vitamin C in orange juice by titration with cerium(IV) and with 2,6-dichlorophenol indophenols
2. Determination of aluminium and magnesium in antacids by EDTA titration.
3. Determination of saccharin in tablets by precipitation titration.
4. Determination of sulpha drugs by potentiometry using $NaNO_2$ and iodometric assay of penicillin
5. Determination of iron in mustard seeds and phosphorus in peas by spectrophotometry.
6. Fluorimetric determination of riboflavin (vit. B_2) in tablets.
7. Analysis of urine for
   a) Urea and uric acid by titrimetry snd spectrophotometry.
   b) Sulphate by precipitation titration after ion-exchange separation.
   c) Sugar by Benedict's reagent.
8. Analysis of blood for
   a) Cholesterol by spectrophotometry
   b) Bicarbonate by acid-base titration.
9. Ultraviolet spectrophotometric determination of aspirin, phenacetin and caffeine in APC tablets using solvent extraction.
10. Fluorimetric determination of quinine in an antimalarial tablet.

11. Determination of iodine value and saponification value of edible oils.

12. Assay of methyl salicylate and diethylphthalate in surgical spirit by UV-spectrophotometry.

13. Assay of chlorpramazine HCl in a syrup formation by difference spectrophotometry.

14. Assay of isoniazid in tablet formulation by titrimetric with $KBrO_3$.

15. Assay of diphenylhydramine HCl and nicotinic acid in pharmaceuticals by titration with perchloric acid.

16. Analysis of Phenobarbital by visual, potentiometric and conductometric methods.

References:

1. C. A. Burtis and E.R. Ashwood, eds., *Tietz* Fundamentals of Clinical chemistry, 4th ed., Wasington, DC: American Association of clinical chemistry, 1995.

2. C. A. Burtis and E.R. Ashwood, eds., *Tietz* textbook of Clinical Chemistry, 3th ed., Wasington, DC: American Association of clinical chemistry, 1998.

3. M. Reiner and D. Seligson, eds., Standard methods in clinical chemistry. San Diego: Academic. Multivolume series started in 1953.

4. D. Glick, ed., Methods of biochemical analysis. New York: Wiley-Interscience. A series of annul volumes, started in 1954.

5. D.S. Young and R.B.Friedman, Effect of diseases on clinical laboratory tests, 4th ed. Washington, DC: American Association of clinical chemistry, 2001.

6. D.S. Young and R.B.Friedman, Effect of drugs on clinical laboratory tests, 5th ed. Washington, DC: American Association of clinical chemistry, 2000.

7. J. Wang, Electro analytical techniques in clinical chemistry and laboratory medicine.New York: VCH, 1988.

8. Practical Clinical biochemistry methods and interpretations, R. Chawla, J.P. Bothers Medical Publishers (P) Ltd., 1995.

9. Laboratory manual in biochemistry, J. Jayaraman, New Age International Publishers, New Delhi, 1981.

10. Practical Clinical Biochemistry by Harold Varley and Arnold.Heinmann, 4th edition.

FOURTH SEMESTER

Chem-SC-I-T-4.3 **BIOINORGANIC CHEMISTRY**

UNIT – I

Structural and molecular biology: Introduction, The structural building blocks of proteins and nucleic acids, Metal ion interactions with nucleosides and nucleotides.

Bioenergetics: Introduction, Redox reactions in metabolism, the central role of ATP in metabolism, Kinetic stability of ATP, Mitochondrial flow of electrons from NADH to O_2, Oxidative phosphorylation and respiratory chain.

Biochemistry of sodium and potassium: Introduction,Transport across membranes. Potassium and sodium channels, Sodium-potassium ATPase, Metal ion carriers (crown ethers, cryptands and ionophores).

Biochemistry of calcium: Introduction, Biological role of calcium, Binding sites of calcium and proteins, Storage of calcium, Calcium in muscle contraction, Calcium in blood clotting process.

Biochemistry of Magnesium: Chlorophyll and its role in photosynthesis.

Biochemisrty of cobalt: Chemistry of cobalamin, Structural features, Biochemical functions of cobalamins, Model compounds, Special characteristics of B_{12} co-enzyme

UNIT – II

Metal ion transport and storage: Iron storage and transport: Transferrin, ferratin, phosvitin and gastroferrin, Iron transport in microbes: siderophores, *in vivo* microbial transport of iron

Oxygen transport: Properties of dioxygen (O_2), Thermodynamic and kinetic aspects of dioxygen as an oxidant, Activation of dioxygen through complexation with metal ions.

Haemoglobin (Hb) and Myoglobin (Mb) in oxygen transport mechanism: Introduction to porphyrins, Substituent effects on porphyrin rings, Functions of Hb and Mb, Characteristics of O_2 binding interaction with Hb and Mb, Model compounds for oxygen carriers (Vaska's complex and cobalt(III) – Schiff base complexes), Hemerythrin and hemocyanin.

Electron transport proteins and redox enzymes: Iron – sulfur proteins (rubredoxins and ferredoxins) and cytochromes including cytochrome P450, Catalase and peroxidase-structure and reactivity.

Superoxide dismutase: Structure and reactivity.

Molybdenum containing enzymes: Aspects of molybdenum chemistry, Xanthine oxidase, aldehyde oxidase, Sulfite oxidase, Nitrogenase and nitrite reductase.

Non-redox metalloenzymes - Structure and reactivity of metalloenzymes**,** Carboxypeptidase-A, Alcohol dehydrogenase, Leucine aminopeptidase and carbonic anhydrase.

UNIT - III

Therapeutic uses of Metals - Introduction, Metals in medicine**,** Metals and human biochemistry.

Disease due to metal and nonmetal deficiency: Deficiency due to iron, zinc, copper, sodium, potassium, magnesium, calcium and selenium and their treatment.

Metal complexes as drugs and therapeutic agents: Introduction, Antibacterial agents, Antiviral agents, Metal complexes in cancer therapy, metal complexes for the treatment of rheumatoid arthritis, Vanadium diabetes, Metal complexes as radio diagnostic agents.

Treatment of toxicity due to inorganics: General aspects of mechanism of metal ion toxicity,

(i) Mechanism of antidote complex with poison, rendering it inert: arsenic, lead, mercury, iron and copper.

(ii) Antidote accelerated metabolic conversion of poison to non-toxic product: cyanide and carbon monoxide.

References

1. The Inorganic Chemistry of Biological Process- 2nd edition, M. N. Hughes, John Wiley and Sons, (1988).
2. Bioinorganic Chemistry - R.W. Hay, Ellis Horwood Ltd., (1984).
3. Biological Inorganic Chemistry – An Introduction, R.R. Crichton, Elsevier, (2008).
4. Bioinorganic Chemistry - A.K. Das, Books and Allied (P) Ltd, (2007).
5. Bioinorganic Chemistry - K. Hussain Reddy, New Age International Ltd. (2003).
6. Bioinorganic Chemistry: A Survey - Eiichiro Ochiai, Academic Press, (2008).
7. Bioinorganic Chemistry: A Short Course - 2nd edition, R.M. Roat-Malone, Wiley Interscience, (2007).
8. Medicinal Applications of Coodination Chemistry - Chris Jones and John Thornback, RSC Publishing, (2007).
9. Transition Metal Complexes as Drugs and Chemotherapeutic Agents - N. Farrell, Kluwer Academic Publishers (1989).
10. The Biological Chemistry of the Elements: The Inorganic Chemistry of Life - 2nd edition, J.J.R. Frausto da Silva and R.J.P. Williams, Oxford University Press,(2001).

FOURTH SEMESTER

Chem-SC-I-P-4.3 INORGANIC CHEMISTRY PRACTICALS -IV

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I. 1. Analysis of alloys:
   a) nickel gravimetrically using diethyl glyoxime
   b) chromium titrimetrically by persulphate oxidation
   c) iron titrimetrically using cerium sulphate
   d) chromium and manganese.

2. Ferromanganese: Manganese using EDTA
3. Molybdenum and tungsten steels: gravimetric
4. Semi- micro gravimetric estimation of aluminium and molybdenum.
5. Electrogravimetric estimation of:
   i) Lead
   ii) Nickel and copper.

6. Flame photometric determination of sodium, potassium and calcium in environmental and biological samples.

7. Polarographic determination of Cadmium, zinc + lead .
8. Stability constant of lead oxalate complex.

Solvent extraction and spectrophotometric determination of:

b. Uranium or molybdenum
c. Nickel

10. Specrtophotometric determination of titanium and zirconium.

References:

1. Advanced Physico-Chemical Experiments – J. Rose.
2. Instrumental Analysis Manual - Modern Experiments for Laboratory – G.G. Guilbault and L.G. Hargis.
3. A Text Book of Quantitative Inorganic Analysis – A.I. Vogel, 5th edition.
4. Experimental Inorganic Chemistry – G. Palmer.
5. Inorganic Synthesis – O. Glemser.
6. Experimental Inorganic/Physical Chemistry- Mounir A. Malati.
7. Quantitative Chemical Analysis – Daniel C. Harris, (2006) 7th edition.
8. Spectrophotometric Determination of Elements – Z. Marczenko

FOURTH SEMESTER

Chem-SC-I-T-4.4 STRUCTURAL METHODS IN INORGANIC CHEMISTRY

UNIT-I

Vibrational spectroscopy: Introduction, Selection rules, Vibrations of polyatomic molecules, Group frequency Structure of small molecules, Applications to coordination compounds (aquo, ammine, DMSO and DMF complexes), Linkage (SCN, NO_2) and geometrical isomers, Spectra of sulphate and perchlorate, carbonate and nitrate complexes.

NMR Spectroscopy: Basic principles, Chemical shift and factors affecting it, $F^{19}$and P^{31} NMR, Fluxional Molecules, Chemical exchange, and their applications to simple molecules, Lanthanide shift reagents, NMR of Paramagnetic compounds and Nuclear Overhausser Effect, NMR spectra of solids.

UNIT –II

Electron Spin Resonance spectroscopy(ESR): Basic principles, selection rules, g-factor and hyperfine splitting, Spectra of simple free radicals (NO, NH_3, NH_2, methyl, hydrazyl, benzene, parabenzoquinone, cyclopentadienyl etc), Zero field splitting, and Kramer's degeneracy, Applications to transition metal complexes of d^1, d^5, and d^9.

Nuclear Quadrupole Resonance Spectroscopy (NQR): Basic principles, electric field gradient, Quadrupole moment, asymmetric parameter, Quadrupole transitions for I = 1, 3/2, 5/2 and 7/2 systems, Instrumentation, Applications to chemical bond and structures.

Mossbauer spectroscopy: Basic principles, Isomer shift, Quadrupole splitting and magnetic hyperfine structure, Applications to iron and tin compounds (eg. Low spin Fe complexes, Divalent and tetravalent tin complexes) study of spin cross over.

UNIT-III

Photoelectron Spectroscopy: Introduction, chemical shift, Koopman's theory, spectra of simple molecules(H2, N2, O2, F2, and CO) , X-ray photoelectron spectroscopy, Auger spectroscopy, Instrumentation,Applications

CRD and CD: Introduction, Optical activity of inorganic compounds, ORD and CD, Cotton Effect, Applications to d-d transitions, Absolute configuration

Mass spectroscopy: Introduction, Fragmentation process, ion sources, Mass spectra, Meta stable ion, Applications to inorganic systems, Mass spectrometer.

References

1. Electronic Absorption Spectroscopy and Related Techniques – D.N. Sathyanarayana, Universities Press (2001).
2. Structural Methods in Inorganic Chemistry – E.A.V. Ebsworth, D.W.H. Ranklin and Cradock, Blackwell Scientific Publications (1988).
3. Physical Methods in Inorganic Chemistry – R.S. Drago, Saunders Publishers (1966).

4. Spectroscopy, B.P. Straughan and S. Salker, John Wiley and Sons Inc., New York, Vol.2, 1976.
5. Organic Spectroscopy, William Kemp, English Language Book society, Macmillan, 1987.
6. Application of Absorption Spectroscopy of Organic Compounds, John R. Dyer, Prentice Hall of India Private Ltd., New Delhi, 1974.
7. Spectrometric Identification of Organic Compounds, 4th edition, Robert M. Silverstein, G. Clayton Bassler and Terence C. Morrill, John Wiley & Sons, New York, 1981.
8. Organic Spectroscopy, V.R. Dani, Tata MeGraw-Hall Publishing Company Limited, New Delhi. 1995.
9. Interpretation of Carbon-13 NMR Spectra, F.W. Wehrli and T. Wirthin, Heyden, London, 1976.
10. NMR spectroscopy – Powai.

FOUTH SEMESTER

Chem-SC-I-P-4.4 INORGANIC CHEMISTRY PRACTICALS-V

1. Preparation and characterization of:
   a) Chloropentammine cobalt(III) chloride
   b) Estimation of chloride in a complex by potentiometric or ion-exchange method
   c) Record the electronic absorption spectrum of a complex and verify Tanabe Sugano diagram
2. Preparation of *cis*- and *trans*- dichlorobis(ethylenediammine) cobalt(III)chloride. Record the UV-Vis spectra and compare it with *cis*-form. Measure the molar conductance.
3. Preparation of hexamine cobalt(III) chloride and estimate cobalt ion.
4. Determination of magnetic susceptibility of any two compounds/complexes by Gouy method.
5. Determination of the composition of iron-phenanthroline complex by:
   (a) Job's method
   (b) mole-ratio method and
   (c) slope-ratio method.

7 Determine the stability constant of copper-sulphosalicylate complex by Bejrrums's method.

8. Determine the stability constant of iron-tiron/iron-phenanthroline by Turner-Anderson method.

9. Preparation of tris(oxalate)ferrate(III) and estimate the metal ion.

10.Using chloropentamine cobalt(III) chloride, prepare nitro and nitritopentamine cobalt(III) chloride. Record the IR spectra of the isomers and interpret.

11.Estimate the chloride ion in a given complex by silver nitrate titration after ion-exchange separation.

12.Demonstration Experiments:

(a) Recording and interpretation of IR and NMR spectra of complexes.

(b) Spectrochemical series - Evaluation of Dq value.

(c) DNA interaction with metal complexes by UV-visible absorption and viscosity methods.

References:

1. Advanced Physico-Chemical Experiments – J. Rose.
2. Instrumental Analysis Manual - Modern Experiments for Laboratory – G.G. Guilbault and L.G. Hargis.
3. A Text Book of Quantitative Inorganic Analysis – A.I. Vogel, 5th edition.
4. Experimental Inorganic Chemistry – G. Palmer.
5. Inorganic Synthesis – O. Glemser.
6. Experimental Inorganic/Physical Chemistry- Mounir A. Malati.
7. Quantitative Chemical Analysis – Daniel C. Harris, (2006) 7th edition.
8. Spectrophotometric Determination of Elements – Z. Marczenko

FOURTH SEMESTER

Chem-SC-O-T-4.5 SYNTHETIC ORGANIC CHEMISTRY

UNIT – I: Synthetic dyes

Dyes: Introduction, modern theories of colour and chemical constitution. A general study of the following: Direct azo dyes (congored, rosanthrene O, procion dyes), acid azo dyes (ponceau2R, Naphthol blue black 6B), basic azo dyes (chrysoidin G, bismark brown), developed dyes, mordent dyes, vat dyes, disperse dyes, fibre reactive dyes, sulphur dyes and solvent dyes. Fluoroscent brightening agents (tinopal B.V), cyanine dyes (classification, application in photography, quinoline blue and sensitol), chemistry of colour developer, and instant colour processes. Synthesis and applications of malachite green, rhodamine-B, phenolphthalein and methyl orange. Triphenylmethane dyes: crystal violet, pararosaniline, aurin, chromeviolet.

Application of dyes: In photography, DVD, CD and LCD, and electronics.

UNIT – II: MEDICINALLY IMPORTANT COMPOUNDS:

Synthetic Drugs: Introduction, chemotheraphy, pharmacodynamics, metabolites and antimetabolites, agonists and antagonists. A general study of the following class of drugs; a). Sulpha drugs - sulphanamides, sulphamethoxazole. b). Antipyretics –phenacetin, novalgin. c). Antimalarials – Quinine, chloroquine. d). Hypnotics, analgesics and sedatives – Phenobarbital, meprobamate. e). Antihistamines – chlorpheniramine. f). Stimulants – caffeine. g). Antineoplastics – 5-Fluorouracil and chlorambucil. h). Antibiotics: introduction, structure (no elucidation) and mode of action streptomycin, chloromycetin and tetracyclines.

Insecticides: Introduction, classification, mode of action and synthesis of chlorinated insecticides (DDT and hexachlorocyclohexane), Naturally occurring insecticides-pyrethroids-natural pyrethrins-isolation and structures. Organophosphorous insecticides: Malathion, DDVP. Carbamate insecticides: Sevin, beygon. **Fungicides**: Introduction, organic fungicides, Systemic fungicides-types & examples. **Herbicides:** Introduction, study of heterocyclic sulfonamides, heterocyclic amines, hydroxyoxazolidinones, pyridine herbicides and 1,3,4-oxadiazoles.

Mechanism of action and toxicities of insecticides, fungicides and herbicides.

UNIT – III: POLYMERS

Basic concepts: monomers, repeat units, degree of polymerization, linear, branched and network polymers. Classification and nomenclature of polymers, conducting polymers-

polyanilines. Properties of polymers (brief explanation of molecular weight, glass transition temperature - T_g , solubility and visco-elasticity). Methods of polymerization-addition and condensation polymerization, ionic and free-radical polymerization processes, polymerization with complex catalysts (Ziegler-Natta catalysis), co-polymerization and their mechanisms. Techniques of polymerization - bulk, emulsion.

Stereospecific Polymers - Preparation and significance- classification of polymers based on physical properties - thermoplastics - thermosetting plastics - fibers and elastomers. General applications.

Preparation of Polymers - Preparation of polymers based on different types of monomers -Industrial applications-olefin polymers - diene polymers- nylons - glyptal resins, epoxy resins - ion exchange resins, polycarbonates and its applications.

Polymer degradation reactions: Thermal and oxidative processes.

FOURTH SEMESTER

Chem-SC-O-P-4.5 **ORGANIC CHEMISTRY PRACTICALS-IV**

PAPER-1: Multi step synthesis

1. Oxidation of cyclohexanol to adipic acid via cyclohexanone
2. Esterification: Preparation of benzoccaine from *p*-nitrotoluene
3. Diazotization (Sandmeyer's reaction): Preparation of *p*-chlorobenzoic acid from *p*-toluidine
4. Molecular rearrangement:
    i. Preparation of *o*-chlorobenzoic acid from phthalic anhydride
    ii. Preparation benzilic acid from benzaldehyde
    iii. Preparation of *o*-hydroxy benzophenone from phenyl benzoate via Fries rearrangement
    iv. Prepartion of benzanilide from benzophenone oxime via Beckmann rearrangement.
5. Grignard reaction: Prepearation of triphenyl carbinol
6. Preparation of luminol from phthalic anhydride
7. Synthesis of isoxazolines and pyrazolines via 1,3-dipolar cycloaddition.
8. Solvothermal synthesis
9. Synthesis of tetralones starting from aryl aldehydes.

Synthesis of *m*-chloroiodobenzene from *m*-dinitrobenzene

FOURTH SEMESTER

Chem-SC-O-T-4.6 NATURAL PRODUCTS

UNIT – I: CARBOHYDRATES:

Carbohydrates: Introduction, Ring size determination of monosaccharides, configuration and conformations of monosaccharides, anomeric effect, Hudson's rules, epimerization and mutarotation.

Synthesis, industrial and biological importance of glycosides, amino sugars, sucrose, maltose and lactose.

Polysaccharides: General methods of structure elucidation. Industrial importance and biological importance of cellulose, starch, glycogen, dextran, hemicellulose, pectin, agar-agar. Photosynthesis and biosynthesis of carbohydrates.

Lipids: Nomenclature, classification, purification, synthesis of lipids, phospholipids, sphingolipids, biological importance of lipids: Lecithin, sphingolipids, oils and fats.

Prostaglandins: Introduction, classification and biological importance, constitution of PGE_1.

UNIT – II: AMINO ACIDS, PEPTIDES, PROTEINS AND NUCLEIC ACIDS

Amino Acids: General structure, physiological properties

Peptides: Structure and conformation of peptide bond, peptide synthesis: Solution phase and Merrifield's solid phase synthesis, Racemization and use of HOBt, Synthesis of

oxytocin and vasopressin, biological importance of insulin, selective cleavage of polypeptide bonds (chemical and enzymatic).

Proteins: Structure determination: *C* and *N* terminal residue determination, primary, secondary, tertiary and quartenary structure determination, denaturing and renaturing of proteins.

Nucleic acids: Introduction, structure and synthesis of nucleosides and nucleotides, protecting groups for hydroxy group in sugar, amino group in the base and phosphate functions. Methods of formation of internucleotide bonds: DCC, phosphodiester approach and phosphoramide methods. Solid phase synthesis of oligonucleotides. Structure of RNA and DNA, Crick-Watson model, role of nucleic acids in the biosynthesis of proteins.

Protecting groups: Protection of hydroxyl, carboxyl, carbonyl, thiol and amino groups. Illustration of protection and deprotection in synthesis.

UNIT – III: ALKALOIDS AND STEROIDS:

Alkaloids: Introduction, classification, isolation and general methods of structural elucidation. Biological importance of alkaloids. Structure and synthesis of quinine, morphine, reserpine and lysergic acid. Biosynthesis of alkaloids (nicotine and morphine).

Steroids: Introduction, Structure and synthesis of cholesterol. Ergosterol and its irradiation products. Biological importance of bile acids, estrone, progesterone, testosterone, androsterone and corticosterone.

I. L. Finar, Organic Chemistry, ELBS Longmann, Vol. I & II, 1984.

1. Essentials of physiological chemistry – Anderson, John Wiley & Sons, New York, 1953.
2. K. Albert, L. Lehninger, D.L. Nelson, M.M. Cox, Principles of Biochemistry, CBZ publishers, 1st edition, New Delhi, 1993.
3. Harper's Biochemistry, Ed. R.Harper, 22nd edition, Prentice Hall Press, New York, 1990.
4. Intrdouction to Alkaloids – G.A. Swan
5. The Alkaloids - K.W. Bently
6. Steroids – L. Fiescher and M. Fiescher
7. Steroids – Shoppe
8. Encyclopedia of Chemical Technology – Kirck-Othmer series
9. Harper's Review of Biochemistry – P.W. Martin, P.A. Mayer and V.W. Rodfwell, 15th edition, Maurzen Asian Edition, California, 1981.

I. L. Finar, Organic Chemistry, ELBS Longmann, Vol. I & II, 1984.
A text on petrochemistry by Dr. B.K. Bhaskar Rao, Khanna Publishers, Delhi.
Chemistry of pesticides-Melnikov.
Burger's medicinal chemistry and drug discovery, ed Manfred. E , John Wiley sons, 1995.
Pharmaceutical chemistry, Gurudeep R chatwal, Himalaya publishers, Delhi.
Essentials of physiological chemistry – Anderson, John Wiley & Sons, New York, 1953.
Harper's Biochemistry, Ed. R.Harper, 22nd edition, Prenctic Hall Press, New York, 1990.

FOURTH SEMESTER

Chem-SC-O-P-4.6 **ORGANIC CHEMISTRY PRACTICALS-V**

Organic estimations

1. Estimation of sugars by Fehlings method
2. Determination of enol content by Meyer's method
3. Estimation of ketones by haloform reaction
4. Estimation of sugars by Bertrand's method
5. Estimation of nitro groups
6. Estimation of amino group
7. Estimation of keto group by oxime method
8. Estimation of hydroxyl group.
9. Estimation of vicinal hydroxyl groups
10. Determination of iodine value of an oil or fat
11. Determination of saponification value of an oil
12. Determination of equivalent weight of carboxylic acid by silver salt method.

References:

1. Manual of Organic Chemistry - Dey and Seetharaman.
2. Modern Experimental Organic Chemistry by John H. Miller and E.F. Neugil, p 289.
3. An Introduction to Practical Organic Chemistry - Robert, Wingrove etc.
4. A Text Book of Practical Organic Chemistry – A.I. Vogel, Vol.III
5. Practical Organic Chemistry - Mann & Saunders
6. Semimicro Qualitative Organic Analysis by Cheronis, Entrikin and Hodnet .
7. R.K. Bansal, Laboratory Manual of Organic Chemistry, New Age International (P) Ltd. London, 3rd edition, 1996.

FOURTH SEMESTER

Chem-SC-P-T-4.7 **POLYMERS, SEMICONDUCTORS AND STATISTICAL THERMODYNAMICS**

UNIT I

Polymers: A review of fundamentals of polymers, linear, branched and network polymers. Classification of polymers.

Kinetics of Polymerization - condensation, addition, free radical, ionic, co-ordination polymerization. Kinetics of Copolymerisation and polymer degradation.

Phase transitions in polymers and thermal characterization : Glass transition, crystallinity and melting- correlation with the polymer structure.

Polymers in solution: Criteria of polymer solubility. Thermodynamics of polymer solutions.

Advanced polymeric materials: Polymer Blends interpenetrating Networks and composites- Types, preparation techniques, properties and applications

Polymer processing–processing of plastics, elastomers and fibres. Compounding & processing techniques-calendering, casting, moulding, foaming, fibre spinning & reinforcing techniques.

Polymer degradation and management of plastic waste : Thermal, mechanical, chemical & photodegradation. Methods of plastic waste management. Biodegradable polymers.

UNIT II

Solid state chemistry: Types of imperfections, classification of imperfections, point defects,

Schottky defects, Frenkel defects, disordered crystals, line defects, dislocation types, plane

defects, small-angle and large-angle boundaries, stacking faults, crystal growth and twinning.

Semiconductors: Band theory, energy bands, intrinsic and extrinsic semiconductors.

Conductivity: electrons and holes, temperature dependence on conductivity, Optical properties: absorption spectrum, photoconductivity, photovoltaic effect and luminescence. Junction properties: metal-metal junctions, metal-semiconductor junctions, p-n junctions, transistors, industrial applications of semiconductors: Mixed oxides, spinels and other magnetic materials.

Superconductors: Meissner effect, type I and II super conductors, isotope effect, basic concepts of BCS theory, manifestations of the energy gap, Josephson devices.

UNIT - III :

Statistical Thermodynamics : Micro and macrostates, phase space and ensembles. Concept of distribution - thermodynamic probability and most probable distribution - Maxwell-Boltzmann distribution law. Maxwell`s distribution of molecular velocities. Maxwell-Boltzmann statistics and applications, Bose-Einstein and Fermi-Dirac statistics. Partition functions - definitions and separations, evaluation of translational, rotational, vibrational and electronic partition functions for monoatomic, diatomic and polyatomic gaseous molecules. Calculations of thermodynamic functions and equilibrium constant in

terms of partition functions, entropy of monoatomic gas - Sackur-Tetrode equation, comparison of 3rd law and statistical entropies. Heat capacity behaviour of solids 9hrs.
Irreversible Thermodynamics- Thermodynamic criteria for non-equilibrium states. Entropy production in chemical reactions. Transformations of the generalized fluxes and forces, non-equilibrium stationary states, phenomenological equations. Microscopic reversibility and Onsager`s reciprocity relations. Electrokinetic phenomena and thermoelectricity. Irreversible thermodynamics for biological systems and non-linear regime.

REFERENCES

1. Text book of polymer Science. F.W. Billmeyer, Jr., John Wiley. London (1994).
2. Polymer Science. V. R. Gowrikar, N. V. Vishwanathan and J. Srreedhar, Wiley Eastern,
New Delhi (1990).
3. Fundamentals of Polymer Science and Engineering. A. Kumar and S.K. Gupta, Tata – McGraw Hill New Delhi (1978).
4. Polymer Characterization, D. Campbell and J. R. White, Chapman and Hall, NewYork.
5. Fundamental Principles of Polymer materials, R. L. Rosen, John Wiley, New York.
6. Functional monomers and polymers by K. Takemoto, Y. Inaki and P. M. Ottenbrite, Marcel dekker, Inc., New York, 1987.
7. Solid State Chemistry and Its ApplicationsAnthony R. West.
8. Basic Solid State Chemistry, Second Edition, Anthony R. West.
9. Solid State Chemistry: An Introduction, 3rd editionLesley E. Smart and Elaine A. Moore.
10. Introduction to Solid state Physics—C. Kittel, 5th Edition, Wiley EasternLimited.
11. C.N.R. Rao and J. Gopalakrishna "New Directions in solid state Chemistry"Cambridge
University Press, Cambridge (1999).
12. Binay Kumar, R.P. Tandon "Advances in technologically important crystals" Macmillan
India Ltd.
13. Physical Chemistry, 5th Ed., - Atkins, (ELBS) 1995
14. Themodynamics - Rajaram and Kuriokose (East-West) 1986.
15. Statistical Thermodynamics, M. C. Gupta (Wiley eastern Ltd.) 1993.

FOURTH SEMESTER

Chem-SC-P-P-4.7 **PHYSICAL PRACTICALS –IV**

1. Determination of thermodynamic parameters for the kinetics of decomposition of diacetone
alcohol by NaOH.

2. Spectrophotometric kinetics of oxidation of indigocarmine by chloramine-T (CAT) (a) Determination of order of reaction w.r.t. [CAT] (b) Effect of pH and determination of order
of reaction w.r.t. [H^+].
3. Kinetic study on Ru(III) –catalysed reaction between primary amine and CAT (a) Determination of order of reaction w.r.t. [Ru(III)], (b) Determination of order of reaction w.r.t. [H^+], (c) Determination of E_a and thermodynamic parameters.
4. Kinetics of saponification of ethyl acetate by conductivity method and study the effect of
dielectric constant of the medium (using CH_3OH).
5. Study of photolysis of uranyl oxalate: (a) determination of intensity of light source (b) study of photocatalysis of oxalic acid.
6. Determination of rate for the photolysis of CAB solution.
7. Statistical aspects of radioactivity measurements.
8. Determination of maximum beta energy by Nomogram method.
9. Determination of half-life of ^{40}K.
10. Determination of ratio and product of two activities.
11. Study of salt effect on solubility and determination of activity coefficient.
12. Determination of pK value of an indicator (bromophenol blue).
13. Spectrophotometric analysis of a mixture of (a) $CuSO_4$ and K_2CrO_4.
14. Study of complex formation between ferric salt and salicylic acid.
15. Determination of half wave potential of metal ions in a mixture (Mn^{2+}, Pb^{2+} and Cu^{2+}).
16. Estimation of a metal ion in solution by polarographic method.

REFERENCES

1. Practical Physical Chemistry – A.J. Findlay.
3. Experimental Physical Chemistry –F. Daniels et al.
4. Selected Experiments in Physical Chemistry – Latham.
5. Experiments in Physical Chemistry – James and Prichard.
6. Experiments in Physical Chemistry – Shoemaker.
7. Advanced Physico-Chemical Experiments –J. Rose.
8. Practical Physical Chemistry –S.R. Palit.
9. Experiments in Physical Chemistry – Yadav, Geol Publishing House.
10. Experiments in Physical Chemistry – Palmer.
11. Experiments in Chemistry –D.V. Jahagirdar, Himalaya Publishing Bombay(1994).
12. Experimental Physical Chemistry –Das. R.C. and Behera B, Tata Mc Graw Hill.

FOURTH SEMESTER

Chem-SC-P-T-4.8 **PHARMACO KINETICS AND BIOPHYSICAL CHEMISTRY**

UNIT I

Introduction: Biopharmaceutics, pharmacokinetics, clinical pharmacokinetics, Pharmaco-dynamics, toxicokinetics and clinical toxicology. Measurement of drug concentration in blood, plasma or serum. Plasma level-time curve, significance of measuring plasma drug concentrations. One compartment open model: Intravenous route of administration of drug, elimination rate constant, apparent volume of distribution and significance. Calculation of elimination rate constant from urinary excretion data, clinical application.

Two compartment model: Plasma level-time curve, relationship between tissue and plasma drug concentrations, Apparent volumes of distribution. Drug clearance,

clinical example. Plasma level-time curve for a three compartment open model. Drug absorption:

Factors affecting the rate of drug absorption-nature of the cell membrane, Route of drug administration- oral drug absorption, Intravenous infusion and intravenous solutions, Effect of food on gastrointestinal drug absorption rate.

UNIT II

Drug Bioavailability: Factors affecting the drug bioavailability, rate of dissolution, pH and drug absorption, particle size, clinical applications. *In vitro – In vivo* correlation of rate of dissolution.

Drug release; Kinetics of extended- release dosage forms. Relative and absolute availability, Bioequivalence, clinical significance of bioequivalence studies. clinical examples. Kinetics of Protein binding with drugs: Effect of protein binding on the apparent volume of distribution.

Determination of binding constants and binding sites by Invitro methods (known protein concentration and unknown protein concentration), Relationship between protein concentration and drug concentration in drug-protein binding. Clinical significance. Kinetics of drug elimination and clearance. Renal drug excretion, relation of rate of drug excretion and drug in the plasma. Drug biotransformation reaction, effect of blood flow on elimination half-life and hepatic excretion., drug elimination by capacity limited pharmacokinetics for one component model (IV Bolus). Determination of Km and Vmax in patients, bioavailibility and protein binding reactions. A brief survey of applications of pharmacokinetics in clinical situations.

UNIT III

Electrokinetic Phenomena: Electrophoresis - principles of free electrophoresis, zone electrophoresis, gel electrophoresis and its applications in qualitative and quantitative study of proteins. Determination of isoelectric point of a protein. Electro osmosis and streaming potential and its biological significance. Biological significance of Donnan membrane phenomenon. Micelles and its involvement during digestion and absorption of dietary lipids. Diffusion of solutes across biomembranes and its application in the mechanism of respiratory exchange. “Salting In” and “Salting out” of proteins. Osmotic behaviour of cells and osmo-regulation and its application in the evolution of excretory systems of organisms. Effect of temperature and pH on the viscosity of biomolecules (albumin solution). Significance of viscosity in biological systems - mechanism of muscle contraction, detection of intrastrand disulfide bonds in proteins, polymerization of

DNA and nature of blood flow through different vessels. Effect of temperature, solute concentration (amino acids) on surface tension. Biological significance of surface tension - stability of Alveoli in lungs, interfacial tension in living cells (Danielli and Davson model). Application of sedimentation velocity and sedimentation equilibrium method for molecular weight determination of proteins.

REFERENCES

1. Applied Pharmaceuticals and pharmacokinetics, L.Shargel and Andrew Yu, 4th edition,
Prentice Hall International, London.
2. Essentials of physical chemistry and pharmacy-HJ Arnikar, S. S. Kadam, K. N. Gujan Orient Longman, Bombay, 1992.
3. Introduction to Physical Organic Chemistry, R. D. Gilliom, Madison – Wesley, USA (1970).
4. Physical Organic Chemistry, Reaction Rate and Equilibrium Mechanism – L. P. Hammett, McGraw HillBook, Co., (1970).
5. Biophysical Chemistry, Principle and Technique – A. Upadhyay, K. Upadhyayand N. Nath, Himalaya Publishing House, Bombay, (1998).
6. Essentials of Physical Chemistry and Pharmacy – H. J. Arnikar, S. S. Kadam, K. N. Gujan, Orient Longman, Bombay, (1992).

FOURTH SEMESTER

Chem-SC-P-P-4.8 PRACTICAL PHYSICAL CHEMISTRY- V

1. Amperometric titration of lead nitrate against potassium chromate/potassium dichromate.
2. Coulometric titrations - NaOH vs HCl.
3. Determination of energy gap for semiconductor (Ge) and effect of temperature on semiconductor by four probe method.
4. Electrochemical degradation of Indigocarmine Dye

5. Determination of acidic and basic dissociation constants and isoelectric point an amino acid.
6. Determination of the potential of an electrochemical cell and mean ionic activity coefficient .
7. Verification of Tafel equation of hydrogen evolution reaction.
8 . Study of self adsorption of rays and determine the adsorption curve.
9. Preparation of Fricke and Ceric sulphate dosimeters & calculation of G-value&dose rate
10. Study of isotope dilution analysis; 8. Radiochemical Determination of I -131 in sea water.

11. Photochemical study of decomposition of hydrogen peroxide.
12. Photochemical study of Bleaching of dyes.
13. Photochemical reaction between threonine and ferrous sulphate.

14. Determination of molecular weight and size parameters of polymers by viscometry.
15. Determination of specific heat of liquids and solutions by calorimetry.

16. Determination of stepwise neutralisation of acids.
20. Cryoscopic and ebullioscopic analysis of the given mixture of urea and glucose.
17. Determination of vant Hoff's factor for benzoic and acetic acid mixtures in benzene.
18. Study of adsorption of picric acid on charcoal using a calorimeter.

23. Spectroscopic investigation of partition coefficient of iodine between H_2O and $CHCl_3$.

REFERENCES

1. Practical Physical Chemistry – A.J. Findlay.
3. Experimental Physical Chemistry –F. Daniels et al.
4. Selected Experiments in Physical Chemistry – Latham.
5. Experiments in Physical Chemistry – James and Prichard.
6. Experiments in Physical Chemistry – Shoemaker.
7. Advanced Physico-Chemical Experiments –J. Rose.
8. Practical Physical Chemistry –S.R. Palit.
9. Experiments in Physical Chemistry – Yadav, Geol Publishing House.
10. Experiments in Physical Chemistry – Palmer.
11. Experiments in Chemistry –D.V. Jahagirdar, Himalaya Publishing Bombay(1994).
12. Experimental Physical Chemistry –Das. R.C. and Behera B, Tata Mc Graw Hill.

Note:

1. **In the fourth semester, the students will be distributed equally among the four branches/specializations based on merit in the first two semesters plus admission merit and their choice. They have to select two elective theory papers and two elective practicals from the same branch/specialization. The Dissertation work has to be carried out on topics from the same branch/specializations under the supervision of same branch/specialization faculty members.**
2. **Each practical includes viva voce in all semester.**

THEORY – OPEN ELECTIVE

Chem-OE-A-T-1 **SEPARATION TECHNIQUES OF BIOCHEMISTRY AND BIOLOGY**

UNIT – I

Principles of chromatography: Distribution coefficients, modes of chromatography, selection of stationary and mobile phases, analyte development and elution. Chromatographic performance parameters - Retention time and volume, capacity factor, plate height and resolution.

Gas-liquid chromatography: Principle. Apparatus-columns, sample application, mobile phase, stationary phases, detectors. Applications.

HPLC principles: Instrumentation - columns, stationary phase and matrices, sample application, mobile phases, pumps, detectors. Fast protein liquid chromatography [FPLC].

Ion-exchange chromatography: Principle, materials and applications.

Molecular exclusion chromatography: Principle, materials. Applications - purification, relative molecular mass determination, solution concentration, desalting.

Affinity chromatography: Principle, materials-matrix, liquid, practical procedure, applications. Lectin affinity chromatography, metal-chelate chromatography, covalent chromatography.

Thin layer chromatography: Principle, apparatus - preparation of plates, sample application, plate development, detection of analytes. Applications. Selection of chromatographic systems.

UNIT – II

Electrophoretic techniques: Electrophoresis & Capillary Electrophoresis**:** Theory **-e**lectrophoretic mobility, electroosmotic mobility, electroosmotic flow velocity, total mobility, migration time, efficiency, selectivity and resolution. Instrumentation - capillary tubes, hydrodynamic and electrokinetic methods of sample injection, applying electric field and detectors. Capillary electrophoresis methods - capillary zone electrophoresis, micellar electrokinetic capillary chromatography, capillary gel electrophoresis and capillary electrochromatography.

Concepts of distillation, crystallization, evaporation, dialysis, electro dialysis, osmosis and reverse osmosis.

Centrifugation: Centrifugal force, centrifugal sedimentation, centrifugal decantation, centrifuges, selection of centrifuge tubes. Preparative, density gradient and isopycnic centrifugation. Applications.

Analytical sedimentation: Sedimentation coefficient, sedimentation velocity, applications in biological separations.

Membrane separation: Principles and applications.

References:

1. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.
2. Principles and Techniques of Biochemistry and Molecular Biology, Wilson and Walker, 6th edition, 2006, Cambridge Univ. Press.
3. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
4. Analytical Chemistry, G.D. Christian, 5th edition, 2001 John Wiley & Sons, Inc. India.
5. Separation Techniques in Chemistry and Biochemistry, Roy Keller; M. Dekkar, Inc. 1967.

THEORY-OPEN ELECTIVE

Chem-OE-I-T-2 INORGANIC CHEMISTRY

Unit-1

Introduction to elements-configurations, systematic arrangement, properties and importance. Elements: Concept of orbitals, electron configurations, systematic arrangements-periodic table and periodic properties, bond formation and bond types and structures.

Unit II

Elements in life, environment, water, industry-conductors, insulators, semi conductors, building materials, paints, ceramics, purifiers, drugs and radioactivity.

References:

1. Basic Inorganic Chemistry – 3rd edition. F.A. Cotton, G. Wilkinson and P.L. Gaus, John Wiley and Sons (2002).
2. Inorganic Chemistry, 3rd edition. James E. Huheey, Harper and Row Publishers (1983).
3. Inorganic Chemistry, 3rd edition. G.L. Miessler and D.A. Tarr, Pearson Education (2004).
4. Inorganic Chemistry, 2nd edition. D.F. Shriver, P.W. Atkins and C.H. Langford, Oxford University Press (1994).
5..Inorganic Chemistry, 2nd edition. C.E. Housecroft and A.G. Sharpe, Pearson Education Ltd. (2005).
6. Introduction to Modern Inorganic Chemistry, K.M. Mackay and R.A. Mackay, Blackie Publication (1989).
7.Concepts and Models of Inorganic Chemistry 3rd edition. B.E. Douglas, D.H. McDaniel and Alexander, Wiley (2001).
8. Modern Inorganic Chemistry, William Jolly, TMH.
9.Chemistry of Elements, M. M. Greenwood and Earnshaw, Elsevier.

THEORY – OPEN ELECTIVE

Chem-OE-O-T-3 APPLICATIONS OF SYNTHETIC PRODUCTS

UNIT – I

Dyes: Colour and constitution, classification, dyeing method and their industrial importance.

Drugs: Basic concepts, classification, sources, the requirement of an ideal drug

Synthetic drugs: Structure and medicinal properties:

Sulphanilamide – an example of sulpha drug-paracetamol, aspirin, oil of wintergreen; Mephensin – a muscle relaxant; Ibuprofen – an anti-inflammatory drug; L-dopa – cures Parkinson's disease; Chloroquine – an antimalarial drug; Chlorpromazine – an antipsychotic agent; Phenobarbital – a barbiturate; Omeprazole – an drug; Ciprofloxacin – an antibacterial drug; Formulation of drugs – introduction and classification.

Polymers: Introduction, biodegradable and non-biodegradable polymers and their industrial importance, plastics (uses and effects on enviornment), natural and synthetic rubbers, polyamides and poly esters like nylon, decron, terelyne. Thermoplastics - poly carbonates, poly acrylates in lens applications, polyurethanes and conducting polymers.

UNIT – II

Soaps and detergents: Production and their cleansing action.

Liquid crystals and their applications.

Surfactants

Cosmetics: Detailed study of formulations and manufacturing of cream and lotions, lipstick and nail polish, shampoos, hair dyes and tooth pastes.

Flavours: Natural flavouring materials and classification

Sweeteners: Natural and synthetic sweeteners.

Insecticides: Introduction, classification, applications and their effect on environment.
Pheromones: Introduction, Sources, biological importance.

Explosives: Introduction, RDX, Gun powder.

References:

1. I.L. Finar, Organic Chemistry, ELBS Longmann, Vol. I & II, 1984.
2. K. Albert, L. Lehninger, D. L. Nelson, M. M. Cox, Principles of Biochemistry, CBZ publishers, 1st edition, New Delhi, 1993.
3. Harper's Biochemistry, Ed. R. Harper, 22nd edition, Prentice Hall Press, New York, 1990.
4. Encyclopedia of Chemical technology – Kirck-Othmer series
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6. Green Chemistry and Catalysis, R.A. Sheldon, I. Arends and U. Hanefeld, Wiley-VCH, 2007.
7. Green Chemistry and Practice, P.T. Anastas and J.C. Warner, Oxford University Press, 2000.
8. Greener Approaches to Undergraduate Chemistry Experimnets, American Chemical Society, 2002.

THEORY-OPEN ELECTIVE

Chem-OE-P-T-4 **PHYSICAL CHEMISTRY**

UNIT-I

Chemical kinetics and Electrochemistry

Applications of chemical kinetics: industrial waste water treatment (photodegradation), quantitative determination of effect of drug interaction to the living body, oxidation-reductions reaction study, application of radiochemistry in medicinal chemistry.
Application of Electrochemistry to prevention of corrosion of metals by painting, significance of entropy in the universe.

UNIT-II

Nanochemistry and photochemistry

Synthesis of nano materials by electrochemical method: application of nano materials in colored glasses, waste water treatment, bullet proof jacket, electrochemical oxidation to waste water treatment.
Significance of physical properties: viscosity, surface tension, osmosis, micelles formation in biological system (lungs, kidney, muscle contraction), effect of photochemistry on glucose and some organic compounds.

References:

1. Chemical Kinetics - K.J.Laidler (Harper and Row) 1987.
2. Kinetics and Mechanism of Chemical Transformation by J. Rajaram and J.C. Kuriacose.
3. Biophysical Chemistry, Principle and Technique – A. Upadhyay, K. Upadhyay and N. Nath, Himalaya Publishing House, Bombay, (1998).
4. Nuclear Radiation Detection by Price. Nuclear Radiation Detectors by S.S. Kapoor and
5. Ramamoorthy, Wiley Eastern (1986).
6. 7. Fundamentals of Radiochemistry by D.D. Sood, A.V.R. Reddy and N. Ramamoorthy
7. 8. Fundamentals of Photochemistry – Rohatgi and Mukherje (New Age Bangalore) 2000.
8. 9. Introduction to electrochemistry by S. Glasstone.
9. 10. Treatise on Electrochemistry, G. Kortum 2nd Edition, Elsevier, London (1965).
10. . Nanometerials, A.K. Bandopadhyay, New Age International, 2nd edition.

11. 20. Nanotechnology - Importance and Applications, M. H. Fulekar, Ink International
12. publishing.
13. Themodynamics - Rajaram and Kuriokose (East-West) 1986.

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