

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD
DEPARTMENT OF CHEMISTRY

Credit based syllabus

M.Sc. Chemistry I & II Semester

Effective from June 2013

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD
DEPARTMENT OF CHEMISTRY

Syllabus Based upon Credit System Effective from –June 2013

The department of Chemistry conducts four specializations namely Analytical, Inorganic, Organic and Physical Chemistry.

The M. Sc. Chemistry program of each specialization is divided into Four Semesters with 108 credits, comprising of 16 theory papers and 16 laboratory courses including projects, seminars and tutorials.

A) The 16 theory papers of each specialization include:

Core Courses: 08
Specialized Courses: 08
Elective Courses: 02 not compulsory
Service Courses: 01

B). The 16 laboratory course includes:

Core Courses: 08
Specialized Courses: 08

Credit System and Cafeteria approach

- The credit system with cafeteria approach has been adopted by the department.
- Students will have to learn at least 108 credits for the award of M. Sc. Degree.
- Out of 108 credits students will have to learn at least 36 credits of core courses, 24 credits of specialized courses and 12 credits of elective/service courses.
- Along with these credits of theory courses students are required to earn at least 36 credits of laboratory courses.

-

The following will be the structure for revised syllabus for M. Sc. Chemistry I & II semester effective from June 2013

Semester	Paper No.	Title	Total number of teaching hours	Credits
Semester- I	CHE-101	Analytical chemistry	60 hrs	4
	CHE-102	Inorganic Chemistry	60 hrs	4
	CHE-103	Organic Chemistry	60 hrs	4
	CHE-104	Physical Chemistry	60 hrs	4
	CHE (a)- 209	Laboratory course (General & Analytical)	67.5 hrs.	2.25
	CHE(a)-210	Laboratory course (Inorganic)	67.5 hrs.	2.25
	CHE(a)-211	Laboratory course (Organic)	67.5hrs.	2.25
	CHE(a)-212	Laboratory course (Physical)	67.5 hrs.	2.25
Semester -II	CHE-205	Spectroscopic methods of analysis	60 hrs	4
	CHE-206	Inorganic Chemistry	60 hrs	4
	CHE-207	Organic Chemistry	60 hrs	4
	CHE-208	Physical Chemistry	60 hrs	4
	CHE (b)-209	Laboratory course (General & Analytical)	67.5 hrs	2.25
	CHE(b)210	Laboratory course (Inorganic)	67.5 hrs.	2.25
	CHE(b)211	Laboratory course (Organic)	67.5hrs.	2.25
	CHE(b)212	Laboratory course (Physical)	67.5hrs.	2.25

CHE-101 ANALYTICAL CHEMISTRY**Teaching hours : 60 Clock Hrs****Credits: 04****Unit- I. Basic concepts of Analytical Chemistry:****12 hrs**

The nature of analytical chemistry, the role of analytical chemistry, qualitative and quantitative analytical methods, a typical quantitative analysis - sampling and treatment of samples, validation of a method.

Statistical Treatment of analytical data:

Introduction, types of errors, significant figures, precision and accuracy, methods of expressing accuracy, methods of expressing precision, the confidence limit, tests of significance- the F test, the student T test, rejection of results - the Q test. Statistics for small data sets, linear least squares, correlation coefficient, using spreadsheets for plotting calibration curves, slope, intercept and coefficient of determination, numericals.

Unit - II. Basic Separation techniques: Distillation and Solvent and Solid**Phase extraction:****12hrs**

Distillation: Fractional distillation, distillation under vacuum, theory of operation of distillation methods, some practical considerations.

Solvent and Solid Phase extraction: Phase equilibrium, the partition coefficient the distribution ratio, theory of phase contact methods, single equilibrations, repeated equilibrations, counter current distribution, practical aspects and applications - extraction of metals, extraction of molecular species, Ion pair extractions, Accelerated and microwave assisted extraction, solid phase extraction, Numericals.

Unit - III. Chromatography**12 hrs**

Introduction, basic principles and theory of chromatographic techniques, plate theory of chromatography, rate theory of chromatography, other factors in zone broadening, Development of the chromatogram - Frontal analysis, elution analysis displacement analysis, selection of chromatograph system, qualitative and quantitative analysis by chromatography.

Unit - IV. Chromatographic Systems**12 hrs****(a) Thin layer Chromatography:**

Basic principles, experimental techniques, solvent systems, plate development, detection of components, evaluation of chromatogram by different methods, applications of TLC.

(b) Liquid-Liquid partition chromatography:

Introduction, theory, solid supports, selection of stationary and mobile phases, reverse phase chromatography, choice of adsorption or partition, applications of partition chromatography.

(c) Column Chromatography:

Principle, experimental details, theory of development, column efficiency, factors affecting column efficiency, and applications.

(d) Gel permeation Chromatography:

Principle materials, gel preparation, column packing, detectors and applications.

(e) Ion Exchange Chromatography:

Ion Exchange resins, ion exchange equilibria, ion exchange capacity of resins and its determination, applications of ion exchange resins to chromatography, ion chromatography based on suppressors

Unit- V.**(a) Gas Chromatography:****12 hrs**

Introduction, principles of gas-liquid chromatography, instrumentation - Carrier gas, sample introduction system, columns, detectors, substrates, temperature control, evaluation

Retention volume, resolution, branches of gas chromatography, applications, numericals.

(b) High Performance Liquid Chromatography:

Principle, instrumentation - column, column packing, mobile phase, pumping system, detector system, practical procedure, applications, HPLC adsorption and partition chromatography.

Reference Books:

1. Fundamental of Analytical Chemistry 8th Edn. Skoog, West Hollar, Couch.
2. Analytical Chemistry 6th Edn., G.D. Christian
3. Chemical Separations and Measurements, D.G. Peters, J.M. Hayes and G.M. Hieftie
4. Instrumental Method of Chemical Analysis, G.R. Chatwal & S.K.Anand.

-

CHE-102 INORGANIC CHEMISTRY**Teaching hours: 60****Credit : 04****Unit -I & II: Group theory and symmetry concepts 24 hrs.**

Introduction to symmetry operations, symmetry elements, point group, classifications of point groups, point group of H₂O, NH₃, CO₂, BF₃, C₂H₄, PCl₃, PCl₅, C₆H₆, [PtCl₄]²⁻, [PtCl₂(NH₃)₂], [CoCl₂(NH₃)₄] HCl, BeF₂, CO, [FeF₆], C₂H₂Cl₂, o, m, & p substituted benzene molecule. (AB₂, AB₃, AB₄, AB₅ and AB₆ type molecules) Application of point group, definition of group, properties of group,

Group multiplication table, matrix representation of symmetry elements. Reducible and irreducible representation, character of representation, character of matrix, Conjugate matrix, Properties of irreducible representations, Great orthogonality theorem (without proof) and its importance, construction of character table of C_{2v} & C_{3v} point group. Mulliken symbolism rules for irreducible representations & its applications with examples. Standard reduction formula direct product and uses.

Unit III : Reaction mechanism of transition metal complexes. 12 hr

Classification of inorganic reactions, ligand substitution reaction and their mechanisms of octahedral complexes, acid hydrolysis, factors affecting the acid hydrolysis base hydrolysis, conjugate base mechanism, Electron transfer reaction: mechanism of inner and outer sphere electron transfer reactions in octahedral complexes.

Unit IV : Metal ligand equilibria in solution: 12 hrs

Definition of stability constant, step wise and overall formation constant, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand. Determination of formation constant for binary complexes using pH-metric technique.

Unit V : Inorganic chemistry in biological systems 12 hr

Essential and trace elements in biological systems and their functions, structure and function of metalloenzymes, metallodrugs and metalloporphyrins, Role of Rhodium, Gold, Copper and cobalt complexes as anticancer agents, Electron transfer, Respiration and photosynthesis reaction, Metal deficient diseases of Fe, Zn, Cu and Mn and their therapy.

Reference books:

1. Symmetry and Spectroscopy of Molecules, K.Veera Reddy.
2. Group Theory and symmetry in Chemistry, Gurdeep Raj.Ajay Bhagi and Vinod Jain.
3. Inorganic Chemistry, J.E.Huhey and Keiter R. L
4. Mechanism of Inorganic Reaction. II Edn. Fred Basolo and R.G.Pearsons.
5. Selected Topic in Inorganic Chemistry, Wahid U. Malik, G.D.Tuli and R.D.Madan.
6. Advanced Inorganic Chemistry, F.A.Cotton and Wilkinson.
7. Advanced Inorganic Chemistry, Satyaprakash, G.D.Tuli, S.K.Basu and R.D.Madan.
8. Advanced Inorganic Chemistry, Volume I and II Gurdeep Raj.
9. Concise Inorganic Chemistry, J.D.Lee.
10. A Textbook of bioinorganic chemistry, A. K. Das

CHE-103 ORGANIC CHEMISTRY**Total teaching hrs: 60****Credits: 04****Unit-I: Nature of Bonding in Organic Molecules: [12 hrs]**

Delocalized chemical bonding, conjugation, cross conjugation, resonance, hyperconjugation, bonding in fullerenes, tautomerism.

Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant compounds, Huckel rule, energy level of π -molecular orbitals, annulenes, aromaticity, homoaromaticity, ψ -aromaticity, PMO approach; Bonds weaker than covalent - addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrin, catenanes and rotaxanes.

Unit-II: Reaction Mechanism : Structure and Reactivity [12 hrs]

Types of Mechanisms, Types of reactions, Thermodynamic and Kinetic requirements, Kinetic and Thermodynamic control, Hammond's postulate, Curtin-Hammett Principle, Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects, hard and soft acids and bases, Generation, structure, stability and reactivity of carbocations, Carbanions, free radicals, carbenes and Nitrenes. Effect of structure on reactivity, resonance and field effect, steric effect quantitative treatment, The Hammett equation, Linear free energy relationship, substituent and reaction constants, Taft equation.

Unit-III & IV: Stereo-chemistry: [24 hrs]

Elements of symmetry, chirality, Enantiomeric and diastereomeric relationships, R and S, E and Z nomenclature. Molecules with more than one chiral center, Threo and Erythro isomers, Prochiral relationships, groups and faces, stereospecific and stereoselective reactions. Optical activity in the absence of Chiral Carbon (Biphenyls, allenes and Spiranes), Chirality due to helical shape. Methods of resolution, optical purity, stereochemistry of the compounds containing Nitrogen, Sulphur and phosphorous. Conformational analysis of cycloalkanes, Mono and disubstituted cyclohexanes, decalins, effect of conformation on reactivity.

Unit-V: Aliphatic Nucleophilic and Electrophilic Substitutions: [12 hrs]

Nucleophilic: The SN^2 , SN^1 mixed SN^1 and SN^2 and SET mechanisms. The neighbouring group mechanism, Neighbouring group participation by π and σ -bonds, anchimeric assistance. The SN^1 mechanism. Nucleophilic Substitution at an allylic aliphatic trigonal and a vinylic carbon.

Reactivity : Effect of substrate structure, attacking nucleophile, leaving group and reaction medium. Phase transfer catalysis, Ambident nucleophiles, regioselectivity.

Electrophilic: Bimolecular mechanisms- SE^2 and SE^1 . The SE^1 mechanisms. Electrophilic substitution accompanied by double bond shifts.

Reference Books:

1. Advanced Organic Chemistry, IV Edition: J. March
2. Stereochemistry of Carbon Compounds: E. L. Eliel
3. Advanced organic Chemistry, Part-A and Part-B: F. A. Carey, & R. J. Sundburg.
4. A Guide Book to Mechanism in Organic Chemistry: Peter Sykes.
5. Synthetic Organic Chemistry: H. O. House
6. Principles of Organic Synthesis: R. O. C. Norman
7. Stereochemistry of Organic Compounds: D. Nashipuri
8. Organic Chemistry: Clayden and Greeves
9. Mechanism and Structure in Organic Chemistry: E. S. Gould

CHE-104 PHYSICAL CHEMISTRY**Total Teaching Hours : 60****Credits: 04****Unit I: Ionic Equilibria and Biological Reactions****12 hrs.**

Exact treatment of the dissociation of weak acids and bases, Dissociation constant of polyprotic acids, Statistical effects in polyprotic acids, Dissociation constant of complex ions, Logarithmic expression for pH and pOH, Calculations involving buffer solution, buffer capacity and buffer index, Salt effect and solubility product and its applications.

Thermodynamics of biochemical reactions, Binding of oxygen by myoglobin and hemoglobin, Reaction between microscopic and macroscopic dissociation constant.

Unit II: Chemical Dynamics**12 hrs.**

Collision theory, modified collision theory, weakness of the collision theory, Theory of absolute reaction rates, equilibrium hypothesis, Derivation of the rate equation, statistical mechanical derivation and thermodynamic formulation. Isotope effect on reaction rate. Primary salt effect, secondary salt effect.

Dynamics of uni-molecular reactions, Lindmann and Hinshelwood theory

Kinetics of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis and NMR method.

Reactions in solution: Reaction between ions, influence of solvent-double sphere model, single sphere model, influence of ionic strength, numericals.

Unit III: Classical Thermodynamics**12 hrs.**

Nernst heat theorem, the third law of thermodynamics, determination of absolute entropies of solids, liquids and gases. Partial molar properties : Partial molar free energy, chemical potential, partial molar volume and partial molar heat content and their significance, determination of these quantities, concept of fugacity and determination of fugacity.

Thermodynamic probability of a system of a distinguishable and indistinguishable particles, Sterling approximation, Boltzmann distribution law, Bose Einstein distribution law and Fermi – Dirac distribution law, partition function, energy in terms of partition function, entropy in terms of partition function, translational partition function, entropy for monoatomic gases, Sakur-Tetrode equation, rotational partition function, vibrational partition function, numerical.

Unit IV: Surface Chemistry:**12 hrs.**

Surface tension, capillary action, pressure difference across curved surface (Laplace equation) vapour pressure of droplets (Kelvin equation) Gibbs adsorption isotherm, estimation of surface area (BET equation), surface films on liquids (Electro kinetic phenomenon), catalytic activity at surfaces, numericals.

Colloidal electrolytes, Types of micelles in colloidal electrolytes, Micellization, Thermodynamics of micellization, Mechanism of Micellization, critical micellar concentration, Determinations of critical micellar concentration, Surface active agents, Classifications of surface active agents, Reverse micelles, Solubilization

Unit V: Electro-Chemistry**12 hrs.**

Debye-Huckel theory of strong electrolytes, Debye-Huckel-Onsager equation Testing of the equation, Debye-Falkenhagen effect, Wien effect, activity coefficient, mean ionic activity coefficient; Debye-Huckel limiting law ionic strength. Electrocapillary phenomena, and its measurements. Effect of anions, cations and molecules on electrocapillary curves. Electrocapillary properties of mercury-solution interface.

Polarography: the Ilkovic equation and its derivation, concentration polarization, instrumentation, advantages of DME, half wave potential. Applications of polarography, numerical.

-

References books:

1. Chemical Kinetics - Laidler (McGraw-Hill)
2. Kinetic and Mechanism of Chemical Transformations - J. Rajaram and J.C. CURIACOSE (Macmillan India Ltd.)
3. Physical Chemistry - Alkins (Oxford)
4. Thermodynamics for Chemists - S. Glasstone (EWP, New Delhi)
5. Physical Chemistry - G. M. Barrow
6. Advanced Physical Chemistry - Gurdeep-Raj (Pelenum)
7. Micelles : Theoretical and Applied Aspects - V. Moroi (Plenum)
8. Text Book of Physical Chemistry - S.Glasstone (McMillan)
9. An Introduction to Electrochemistry - S. Glasstone (EWP, New Delhi)
10. Physical chemistry – Robert A .Alberty ., Robert J .Silbey
11. Statistical Thermodynamic – M. C. Gupta

-

CHE-205 SPECTROSCOPIC METHODS OF ANALYSIS**Teaching hours : 60 hrs****Credits : 04****Unit -I : General introduction of spectral methods of analysis. 12 hrs**

Characterization of electromagnetic radiations, Regions of the spectrum, Interaction of radiations with matter - absorption, emission, transmission, reflection, dispersion, polarization and representation of spectra. resolving power, signal to noise ratio. line width, and intensity of spectral lines. Energy levels. Components of spectrometer and their functions.

Microwave spectroscopy: Rotation of molecules, rotational spectra, diatomic molecules - rigid diatomic molecules, effect of isotopic substitution, non-rigid rotator, the spectrum of non-rigid rotator, instrumentation and applications, numerical problems.

Unit – II : Vibrational and Raman spectroscopy 12 hrs

Review of linear harmonic oscillator, the vibrating diatomic molecule, the simple harmonic oscillator, the anharmonic oscillator, the diatomic vibrating rotator, the vibration-rotation spectrum of carbon monoxide, breakdown of the Born-Oppenheimer approximation, the vibration of polyatomic molecules, overtones and combination frequencies, the influence of rotation on the spectra of polyatomic molecules, the influence of nuclear spin, symmetric top molecules, analysis by Infra-red technique - Group frequencies, outline of technique and instrumentation. **Raman spectroscopy:** Theories of Raman effect, pure rotational, Vibrational and Vibrational-rotational. Raman spectra, rule of mutual exclusion, overtone and combination vibrations, Rotational fine structure, Instrumentation and applications.

Unit –III : 12 hrs

Photoelectron spectroscopy : Basic principles, ESCA- Introduction - ESCA - ESCA satellite peaks spectral splitting ESCA chemical shifts, instrumentation, applications, Auger electron spectroscopy (brief review)

Thermal methods of analysis :

Thermogravimetry, principles, factors affecting thermal curve and application. Differential thermal analysis - principles, factors affecting DTA curve, applications. Differential scanning calorimetry - principles, instrumentation and applications. thermometric titrations, numerical.

Unit -IV. 12 hrs**Ultraviolet- Visible Spectroscopy :**

Various Electronic transitions, chromophores, Auxochromers, Bathochromic and Hypsochromic Shifts, Effect of solvent on electronic transitions, Woodward-Fieser rules for dienes, enones and aromatic compounds, Applications of U.V.

Infrared Spectroscopy

Characteristic vibrational frequencies of alkenes, alkynes, aromatic compounds, Carbonyl compounds, hydroxy compounds, amines and metal-ligand complexes. Factors affecting IR group frequencies, overtones, combination bands and Fermi resonance. Applications of IR.

Unit- V.**Nuclear Magnetic Resonance Spectroscopy 12 hrs**

Elementary Ideas, Chemical Shifts, Factors affecting chemical shifts, Spin-Spin couplings and coupling constants (J), Integration. Problems based on combined applications of UV, IR and NMR.

References Books :

1. The Determination of Molecular Structure : P. J. Wheatley
2. Physical Chemistry : G. M. Barrow
3. Instrumental Methods of Chem. Analy. Chatwal and Anand.
4. A Text book of Phy. Chem. : A.S. Negi & S. C. Anand
5. Instrumental Methods of Chemical Analysis - Willard, Merritt, Dean & Seale
6. Instrumental Methods of Chemical Analysis - Chatwal, Anand
7. Instrumental Methods of Chemical Analysis - B.K. Sharma
8. Instrumental Methods of Chemical Analysis -R.D. Braun
9. Analytical Chemistry : Skoog and West
10. Principles of Instrumental Analysis : Skoog and West.
11. Fundamentals of Molecular Spectroscopy : Banwell.
12. Atomic and Molecular Structure : Manas Chanda
13. Molecular Spectroscopy : B.D. Acharya
14. Molecular Spectroscopy : Dyer.
15. Organic Spectroscopy : P.S. Kalsi (6th Edition).
16. Spectroscopic Methods in Organic Chemistry : D.H. Williams and I.Fleming.
17. Spectrometric Identification of Organic Compounds : R.M. Silverstein, Morrill and G.C. Bassler
18. Introduction to Spectroscopy : Pavia, Lampman and Kriz (3rd Edition)
19. Organic Spectroscopy : William Kemp (3rd Edition).
20. Quantum Chemistry- B. K. Sen
21. Inorganic Chemistry - Atkin and Shriver.

-

CHE-206 INORGANIC CHEMISTRY**Teaching hours: 60****Credit : 04****Unit -I : Spectroscopic term symbols:****12 hrs.**

Terms, Inter-electronic repulsion, spin orbit coupling, ground terms, determination of term symbol for d^1 to d^5 Configuration / complexes, Hund's rule, microstates, Racah Parameter. Weak and stronger field approach, correlation diagram of d^1 , d^2 , d^8 and d^9 configuration in octahedral and tetrahedral environments, Non-crossing rule, Orgel diagram of d^1 to d^9 configuration in an octahedral and tetrahedral environments, Tanabe Sugano diagram of d^2 and d^3 configuration of an octahedral environments.

Unit II : Electronic Spectra and magnetic properties of metal complex :**12 hrs.**

Types of experimental recording of the spectra, interpretation of electronic spectrum of transition metal complex with suitable examples, Band intensities, intensity of d-d bands, intensity of charge transfer bands. Calculation of D_q , B and β parameters. Classification of charge transfer transitions and their mechanisms with suitable examples. **Magnetic moment, electronic spectrum and structure of cobalt and Nickel complexes. ferromagnetic and anti-ferromagnetic behavior of compounds. Magnetic exchange coupling,**

Unit III : Chemistry of Metal Carbonyls**12 hrs.**

Classification; Chemistry of carbonyl group Preparation, properties, structures and bonding in - iron carbonyls, $Ni(CO)_4$, $Co_2(CO)_8$, $Mn_2(CO)_{10}$, $Cr(CO)_6$, $Mo(CO)_6$ and $W(CO)_6$, $Co_4(CO)_{12}$ and $V(CO)_6$. EAN rule applied to these carbonyls structures of mixed carbonyls of transition metals and EAN rule applied to these carbonyls. Preparations carbonyl halides

Unit IV: Metal nitrosyl compounds**12hrs.**

Preparations and properties of Nitrosyl halides (NOX), Metal nitrosyl halides, compounds containing NO- group, Compounds containing NO+ groups, Preparation, structure and application of sodium Nitropruside. EAN and Eighteen electron rules applied to: Nitrosyl compounds of Cobalt, iron and Manganese. Significance of NO for the life of living animals

Unit-V : Dioxygen and Dinitrogen Complexes:**12 hrs.**

Preparation of Cobalt containing dioxygen complexes, structural and functional analogy of cobalt dioxygen complexes with naturally occurring dioxygen complexes.

Preparation, properties and structures of dinitrogen complexes of Molybdenum, Structural and functional similarities with naturally occurring hemoglobin and nitrogenase protein and enzymes. Preparation, structure and bonding in Non-carbonyl metal clusters viz. Binuclear (Re_2Cl_8)²⁻, Trinuclear ($ReCl_3$)₃, Tetranuclear ($W_4(OR)_6$) and Hexanuclear (Mo_6Cl_6)⁴⁺ ions.

Preparation, properties and structures of Zintl anions & cation of the metal Ge, Sn, Pb, Sb, Bi

References Books:

1. Advanced Inorganic Chemistry Vol. I & Vol. II - By - Gurdeep and Raj.
2. Inorganic Chemistry (Principles, Structures and Reactivity) (Fourth Edition)
By - J.E. Hubeey, E.A. Keitler, R.L. Keitler.
3. Inorganic Chemistry (IIIrd Edition) - By G.Y. Miessler and D.A. Tarr.
4. Advanced Inorganic Chemistry - Vol. I - By Satyaprakash, Tuli, Basu and Madan.
5. Selected Topics in Inorganic Chemistry - By W.U. Malik, G.D. Tuli & R.D. Madan.
6. Chemistry of the Elements - By N. N. Greenwood and A. Earnshaw.
7. Inorganic electronic spectroscopy, - A.B.P. Lever.
8. Symmetry and Spectroscopy of Molecules - K. Veera Reddy.
9. Physical Chemistry through problem - Dogra and Dogra.
10. Inorganic Chemistry - Attkin and Shriver.
11. Concise Inorganic Chemistry - By J.D. Lee.
12. Element of Magnetochemistry - By A.Samal & R. L. Datta.
13. Some aspect of Crystal Field theory- T. M. Dunn, D.S. McClure & R. G. Person
14. Introduction to Magnetochemistry- Alan Earnshaw
15. Introduction to Ligand Field - B. N. Figgis.-

CHE-207 ORGANIC CHEMISTRY**Teaching hrs: 60****Credits: 04****Unit-I: Aromatic Electrophilic and Nucleophilic Substitutions: [18 hrs]**

Electrophilic Substitutions: The arenium ion mechanism, orientation and reactivity, energy profile diagram. The ortho/para ratio, IPSO substitution, orientation in other ring system, Recapitulation of halogenation, nitration, sulphonation and Friedel Craft's reaction, diazonium coupling. **Nucleophilic Substitution:** The S_N^{Ar} , S_N^1 , benzyne mechanism, Effect of substrate structure, leaving group and attacking nucleophile on reactivity.

Unit-II: Addition to Carbon –Carbon multiple bond: [12 hrs]

Mechanism and stereochemical aspect of addition reaction involving electrophile, nucleophile and free radicals. Regioselectivity and chemoselectivity, orientation and reactivity, Michael addition, Sharpless asymmetric epoxidation.

Unit-III: Addition to Carbon–Hetero Multiple bond: [12 hrs]

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acid, ester and nitriles. Addition of Grignard reagent, Organo zinc and organo lithium reagent to carbonyl and unsaturated carbonyl compounds. Wittig reaction. Mechanism of condensation reaction involving enolates – Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin, Stobbe reaction. Hydrolysis of esters and amides.

Unit-IV: Elimination Reactions: [12 hrs]

The E_1 , E_2 , and E_{1CB} mechanism, orientation of double bond. Reactivity: effect of substrate structure, attacking base, the leaving group and the medium, pyrolytic elimination.

Unit-V: Rearrangements: [06 hrs]

General mechanistic consideration, nature of migration, migratory aptitude, memory effect, pinacol-pinacolone, Benzil–Benzilic acid, Beckmann, Hoffman and Fries rearrangements.

Reference Books:

1. Advanced Organic Chemistry, IV Edition: J. March
2. Advanced organic Chemistry, Part-A and Part-B: F. A. Carey, & R. J. Sundburg.
3. A Guide Book to Mechanism in Organic Chemistry: Peter Sykes.
4. Synthetic Organic Chemistry: H. O. House
5. Principles of Organic Synthesis: R. O. C. Norman
6. Organic Chemistry: Clayden and Greeves
7. Mechanism and Structure in Organic Chemistry: E. S. Gould

CHE-208 PHYSICAL CHEMISTRY**Teaching Hours : 60****Credits: 04****Unit - I: Quantum Chemistry: I****12 hrs.**

The Schrodinger equation, particle in a one dimensional box, Eigen values and Eigen functions, operators, properties of quantum mechanical operators, Hermitian, Linear, Ladder, Hamiltonian and angular momentum operators.

Particle in three dimensional box, harmonic oscillator, rigid rotator and numericals.

Unit - II: Quantum Chemistry: II**12 hrs.**

Term symbols and selection rules, spin-orbital coupling, the variation theorem, non-degenerate perturbation theory and applications. Huckel molecular orbital theory of conjugated systems, application to ethylene, butadiene, cyclopropenyl radical, cyclobutadiene and benzene, numericals.

Unit –III : Phase Rule:**12 hrs.**

Recapitulation of phase rule and terms involved in it, one component system, two component systems (solid-solid, solid-liquid and liquid-liquid), reduced phase rule, three component systems, partially miscible three liquid systems : one partially miscible pair, two partially miscible pairs, three partially miscible pairs, systems composed of two solids and a liquid : crystallization of pure components only, formation of binary compounds, formation of ternary compounds, formation of solid solutions, partial miscibility of solid phases, numericals.

Unit –IV : Crystallography**12 hrs**

Classification of solids on the basis of shapes, and bonding, crystal lattice and unit cell, laws of crystallography crystal symmetry, symmetry elements, lattice planes and their designations, liquid crystals.

Principle of crystal structure. close packing of atoms, packing of equal sized spheres in HCP, CCP, BCC structures. packing in ionic solids, ionic radius, radius ratio rule, (3, 4, 6, 8 coordinate structures). octahedral and tetrahedral voids, isomorphism and polymorphism, numericals.

Unit –V : Photochemistry**12 hrs.**

Absorption of light and nature of absorption spectra, electronic transitions. photo-dissociation and pre-dissociation. photo-oxidation, photo-reduction and photo-dimerization. photo-physical phenomenon. Jablonski diagram. photo-physical pathways of molecular de-excitation, difference between delayed fluorescence and phosphorescence, Stern-Volmer equation, deviations from Stern-Volmer equation, concentration dependence of quenching and excimer formation, quenching of fluorescence formation of excimer and exciplexes.

References Books:

1. Quantum Chemistry : Ira N. Levine
2. Quantum Chemistry : R.K. Prasad
3. Quantum Chemistry : B.K. Sen
4. Principles of Physical Chemistry : Puri, Sharma, Pathania
5. Advanced Physical Chemistry : Gurdeep - Raj, Plenum.
6. Physical Chemistry : Maron and Prutton
7. Introduction to Molecular Photo-chemistry : C.H.J. Wells
8. Fundamentals of Photo-chemistry : Rohatgi-Mukherjee.
9. Photo-chemistry : J.G. Calvert & J.N. Pitts.
10. Photo-luminescence of solutions : C.A. Parker.
11. Photo-chemistry : A. Singh and R. Singh
12. Atkins's Physical Chemistry : Peter Atkins

13. Solid State Chemistry : D.K. Chakraborti
14. Solid State Chemistry and its applications : A.R. West.
15. The Determination of Molecular Structure : P.J. Wheatley.
16. Solid State Chemistry : N.B. Hannary.
17. Principles of Solid State : H.V. Keer.
18. Physical Chemistry : G.K. Vemulapalli.

-

CHE -210 (A & B) LABORATORY COURSE (INORGANIC)**Laboratory work hours: 135 hrs.****Credit : 4.50****List of experiments****I) Semi micro Qualitative Inorganic analysis.****08 mixtures**

Identification of basic radicals including one rare earth and three common metal ion and one interfering acidic radical using semi micro qualitative analysis method

Note : Each mixture should contain different rare earth elements

II) A. Separation and estimation of metal ions from the following**binary mixture solutions :****Any[04]**

- | | | |
|--------------------|-------------------|--------------------|
| 1. Copper- Nickel | 2. Copper- Iron | 3. Nickel- Zinc |
| 4. Iron- Magnesium | 5. Copper- Barium | 6. Iron –Aluminium |

III).Synthesize, characterization and estimation of metal ion from the metal complexes.**Any [07]**

- | | | |
|---|---|---|
| 1. $\text{Ti}(\text{C}_9\text{H}_8\text{NO})_2 \cdot 2\text{H}_2\text{O}$ | 2. $\text{VO}(\text{acac})_2$ | 3. Cis- |
| $\text{K}[\text{Cr}(\text{C}_2\text{O}_4)_2(\text{H}_2\text{O})_2]$ | | |
| 4. $[\text{Mn}(\text{acac})_3]$ | 5. $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3]$ | 6. $[\text{Co}(\text{II})(\text{Py})_2\text{Cl}_2]$ |
| 7. $[\text{Co}(\text{III})(\text{NH}_3)_6]\text{Cl}_3$ | 8. $[\text{Co}(\text{III})(\text{NO}_2)(\text{NH}_3)_5]\text{Cl}_2$ | 9. $[\text{Ni}(\text{NH}_3)_6]\text{Cl}_2$ |

Note : i).Synthesis should be carried out using (0.02 to 0.06 mole) of the starting materials.
ii). Practical Yield, % yield, theoretical yield and percentage of metal ion content should be recorded

IV) Paper Chromatography :**Any [02]**

- Determine the R_f Values of Silver lead and Mercury by paper Chromatographic method.
- Determine the R_f Values of Copper, Cadmium and Mercury by paper Chromatographic method
- Determine the R_f Values of Nickel, Manganese and Zinc by paper Chromatographic method
- Determine the R_f Values of Barium, Calcium and Strontium by paper Chromatographic method

Note : Submit the Paper chromatograph for verification with R_f values.

Note : Student will not be allowed for practical examination if his/her record book is not completed and certified.

Reference Book:

- A Text book of Micro and Semi micro Qualitative Inorganic Analysis ;
IV edn, A. I. Vogel
- A Text book of Quantitative Inorganic Analysis; A. I. Vogel
- Practical Inorganic Chemistry; Pass Geoffrey and Haydn Sutcliffe.
- Advanced Practical Inorganic Chemistry; Gurudeep Raj;.
- Vogel's Qualitative Inorganic Analysis, D. Svehla, VII Edn.Orient Longman Ltd.

Scheme of Marking:

I Semi micro Inorganic analysis:

25 Marks

- i). Preliminary Test : [max. marks:02]
- ii). Group identification: [max. marks:06]
- iii). Step wise analysis of groups : [max. marks:05]
- iv).C.T of Acidic/Basic radicals : [max. marks:06]
- v). Spot test : [max. marks:06]

Note : At least one spot test for each radical should be performed and be reported

II) Separation and Estimations:

20 Marks

- i). Flow chart of separation : [max. marks;02]
- ii). Estimation of first component by gravimetric / volumetric method ,
observation table, : [max. marks:08]
- iii). Estimation of second component by gravimetric / volumetric method,
observation table : [max. marks:08]
- iv). Correct calculation & reporting results : [max. marks:07]

III) Synthesis & estimation of Metal Complexes

20 Marks

- i). Spectral Analysis (UV/IR) : [max. marks :04]
- ii). Yield of complexes : [max. marks: 04]
- iii). Estimation of metal percentage by gravimetric / volumetric method,
observation table, : [max. marks: 08]
- iv). Correct calculation & reporting of results : [max. marks: 04]

IV) Paper Chromatography :

10 Marks

- i) Submission of paper chromatograph: [max.marks:05]
- ii). Correct calculation & reporting of results : [max. marks:04]
- V) Record Book & Viva : [max .marks 05]

CHE -211 (A & B) LABORATORY COURSE (ORGANIC)**Laboratory work hours: 135 hrs.****Credit : 4.50****List of experiments:****1) Qualitative Organic Analysis:****[30 Marks]**

Separation, purification and identification of binary mixtures.

The separation should be carried out using ether/ dichloromethane.

The two components may be solid-solid, solid-liquid or liquid-liquid (non-volatile).

The water soluble solid/liquid should also be given.

Student should submit the purified samples of the separated compounds and prepare a suitable derivative of the two compounds separated out.

Note : Analysis of at least ten mixtures should be carried out.**1) Single Stage Preparations:****[15 Marks]**

i) Benzaldehyde to cinnamic acid (Perkin Reaction).

ii) o-Iodo or o-chlorobenzoic acid from Anthranilic Acid.

iii) β -benzoyl propionic acid from succinic anhydride and benzene
(Friedel-Craft reaction)

iv) p-nitro acetanilide from acetanilide.

v) p-nitrobromobenzene from bromobenzene.

vi) Dibenzal acetone from Benzaldehyde

vii) Salicylaldehyde from phenol (Reimer-Tiemann Reaction).

Note:

i) The preparations should be carried out using (0.02 to 0.05 mole) of the starting material.

ii) The yield, melting point and TLC of the recrystallised product should be recorded.

iii) The sample of the purified product and TLC plate should be submitted for inspection.

Note : Student will not be allowed for practical examination if his/her record book is not completed and certified.**Scheme of Marking:****1. Qualitative Organic Analysis**

	Marks
Type of the mixture	06
i). Analysis of the individual components:	
ii). Detection of Elements	03
iii). Detection of functional groups	02
iv). Determination of MP/BP	03
v). Preparation of the derivative	02
vi). Identification (Spotting)	02
2. Preparation	
i). Yield of the recrystallized product	05
ii). MP of the recrystallized product	05
iii). TLC of the recrystallized product	05
3) Record Book + Viva voce	05

CHE -212 (A & B) LABORATORY COURSE (PHYSICAL)

Laboratory work hours: 135 hrs.

Credit : 4.50

List of experiments

A. Instrumentation.

1. Determination of strengths of halides in a mixture potentiometrically.
2. Determination of dissociation constants of phosphoric acid potentiometrically.
3. Determination of dissociation constants of weak acid potentiometrically.
4. Determination of acidic and basic dissociation constants of an amino acid and its isoelectric point.
5. Determination of the strength of strong and weak acid in a given mixture conductometrically.
6. Determination of solubility and solubility product of sparingly soluble salt BaSO_4 .
7. Study of kinetics of inversion of cane sugar.
8. Determination of equilibrium quotient for the formation of monothiocyanato iron (III) complex.
9. Determine the indicator constant of given indicator by colorimetric measurements.
10. Determine the pK_1 and pK_2 value of phosphoric acid by pH metry.
11. To study the kinetics of mutarotation of glucose/fructose potentiometrically.

B. Non-Instrumentation.

1. Determine the molecular refraction of methyl acetate, ethyl acetate, n-hexane and carbon tetrachloride and calculate the refraction of CH_2 , C, H and O atoms.
2. To study the effect of surfactants (sodium chloride) on surface tension of given liquid.
3. To determine the radius of molecule by viscosity measurements.
4. To study the adsorption of acetic acid from aqueous solution by activated charcoal and examine the validity of Freundlich and langmuir's isotherm.
5. To construct the phase diagram for three component system (chloroform-acetic acid-water).
6. Determine the solubility of benzoic acid in water at different temperature and hence its heat of solution.
7. Determine the velocity constant of hydrolysis of ester.
8. To study auto catalysis reaction between potassium permanganate and oxalic acid.
9. Determine the rate constant of the reaction between potassium persulphate and potassium iodide having equal/unequal concentration of the reacting species.
10. Determine the formula of the complex formed between Cu(II) and ammonia by distribution method.
11. To study the variation of viscosity with the composition of mixtures (ethanol-water- HNO_3 -chloroform) and to determine the formation of complex between two liquids.

-

Note : Student will not be allowed for practical examination if his/her record book is not completed and certified.

Scheme of marking :

1) Experiment I (Instrumentation)	Max .Marks	Experiment -II (Non-instrumentation)	Max. Marks
i) Observation :	10		08
ii) Calculation :	05		04
iii) Graph :	05		04
Accuracy& Results :	05		04
Record book & Viva :	05		05

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
AURANGABAD
Department of chemistry

Revised Syllabus

M.Sc. III & IV Semester Inorganic Chemistry

Effective from June 2014

Effective from June 2014

The following will be the structure for revised syllabus for M. Sc. Inorganic Chemistry III & IV semester effective from June 2014

Semester	Paper Nos.	Title of Paper	Durations (Hr)	Max. Marks	Credits
III- Semester	CHE-313	Applications of Spectroscopy	60	50	4
	CHEI- 314	Bioinorganic and supramolecular Chemistry	60	50	4
	CHEI-315	Applied Inorganic chemistry	60	50	4
	CHEI-316	Chemistry of materials	60	50	4
IV semester	CHEI: 417	Nuclear Chemistry	60	50	4
	CHEI: 418	Photoinorganic Chemistry	60	50	4
	CHEI: 419	Therapeutic Bioinorganic and chemistry of forensic materials	60	50	4
IIIrd & IVth Semester Laboratory course	CHEI: 420	Organo transition metal chemistry	60	50	4
	CHEI- 421	Laboratory course (Inorganic)	135	50	4.5
	CHEI- 422	Laboratory course (Inorganic)	135	50	4.5
	CHEI- 423	Laboratory course (Inorganic)	135	50	4.5
	CHEI- 424	Project Work (inorganic)	135	50	4.5

CHE-313 Structural Elucidation by Spectral methods

Duration : 60 hrs

Marks : 50 Credit : 04

UNIT-I Nuclear Magnetic Resonance Spectroscopy (^1H NMR)

Elementary ideas (Recapitulation); Spin-spin couplings, Different types of couplings, factors affecting on coupling constants, Karplus equation, Spin systems (AB, AX, ABX, AMX), Rate processes, spin decoupling, shift reagents, Nuclear Overhauser effect (NOE), INEPT and INADEQUATE.

UNIT-II ^{13}C Nuclear Magnetic Resonance Spectroscopy

Elementary ideas, instrumental problems, chemical shifts (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbons); Effect of substituent's on chemical shifts.

UNIT-III Mass Spectroscopy

Introduction, ion production (EI, CI, FD and FAB), ion analysis, ion abundance, factors affecting on fragmentation, fragmentation of different functional groups, molecular ion peak, isotopic peaks, metastable peak, Nitrogen rule, McLafferty rearrangement, Retro-Diels-Alder reaction.

UNIT-IV

Problems based on joint applications of UV, IR, ^1H NMR, ^{13}C NMR and Mass spectroscopy.

UNIT-V

Mossbauer spectroscopy: Principle, factors affecting the line position and shape, isomer effect and Quadrupole splitting iron salt like compounds, complexes, carbonyl compounds (temperature dependence of isomer shift and Quadrupole splitting in simple compound and coordination, polynuclear complexes), Numericals.

Electron Spin Resonance Spectroscopy: Introduction, principle of ESR spectroscopy, presentation of spectrum, hyperfine splitting in various structures, hyperfine splitting digram of representative examples, factors affecting the magnitude of 'g' values, Zero field splitting, Kramer's degeneracy, Anisotropy in the hyperfine coupling constant, electron delocalization, instrumentation and applications.

Reference Books:

- 1 Introduction to Spectroscopy: D. L. Pavia, G. M. Lampman, G. S. Kriz
- 2 Spectrometric Identification of Organic Compounds: R. M. Silverstein & F. X. Webster
- 3 ^{13}C NMR Spectroscopy: G. C. Levy, R. L. Lichter, G. L. Nelson
- 4 Spectroscopic Methods in Organic Chemistry: D. H. Williams & I. Fleming
- 5 Absorption Spectroscopy of Organic Compounds: V. M. Parikh
- 6 Mass Spectrometry: K. G. Das & James
- 7 Coordination Chemistry by Experimental Methods: K. Barger
- 8 Coordination Chemistry vol. I: E. Martell
- 9 Physical Methods for Chemistry: R. S. Drago
- 10 Structural Methods in Inorganic Chemistry: E. A. V. Ebsworth & D. W. H. Rankin
- 11 Organic Structure Analysis: Philips Crews

CHEI- 314 Bioinorganic and Supramolecular Chemistry

Duration : 60 hrs

Marks : 50 Credit : 04

Unit- I . Metalloenzymes; [12 hrs]

Structural and functional relationships and mechanisms of enzymatic reaction in the following metalloenzymes. **Zinc Enzymes:** carbonic anhydrase and carboxypeptidases, **Copper Enzymes:** super oxide dismutases **Iron Enzymes:** catalase and peroxidases, **Molybdenum Enzymes:** nitrogenase and xanthanine oxidase, **Coenzyme Vitamin:** B-12

Unit-II. Metal Nucleic Acid Interactions; [12 hrs.]

Introduction, nucleic acid structures, structures and binding sites in nitrogen bases, phosphates and sugar base. Coordination complexes of nucleic acids and their bases with metal ions. Hydrogen bonding, redox reaction and hydrolytic reaction of nucleic acids mechanisms of these reactions, nature's role, pharmaceutical role, catalytic role

Unit-III . Molecular Recognition: [12 hrs]

Basic concepts and principles of supramolecular chemistry, Host-Guest interactions, spherical recognition, anionic receptors, porphyrin-sapphyrin systems, organometallic receptors, tetrahedral multiple and neutral molecular cleft recognition, enzyme models, molecular receptors, design and synthesis.

Unit - IV. Supramolecular reactions and catalysis [12hrs]

- a. Catalysis by anion, cation and metal receptor molecules and co catalysis.
- b. Molecular and supramolecular devices : likes Photonic, Electronic and ionic devices..

Unit-V: Techniques in Bioinorganic chemistry: [12hrs]

Principles and applications of electronic spectroscopy, IR spectroscopy, NMR spectroscopy, Raman spectroscopy

Reference Books:

1. Bioinorganic chemistry By:-Bertini Ivano, Gray H. B., Lippard S. J. & Valentine J. S.
2. Principles of Bioinorganic chemistry By:- S. J Lippard & M. J. Berg
3. Inorganic Biochemistry, (Vol.I & II) By:- G. L. Eicchorn.
4. Bioinorganic chemistry :- A. K. Das.
5. Bioinorganic chemistry - R. W. Hay.
6. Bioinorganic chemistry - Chatwal G. R. & A. K. Bhagi.
7. Supramolecular chemistry -Lehn J. M.
8. Bioinorganic & Supramolecular chemistry - Chatwal G. R. & A. K. Bhagi.
9. Bioinorganic, Bioorganic & Supramolecular chemistry By:-Kalasi P. S.
10. Supramolecular organometallic chemistry By:- j. L. Atwood and Jonathava W. steed, Macel Jekkar Publisher
11. Supramolecular Organometallic chemistry -Jean Marie-Lehn.

CHEI-315 Applied Inorganic chemistry

Duration : 60 hrs

Marks : 50 Credit : 04

Unit -I. Basic concept of zeolites:

[12 hrs]

Introduction, definition, classifications on the basis of morphological appearance, SBU, substitution of other iso-electronic metal ions, types of pore size. Lowenstein's rule. pore and channels, channel dimensions, shape of the pore opening, nomenclature of zeolites, structural aspect of zeolites, acidity of zeolite, identification of acidic sites, nature of active sites, synergetic effects, shape selectivity.

Unit-II Synthesis of zeolites

[12 hrs]

General methods for synthesis of zeolite, hydrothermal treatment, mechanism of aluminosilicate formation during Sol-Gel, co-precipitation process, factors affecting the zeolite formation, general procedure for modification of zeolites, Oswald's rules of successive transformation, crystallization and its identification, factors affecting crystallization, template theory, organic additives, crystallizing zeolites, ZSM-5 from an organic free solvent system, synthesis in nonaqueous solvents.

Unit -III Characterization and applications of zeolite

[12 hrs]

General characterization techniques for analysis of zeolites, Details on FTIR, Pyridine adsorbed- IR analysis, XRD analysis, ^{27}Al MAS NMR and ^{29}Si MAS NMR analysis, Temperature programmed desorption (TPD), probe molecules for TPD analysis, measurement and analysis with suitable examples. Zeolite catalyzed reactions, water softening treatment using zeolites.

Unit -IV. Basic Chemical Calculations:

[12 hrs.]

Moles, mole percent composition, mole fraction, weight & volume percent analysis of solid in composition, **Material balance involving chemical reaction:** Introduction, material balances, definition of terms, Concept of Selectivity, Conversion, numericals

Unit -V

Catalysis, types of catalysis, catalyst, properties of catalyst, classification of catalysts, Sabtier's principle, classification of solid catalysis, fundamentals of heterogeneous catalysis, factor affecting the catalyst performance, promoters, types of promoters, Inhibitors, catalyst poisoning, overview on heterogeneously catalyzed process in industry, Principle of green chemistry, Atom economy, numericals.

Reference Books:

1. Molecular sieves: Principles of synthesis and Identifications R-Szostak.
2. Atlas of zeolite framework type; Ch. Barlocher, W M. Meier, D. H. Olson; 5th rev. Ed. Elsevier Amsterdam 2001
3. Stoichiometry (SI Units): B.I. Bhatt & S.M. Vora.
4. Molecular Sieves Science and technology; H. G. Karge, J Weitkamp Vol I to V, Springer
5. Industrial catalyst- A Practical Approach, Jens Hygen, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany
6. Heterogeneous Catalysis and Solid Catalysts, Olaf Deutschmann, Helmut Knozinger, Karl Kochloefl, Thomas Turek, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim

-

CHEI-316 : Advances in material chemistry

Duration : 60 hrs

Marks : 50 Credit : 04

Unit- I : General introduction & synthesis of nanomaterials by physical methods: [12 hrs]

Objective of study, synthesis of nanoparticles by physical method, mechanical methods- high energy ball milling, melt mixing, method based on evaporation, physical vapour deposition with consolidation. Ionized cluster beam deposition. Laser vaporization, Laser pyrolysis, sputter deposition, electric arc deposition, Chemical Vapour Deposition (CVD).

Unit- II : Synthesis of Nanomaterials by Chemical Methods : [12hrs]

Introduction, colloids and colloids in solution, interaction of colloids and medium, colloids in vacuum, colloids in medium, effect of charge on colloids, stearic repulsion, synthesis of colloids, growth of nanoparticles, synthesis of metal and semiconductor nanoparticles by colloidal route, Langmuir-Blodgett (L-B) method, sol gel method, electrochemical method.

Unit-III : Analysis Technique : [12hrs]

Introduction, microscopes, electron microscopes, SEM, TEM, Scanning probe microscope (SPM), Scanning Tunneling microscope, Atomic force microscope, X-ray diffraction, UV-visible and IR spectroscopy.

Unit-IV : Properties, types and application of Nanomaterials: [12hrs]

- i). Properties of nanomaterials – Mechanical, electrical, optical, magnetic, semiconductor.
- ii). Some special nanomaterials – Carbon nanotubes, porous silicon, Arogels, Zeolites.
- iii). Application – Electronic, energy automobiles, sport and toys, textile, cosmetics, domestic appliances, biotechnology, medical, space, defence & environment.

Unit-V : Imperfections in solids: [12hrs]

Perfect and imperfect crystal, point defects, stoichiometric defects, Schottky & Frankle defects, thermodynamics of their formation, colour centers, Non-stoichiometric defects, metal excess and metal deficiency defects, line imperfections, Edge dislocation, Screw dislocation, Burgers circuits, Surface imperfections, grain boundaries & stacking faults.

Theories of solid states – free electron theory, band theory, refinement to simple band theory.

Reference Books:

- 1) Solid State Chemistry and applications- A.R. West (John Wiley and Sons)
- 2) Principles of the Solid State- H.V. Keer (Wiley Eastern Limited)
- 3) Nanotechnology: Principles and practices- Sulabha K. Kulkarni (capital Pub. Co.)
- 4) NANO- The next revolution –Mohan Surendra Rajan(National book Trust, India)
- 5) The British Glass Website- Types of Glass://www.britiglass.org.uk.
- 6) Fundamental of Nanotechnology – Gabor L. Hornyak, John J. Moore, Harry F. Tibbals, Joydeep Dutta.
- 7) Recent advances in the liquid phase synthesis of Inorganic Nanoparticles- B. L. Cushing , 8) V. L. Kolesmichenko & C.J.O".Connor Chemical Review 104, 3893-3946.(2004)

CHEI: 417 Nuclear Chemistry**Period : 60 hrs.****50 Marks****Credit : 04****Unit- I Nuclear particles and its properties****[12 hrs]**

The fundamental particles, roll call of elementary particles, composition of the nucleus, theories of nuclear composition, nuclear properties, mass defect and binding energy, nuclear stability explained by different factors.

Nuclear size and density, mechanical effects due to orbiting and spinning of nucleons, orbital angular momentum of the nucleons, Total angular momentum of the nucleons, magnetic quantum numbers, principal and radial quantum numbers, total angular momentum of nucleus, total magnetic nuclear angular momentum quantum number, The spin of odd Z odd N nuclei, The Nordheim rule.

Unit- II Nuclear models :**[12 hrs.]**

The shell model and its salient features, periodicity in nuclear properties- magic numbers, forces of nuclear potential, energy level in nuclear potential well, the sequence of filling the orbital including models, nuclear configuration. The liquid drop model, and its details and The Fermi gas model.

Unit III Radioactivity:**[12 hrs.]**

Historical, background, natural radioactive elements, general characteristics of α , β , γ rays, detection and measurement of radioactivity, the theory of radioactive disintegration, decay kinetics, units of radioactivity, parent daughter growth relationship- secular and transient equilibrium, theory of α decay, β decay – energetics of β decay problems of β decay, fermi theory of β decay, nuclear de-excitation – emission, numerical

Unit-IV Nuclear Reactions.**[12 hrs.]**

Definition and Bethes notation, nuclear reaction energetic, nuclear reaction and threshold energy, characteristics of nuclear reactions, types of nuclear reactions, conservation in nuclear reactions, nuclear reactions cross section, cross section and reaction rate, the compound nucleus theory, general properties of compound nucleus, optical model, direct interaction model, specific nuclear reactions- photonuclear reactions, stripping and pickup reactions evaporation, spallation, fragmentation, direct nuclear reactions, thermonuclear reactions.

Unit - V Radiation chemistry and its applications**[12hrs]**

A. Introduction of radiation with matter, primary effects due to charged particle/radiation, Linear energy transfer(LET), Bethes equation for LET, Bremsstrahlung, the cerenkov radians, interactions of electron with matter, interaction of neutrons with matter, interaction of heavy charged particles with matter. typical application of radioisotopes as tracers- chemical investigation, physio-chemical research, analytical applications, agricultural applications, industrial applications, use of nuclear radiations, radioisotope as a source of electricity

Reference Books.

1. Source of Atomic energy by s. Glasstange, D. Van Nostrand co. INC
2. Essentials of nuclear chemistry by H.J. Arnikar 4th Edn, New Age International(p) Ltd.
3. Introduction to Nuclear By chemistry B. G. Harvey,
4. Nuclear chemistry by M. G. Arora & M. Singh Anmol publication, New Delhi
5. Elements of nuclear chemistry by A. K. Srivastav, P. C. Jain, S. Chand & Co.
6. A text book of Nuclear chemistry by C.V. Shekar Dominant publication & distribution, New Delhi.
7. Radiochemistry & nuclear chemistry, 3rd edn G. chappin, Butterwerth-Heinemann.

CHEI :418 Photoinorganic Chemistry**Duration : 60 hrs****Marks : 50 Credit : 04****Unit –I Basic concept of Photo Chemistry:****[12hrs]**

Introduction to photochemistry, laws of photochemistry, Quantum yield, deviation in quantum yield, Experimental determination of quantum yield, Quantum yield and reactivity, life time of electronically excited state, kinetic aspects of photochemical reactions, temperature dependence of photochemical reaction, Methods used to study the kinetics of photochemical reaction: Flow methods, flash photolysis methods, numerical on quantum yield calculations.

Unit- II Physical properties of electronically excited molecules :**[12 hrs]**

Nature of changes on electronic excitation, potential energy diagram, shapes of absorption bands and Franck-Condon principle, emission spectra, environmental effect on absorption and emission spectra. **Photo physical process in electronically excited molecule:** Types of physical pathways, Jablonski diagram, theory of radiationless transition, theory of radiative process, bimolecular quenching, experimental results.

Unit III. Excited States of Metal Complexes:**[12 hrs.]**

Spectroscopic states of d^1 to d^{10} configurations, Ligand field excited states of Co(II), Cr(III), Ru(II), Ru(III), Fe(II) and Rh(III) in an octahedral complex, Excited states of organic ligand with examples, selection rules for electronic transitions. **Charge transfer photochemistry** :Introduction, charge transfer absorption spectra, types of charge transfer excitations and their energy level scheme for charge transfer excitations, Types of reactions observed by CTM, Models of photoredox system.

Unit-IV. Ligand field photo chemistry of transition metal complexes :**[12hrs]**

Photochemistry Cr(III) of complexes : Photo-substitutions, properties of ligand field excited states, Photoaquation reactions, photolysis rule, photoisomerization, photo racemization, photoanation reactions, sensitizer, energy transfer process, Mechanism of photo sensitization, photo reactive excited state, The Doublet hypothesis, Role of quartet excited states, Photochemistry of Co(III) complexes : Introduction, energy level diagram, Photoaquations in Co(III) amine, Co(III) cyanide complexes, Fe(II) low spin complexes., Ru(II) ammine derivative complexes, Photo redox properties of (Ru(III) complexes, **Ce(III) and Ce(IV) complexes.**

Unit-V. Photochemical reactions on solid surface:**[12hrs]**

Introduction, Photo catalysis, photoreactive oxide materials, relation between band gap & energy, wavelength, photo electron transfer mechanism, energy level diagram of solid acceptor and donor levels. Supported photo catalyst: Types of support & need, Supported Semiconductor supported metal oxides for Photolysis of water, Decomposition of organic pollutants, experimental setup, and end product of organic moieties. **OLED, Solar energy conversion and its storage.**

Reference Books :

1. Concepts of Inorganic Photo chemistry, W. Adamson
2. Inorganic spectroscopy, A. B. P. Lever
3. Symmetry and spectroscopy of Molecule, K. Veera Reddy,
4. Inorganic Chemistry, J. E. Huhey
5. Fundamental of Photochemistry, Rohatgi Mukherjee
6. Inorganic chemistry, Attkin and shriver
7. Advanced Inorganic Chemistry, Gurdeep Raj.
8. A. W. Maverick and Harry B. Gray, Pure and applied chemistry, 52, 2339- 2348
9. Peter C Ford, The Photosubstitution Reactions of Rhodium (III) Ammine complexes, Journal of Chemical Education, 60, 10, 831, (1983).
10. Richard J Watts, Ruthenium Polypyridyls, Journal of Chemical Education, 60, 10, 835, (1983).
11. J. N. Demas, Photophysical Pathways in metal complexes, Journal of Chemical Education, 60, 10, 803, (1983)
12. L. D. Kirk, Chromium Ammines and Acidoammines, Journal of Chemical Education, 60, 10, 843, (1983)
13. D. Chatterjee, Visible light induced photo degradation of organic pollutants on dye Adsorbed TiO_2 surface : Bull. Cat. Soc. of India 2,,56-58, 2004

CHEI- 419 Therapeutic Bioinorganic and chemistry of forensic materials

Duration : 60 hrs

Marks : 50 Credit : 04

Unit- I: Metal ions in carcinogenesis: [12 hrs.]

General and biochemical aspects of cancer, carcinogens and anticancer agents. Carcinogenesis and its mechanism. Role of metal complexes and Pt(II) and (IV) as anticancer agents, anticancer activity of rhodium, gold, copper, and cobalt complexes. Selenium and its biochemical role and its mechanism of cacinostatic actions. Some representative metallodrugs containing arsenic, antimony, gold, mercury and tin metal. Antibacterial, antifungal and antiviral activity of metal; complexes.

Unit- II: Chemistry of Forensic Materials [12 hrs]

Forensic toxicology, legal definition of poison and toxinology, human and cattlepoison, and its antidotes. Principle underlying removal of poison from the body and use of antidotes, corrosivepoison and its classification. Common household poisons. Characteristic sign, symptoms, treatment and medicolegal aspects of common household poisons, classifications of poisons according to their mode of action.

Unit- III: Concepts on metal ion toxicity [12 hrs]

Metal ion toxicity in man and animals. Introduction, general aspects of Pb(II), Cd(II), and Hg(II), biochemical and physiological effects caused due to Pb(II), Cd(II), and Hg(II) ion toxicity. Detoxifications of this metals using chelating agents.

Unit- IV: Interactions of metal ions and metal complexes [12 hrs]

Structure and functions of amino acids, proteins, peptides, enzymes nucleoside, nucleotide and comparative study of structures and functions of these biomolecules. Metal ion binding sites present in amino acids, peptides, proteins,enzymes, nucleoside and nucleotide. Interactions of metal ion and metal complexes with these biomolecules.

Unit – V Physical methods in Bioinorganic chemistry : [12 hrs]

A). Electrophoresis method : Types of electrophoresis , principles and applications of capillary electrophoresis , analysis of bands using different methods **B). Centrifugation methods :** Basic principles of sedimentation, types of centrifuges and rotors, types of centrifugations and applications.**C). Spectrophotometric method :** UV- visible spectroscopic techniques and their applications.

Books Suggested

1. Inorganic biochemistry – by Guther L. Eicchornvol 1 and 2 volume (Elsevier Scientific Publishing Company Amsterdam 1973, London New York.
2. Pharmacological basis of therapeutic, 5th and 6th edition by –Louis S. Goodman, (Macmillan Publishing company...INC, New York, Toronto and London)
3. Metal ions in biological system by- Helmut Sigel. Vol. 19 21, 22 - (Marcel Dekker INC, New York and Basel)
4. Metal ions in biological system (Concepts on metal ion toxicity) by Helmut Sigel. Vol.7- (Marcel Dekker INC, New York and Basel)
5. Modi's Medical Jurisprudence and Toxicology 22nd Edition.
6. Parikh's Textbook of Medical Jurisprudence, Forensic Medicine and Toxicology (Six Edi8tion) By C. K. Prikh. (CBS Publishers & distributors 4596/1A 11, Daryagaing New Delhi- 11002
- 7). Bioinstrumentations – L Veerakumari , MJP publisher Chennai
- 8). Principles of bioinorganic chemistry – S. J Lippard & J M Berg , Mill Valley californua
- 9) Elements of BVioinorganic - G N Mukherjii, and Arbinda Das U N Dhur and Sons Pvt. Ltd Kolkatta

CHEI: 420 Organo transition Metal Chemistry

Period : 60 hrs.

50 Marks

Unit- I. General Properties of Organotransition Metal Compounds [12 hrs]

Definition, Classification based on the number of coordinated carbon (Hapticity), number of electrons donated by ligands, and type of bonding. Nomenclature, 16, 17, 18 Electron complexes and ligand substitutions, electron counting for common ligands and geometry of organo transition metal compounds.

Unit – II . Alkyl ,aryl Carbene and carbene transition metal compounds. [12 hrs]

General method of synthesis of alkyl and aryl transition metal compounds, (i.e Ti, V, W, Mn, Ir, Co, Fe), Chemical properties, stability and decomposition pathways.

Carbene transition compounds: Types of carbene compounds, properties of carbene ligands, Synthesis of Fischer type carbene compounds, Chemical reaction on coordinated carbene compounds .**Carbyne transition metal compounds :** Synthesis and chemical properties

Unit- III. Transition metal compounds with Unsaturated organic molecules: [12 hrs.]

H² alkene transition metal compounds : General methods of the synthesis, Chemical properties: Reaction with nucleophiles and Electrophiles, Structure and bonding (DCD model)

η² alkyne transition metal compounds: Introductions, preparation, chemical properties, Structure and bonding. **η³ allyl transition metal compounds:** Introduction, Structural verities in allyl transition metal compounds, General methods of preparation, chemical properties, structure and bonding.

η⁴ butadiene transition metal compounds: Introduction, General methods of preparation, reaction on coordinated ligand, structure and bonding. **η⁴ Cyclobutadiene transition metal compounds:** Preparation and chemical properties of (C₄H₄)Fe(CO)₃, structure and bonding.

η⁵ Cyclopentadienyl transition metal compounds: Introduction, classification of η⁵- Cyclopentadienyl derivatives, Preparation and chemical properties of (η⁵-C₅H₅)₂Mn, (η⁵-C₅H₅)Mn(CO)₃, structure and bonding in Ferrocene.

Unit- IV Organotransition metal compound as catalysts and synthetic reagents [12 hrs]

Activation process: consequent changes in the coordinated ligand reactivity, template effect.

Protection: Steric control, facilitation of nucleophilic addition reactions. **Product isolation:**

Reductive elimination, β-eliminations, radical formation, alkene or arene displacement by competing ligand, electron transfer from metal atom to an oxidant, release of carbenoid ligands.

Unit –V Catalytic processes involving organotransition metal compound: [12 Hrs]

Hydrogenation of alkene using Wilkinson's catalysts, hydrosilation reaction, hydroformulation of alkene (oxo process) Ziegler Natta polymerizations. Fischer Tropsch process, water gas shift reaction. Monsanto process for acetic acid synthesis., Wacker process of oxidation of alkene.

Reference Books:

1. Organo metallic Chemistry, R. C. Mehrotra, & A. Singh
2. Principal and applications of organotransition metal Chemistry, J. P. Collman, L. S. Hegeudus, J. R. Norton
3. Inorganic Chemistry , Attkin and Shriver
4. Advanced Inorganic Chemistry, Gurdeep Raj.
5. Inorganic Chemistry, J. E. Huhey

M. Sc. Inorganic chemistry Semester –III & IV
Laboratory course (Inorganic) CHEI - 421

4.5 hrs/week

Max Marks : 50

I. Preparation, estimation of metal ion, UV/IR spectrum of metal complexes to be prepared (any 05)

• **Single step preparation**

1. Tris (thiourea) Copper(II) Sulphate
2. Bis (thiourea) Zinc (II) sulphate
3. $\text{NH}_4[(\text{Cr}(\text{III})(\text{C}_2\text{O}_4)_3]$
4. $[\text{Ni}(\text{II})(\text{Salicyldoxime})_2]$
5. [Copper (II) (Acetyl acetone)₂]
6. Manganese (II) Phthalocyanine
7. Mercury(II) Dithizonate

• **Two step preparation : i). Preparation of ligand ii). Preparation of metal complex**

1. Copper(II) complexes of Schiff base derived from salicylaldehyde with aniline/ substituted aniline
2. Cobalt(II) complexes of Schiff base derived from salicylaldehyde with aniline/ substituted aniline
3. Nickel(II) complexes of Schiff base derived from salicylaldehyde with aniline/ substituted aniline
4. Zinc(II) complexes of Schiff base derived from salicylaldehyde with aniline/ substituted aniline
5. Iron(III) complexes of Schiff base derived from salicylaldehyde with aniline/ substituted aniline

II Inorganic composite materials.

1. Preparation and magnetic properties of Zinc ferrite.
2. Preparation and magnetic properties of Cobalt ferrite
3. Preparation and magnetic properties of Nickel ferrite
4. Preparation of FeTiO_3 and utilization for degradation of methylene blue.
5. Preparation and catalytic applications of sulphated zirconia for acid catalyzed reactions
6. Preparation, characterization of Nickel nano particles.
7. Synthesis of Aluminosilicate zeolite and their catalytic application.

III. Collection of UV Visible, IR , XRD, TGA/DTA Spectrum/pattern analysis inorganic compounds / metal complexes / metaloxides / nanoparticles

Reference Books:

1. Nano technology: Principles and Practices-Sulbha K. Kulkarni
2. A Text book of Quantitative Inorganic Analysis; A. I. Vogel
3. Practical inorganic chemistry; Pass Geoffrey and haydn Sutcliffe.
4. Advanced Practical inorganic chemistry; Gurudeep Raj.
5. Internet Search of UV Visible, IR , XRD, TGA/DTA Spectrum/pattern analysis metal complex/ metal oxides materials

Scheme of marking

1. Preparation of complexes. Single/ two step preparation [20 marks]
2. Preparation of inorganic composite materials/ diffraction data analysis of inorganic compounds [15 marks]
3. UV Visible, IR , XRD, TGA/DTA Spectrum/pattern analysis [10 marks]
4. Record book and viva voce [05 marks]

Laboratory course (Inorganic) CHEI - 422

**4.5 hr per week
50 marks**

I Spectrophotometer:

1. Estimate the amount of copper and bismuth ions using EDTA, photometric titration method
2. Determine the stability constant, empirical formula, λ max. by job's method, mole ratio and slope ratio method.
3. Determine the pK_a of Methyl red indicator
4. Simultaneous determination of MnO_4^- and $Cr_2O_7^{2-}$
5. Determination of Fe(II) by using O-phenanthroline reagent.

II. P^H metrically

1. Determine the P_k value of benzoic acid by using irri vaing Rossotgi method. by P^H metric method and metal ligand stability constant of its complex.
2. Determine the P_k value of Phthallic acid by using irri vaing Rossotgi method by P^H metric method and metal ligand stability constant of its complex.
3. Determine the P_k value of Glycine by using irri vaing Rossotgi method. by P^H metric
4. Determine the metal ligand stability constant of copper benzoate complex by pH metric method.
- 5 Determine the metal ligand stability constant of copper phthalate complex pH metric method.
6. Determine the metal ligand stability constant of copper glycinato complex by pH metric method.

III. Conductometry

- 1 Analyze the acid mixture hydrochloric acid and acetic acid by conductometric method.
2. Analyze the mixture of copper sulphate, hydrochloric acid and acetic acid by conductometric method.
3. Determine the stability constant and composition/formula of lead oxalate by conductometric method.
4. Determine the solubility and solubility product of sparingly soluble salt by conductometric method.

IV. Potentionmetry

1. Determine the redox potential of Fe(II)/Fe(III) system and hence determine the number of electron involved in the system using $K_2Cr_2O_7$ by potentiometric method.
2. Determine the amount of chloride, bromide and iodide in the given sample by potentiometric method.
3. To determine the stability constant of $[Ag(NH_3)_2]^+$ complex by potentiometric method.
- 4.. To determine the stability constant of silver thiosulphate complex by Potentiometric method.

V. Turbidometry

1. Determine the sulphate content of the given sample using turbidometric titration.

VI. Flame photometry:

1. Estimate the amount of sodium/potassium from the given sample

VII. Application of Computer in Chemistry: at least 05 expt

- A. Application of Microsoft EXCEL in Chemistry (Attach the printed sheet in your record book)**

- | | |
|---|----|
| 1. Calculate the excess molar volume of given data | 02 |
| 2. Calculate the excess viscosity of given data | 02 |
| 3. Calculate the excess free energy of given data | 02 |
| 4. Plot graph between $x = \sin\theta$ Vs $Y = \cos\theta$, $\theta = 0 - 360^\circ$ | |
| 5. Plot the Neat labeled graph from given data | 06 |
| 6. Arrange the data increasing order of trend. | 02 |

Reference Books/ Journals:

1. Systematic experimental physical chemistry – T. K. Chondhekar & S.W. Rajbhoj
2. Experiments in chemistry – D.V. Jahagirdar
3. Textbook of quantitative Inorganic Analysis – IV Edn. J. Bassett, R. C. Denny, G.H.Gefery and J. Mendham
4. Journal of Chemical Engineering Data, India. Journal of Chemistry, Journal of Indian Chemical Society, (Note: Data collection for computer practical)

Scheme of marking

- | | |
|---|-------------|
| 1. Experiment on Spectrophotometer/ P ^H meter/ Conductometry / Potentiometer / Turbidometry / Flame photometry | [30 marks] |
| 2. Experiment on applications of Excel | [15 marks] |
| 3. Record book and Viva Voce | [05 marks] |

=

Laboratory course (Inorganic) CHEI- 423

06 hr per week

50 marks

I. Magneto chemistry : at least 10 sample

1. Determine the number of unpaired electron in the given sample by Gouy's balance method

Select the sample : Copper sulphate, sodium sulphate, calcium carbonate, potassium ferrocyanide, potassium ferricyanide, coordination complexes

2. To verify the Weidemann's law using nickel chloride solution and determine number of unpaired electron in it.

II. Alloy analysis : any 02

- i. Solder alloy analysis
- ii. Stainless steel alloy analysis
- iii. Brass and bronze alloy analysis.
- iv. Copper nickel alloy
- v. Qualitative analysis of soil

III. Ore analysis : 02

- i. Analysis of dolomite ore
- ii. Analysis of calcite ore
- iii. Analysis of Haematite ore
- iv. Analysis of bauxite ore.

IV. Analysis of metals in drug sample

- i. Analysis of calcium from given drug sample
- ii. Analysis of Iron from given drug sample
- iii. Analysis of water soluble vitamin forms the given sample.
- iv. Determination of number of water molecules present in given samples
- v. Analysis of forensic toxic metal ion

Scheme of marking

1. Analysis of Ore/alloy	[25 marks]
2. Experiments on magneto chemistry/ analysis of drug sample, Vitamin, Forensic sample, water in samples	[20 marks]
3. Record book and Viva Voce	[05 marks]

Project work (Inorganic) CHEI - 424

4.5 hrs/week
Max Marks : 50

Tentative topic of Project work

1. Design , synthesis and characterizations of ligands molecules
2. Synthesis and characterizations metal complexes.
3. Preparation of single crystal of metal salts/ metal complexes
4. Synthesis, characterizations and applications of metal nano particles.
5. Synthesis, characterizations and applications of metal oxides / mixed metal oxides of transition/ non transition metals.
6. Synthesis and characterizations of mesoporous materials
7. Designing the assemblies for purification of water using inorganic materials
8. Photodegradation studies of organic pollutants using inorganic catalytic materials
9. Water analysis/ Soil analysis
10. Analysis and utilization of fly ash
11. Preparation and characterization of thin film of semiconductor materials.
12. Application of computer in chemistry.: EXCEL, computational software in chemistry
13. Kinetics of ligand substitution reaction

Scheme of marking

Project work Evaluation : 25 marks

- i. Literature survey
- ii. Experimental procedures , photographs
- iii. Characterizations techniques : Fundamentals principles of respective techniques
- iv. Spectrum / images of prepared materials
- v. Data analysis / applications of synthesized materials
- vi. Conclusion
- vii. Reference citations
- viii. Holistic response of students (scientific thinking, power of imagination, Punctuality, efforts, curiosity,)

Power point presentation of Project work : 25 marks

- i. Self preparation PPT
- ii. Skill of presentation
- iii. Contents of presentation
- iv. Subject knowledge
- v. Manuscript preparation/acceptance/publication

Reference : i). Library Work ii). Internet search is compulsory

**Dr. Babasaheb Ambedkar Marathwada University,
Aurangabad
Department of chemistry**

Revised Syllabus

M. Sc.III & IV semester Organic Chemistry

Effective from June 2014

The following will be the structure for revised syllabus for M. Sc. Organic Chemistry III & IV semester effective from June 2014

Semester	Paper Nos.	Title of Paper	Durations (Hr)	Max. Marks	Credits
III- Semester Theory courses	CHE-313	Structural Elucidation by Spectral methods	60	50	4
	CHEO- 314	Organic Synthesis	60	50	4
	CHEO-315	Asymmetric Synthesis and Bio-Organic Chemistry	60	50	4
	CHEO-316	Photochemistry, Free Radicals And Pericyclic Reactions	60	50	4
IV semester Theory Courses	CHEO: 417	Organic Synthesis: Retrosynthetic Approach	60	50	4
	CHEO: 418	Advanced Organic and Heterocyclic Chemistry	60	50	4
	CHEO: 419	Chemistry of Natural Products	60	50	4
	CHEO: 420	Medicinal Chemistry	60	50	4
III & IV Semester Laboratory Courses	CHEO-421	Laboratory course (Organic)	135	50	4.5
	CHEO - 422	Laboratory course (Organic)	135	50	4.5
	CHEO- 423	Laboratory course (Organic)	135	50	4.5
	CHEO- 424	Project work (Organic)	135	50	4.5

--

Structural Elucidation by Spectral methods**UNIT-I Nuclear Magnetic Resonance Spectroscopy (^1H NMR)**

Elementary ideas (Recapitulation); Spin-spin couplings, Different types of couplings, factors affecting on coupling constants, Karplus equation, Spin systems (AB, AX, ABX, AMX), Rate processes, spin decoupling, shift reagents, Nuclear Overhauser effect (NOE), INEPT and INADEQUATE.

UNIT-II ^{13}C Nuclear Magnetic Resonance Spectroscopy

Elementary ideas, instrumental problems, chemical shifts (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbons); Effect of substituents on chemical shifts.

UNIT-III Mass Spectroscopy

Introduction, ion production (EI, CI, FD and FAB), ion analysis, ion abundance, factors affecting on fragmentation, fragmentation of different functional groups, molecular ion peak, isotopic peaks, metastable peak, Nitrogen rule, McLafferty rearrangement, Retro-Diels-Alder reaction.

UNIT-IV

Problems based on joint applications of UV, IR, ^1H NMR, ^{13}C NMR and Mass spectroscopy.

UNIT-V

- (A) **Mossbauer spectroscopy:** Principle, factors affecting the line position and shape, isomer effect and Quadrupole splitting iron salt like compounds, complexes, carbonyl compounds (temperature dependence of isomer shift and Quadrupole splitting in simple compound and coordination, polynuclear complexes), Numericals.
- (B) **Electron Spin Resonance Spectroscopy:** Introduction, principle of ESR spectroscopy, presentation of spectrum, hyperfine splitting in various structures, hyperfine splitting digram of representative examples, factors affecting the magnitude of 'g' values, Zero field splitting, Kramer's degeneracy, Anisotropy in the hyperfine coupling constant, electron delocalization, instrumentation and applications.

Reference Books:

1. Introduction to Spectroscopy: D. L. Pavia, G. M. Lampman, G. S. Kriz
2. Spectrometric Identification of Organic Compounds: R. M. Silverstein & F. X. Webster
3. ^{13}C NMR Spectroscopy: G. C. Levy, R. L. Lichter, G. L. Nelson
4. Spectroscopic Methods in Organic Chemistry: D. H. Williams & I. Flemming
5. Absorption Spectroscopy of Organic Compounds: V. M. Parikh
6. Mass Spectrometry: K. G. Das & James
7. Coordination Chemistry by Experimental Methods: K. Barger
8. Coordination Chemistry vol. I: E. Martell
9. Physical Methods for Chemistry: R. S. Drago
10. Structural Methods in Inorganic Chemistry: E. A. V. Ebsworth & D. W. H. Rankin
11. Organic Structure Analysis: Philips Crews

UNIT-I Oxidation

- (a) Oxidation of alcohol to aldehyde, ketone or acid: Jones reagent, Swern oxidation, Collins reagent, Fetizon's reagent, PCC, PDC, PFC, IBX, Activated MnO₂, Chromyl chloride (Etard reaction), TEMPO, CAN, NMO, Moffatt oxidation
(b) Oxidative cleavage of Carbon-Carbon double bonds: KMnO₄, Ozonolysis.
(c) Allylic Oxidation: SeO₂, PhSeBr.
(d) Selective cleavages at functional groups: Cleavage of glycols, IO₄⁻, Pb(OAc)₄.

UNIT-II Reductions

- (a) Catalytic Hydrogenation; (b) Reduction of nitriles, oximes and nitro compounds; (c) Reduction of acids and Esters; (d) Reduction with metal hydride- Sodium cyanoborohydride, Diborane, L- & K-Selectrides, LiBH₄, DIBAL-H; (e) Reduction by dissolving metals- Sodium-alcohol, Sodium-Liq. Ammonia, Mg, Zinc-HCl or Acetic acid, Sn/Fe-HCl; (f) Reduction of aldehyde and ketones- Platinum, Raney nickel, NaBH₄, LiBH₄; (g) Birch reduction and related reactions, Luche reagent, Wolf-Kishner reduction, Clemmenson reduction, Wilkinson catalyst, TBTH.

UNIT-III Organic Reagents

Gilbert, DCC, EDC, DDQ, 1,3 Dithiane, LDA, DMDO, OsO₄, RuO₄, SmI₂, Dess-Martin Periodinane, Borane Complexes, Diazomethane, Lawesson's reagent.

UNIT-IV Reaction Intermediates

- (a) Ylides: Preparation and their synthetic applications along with their stereochemical aspects of Phosphorous, Sulphur and Nitrogen ylides.
(b) Enamines: Generation & application in organic synthesis with mechanistic pathways, stork enamine reaction.
(c) Enolates: Generation & reaction of enolates with aldehydes and ketones, Robinson annulations, Reformatsky reaction.

UNIT-V Formation of Carbon-Carbon bonds via organometallic reagents

Synthesis and applications of organo Lithium, Magnesium, Titanium, Cerium, Copper, Chromium, Zinc, Boron, Silicon, Cadmium, Rhodium.

Reference Books:

1. Organic Chemistry: Clayden, Greeves, Warren and Wothers
2. Stereochemistry of Organic Compounds (Principle and application): D. Nasipuri
3. Stereochemistry of Organic compounds: Ernest L. Eliel / Samuel H. Wilen
4. Organic Synthesis: W. Carruthers
5. Organic Reagents: Fieser & Fieser
6. Organic Synthesis: M. B. Smith
7. Advanced Organic Chemistry; Part A and B: F. A. Carey & R. J. Sundberg
8. Modern Organic Synthesis: An Introduction: G. S. Zweifel & M. H. Nantz
9. A Guidebook To Mechanism In Organic Chemistry: Peter Sykes
10. Organic Synthesis Concepts, Methods, Starting Materials: J. Fuhrhop, G. Penzlin
11. Organic Chemistry: An Intermediate Text: Robert V. Hoffmann
12. Advanced Organic Chemistry: Jerry March
13. Organic Synthesis: R. O. C. Norman and Coxan
14. Name Reactions: Jie Jack Li

Asymmetric Synthesis and Bio-Organic Chemistry**UNIT-I Introduction to Bioorganic chemistry**

Basic concepts, Proximity effects in organic chemistry, Molecular adaptation, Molecular recognition.

UNIT-II Enzyme Chemistry

Nomenclature, Classification and Extraction of enzymes, Structural outlines of enzymes (proteins); Introduction to catalysis and enzymes; Multifunctional catalysis, Intramolecular Catalysis, Molecular asymmetry and prochirality, Mechanism of enzyme action, Factors responsible for enzyme specificity, Enzyme activity and kinetics (Michaelis Menten and Lineweaver–Burk plots), Enzyme Inhibitions (Reversible and irreversible), Structure, Mechanism of action and applications of α -Chymotrypsin, Ribonuclease, lysozyme and Carbopeptidase-A. Enzymes in synthetic organic chemistry. [Additions, eliminations, substitutions, condensations, cyclocondensations, oxidations, reductions and rearrangement reactions are to be covered]

UNIT-III Co-Enzyme Chemistry

Introduction to co-enzymes, Cofactors, prosthetic groups and apoenzymes, Chemical structures of co-enzymes and cofactors, Oxidoreduction (NAD^+ , NADP^+), Pyridoxal phosphate (PLP), Thiamine pyrophosphate (TPP), Biotin (CO_2 carrier), Haemoglobin (O_2 -carrier), Flavin (FMN, FAD, FADH_2), Oxene Reactions, Lipoic acid, Mechanisms of reactions catalyzed by co-factors.

UNIT-IV Supramolecular Chemistry and Biomimetic Chemistry (Enzyme Models)

Host-Guest approach, Chiral recognition, Designing Enzyme Models, Ionophores, Crown ethers, cryptands, Micelles, Cyclodextrins, calixarenes.

UNIT-V Asymmetric Synthesis

Chiral pool, Chiral auxiliary, Enantio- & Diastereoselective synthesis, Chiral reagent and chiral catalyst including CBS reagent, NADH, Asymmetric hydrogenation including BINAP, Hydroboration- Ipc_2BH , IpcBH_2 , Asymmetric epoxidation- (+) DET & (-) DET, Sharpless, Jacobson, Asymmetric dihydroxylation- $(\text{DHQD})_2\text{PHAL}$ & $(\text{DHQ})_2\text{PHAL}$, Felkin-Anh model, Zimmermann-Traxler transition state model, Proline catalyzed asymmetric reactions.

Reference Books:

1. Bioorganic chemistry (A chemical approach to enzyme action): Hermann Dugas.
2. Biotransformation in Organic chemistry: K. Faber.
3. Enzyme structure and Mechanism: Alan Fersht.
4. Enzyme catalysis in organic synthesis vol.1: Karlheinz Drauz and Herbert Waldmann.
5. Bioorganic, Bioinorganic and supramolecular chemistry: P. S. Kalsi and J. P. Kalsi.
6. Organic chemistry IVth Edn.: G. Marc Loudon.
7. Stereochemistry of Organic Compounds (Principle and application): D. Nasipuri
8. Stereochemistry of Organic compounds: Ernest L. Eliel / Samuel H. Wilen
9. Advanced Organic Chemistry; Part A and B: F. A. Carey & R. J. Sundberg
10. Organic Chemistry: Clayden, Greeves, Warren and Wothers
11. Organic Synthesis: W. Carruthers
12. Organic Synthesis: M. B. Smith

Photochemistry, Free Radicals And Pericyclic Reactions

UNIT-I Pericyclic Reactions-I

Features and classification of pericyclic reactions, Phases, nodes and symmetry properties Of molecular orbital in ethylene, 1,3-butadiene, 1,3,5-hexatriene. Allyl cation, allyl radical, pentadienyl cation and pentadienyl radical. Thermal and photochemical reactions.

Electrocyclic reactions: Con-rotation and dis-rotation, electrocyclic closure and opening in $4n$ and $4n+2$ systems, Woodward-Hoffmann selection rules for electrocyclic reactions. Explanation for the mechanism of electrocyclic reactions by: (i) Symmetry properties of HOMO of open chain partner; (ii) Conservation of orbital symmetry and orbital symmetry correlation diagram and (iii) Huckel-Mobius aromatic and antiaromatic transition state method.

UNIT-II Pericyclic Reactions-II

Cycloaddition reactions: Suprafacial and antarafacial interactions. (π) and (π^2) cycloadditions. Cycloreversions. Stereochemical aspects in supra-supra, antara-supra and antara-antara (π^2) and (π^4) cycloadditions. Diels-Alder reaction. Woodward-Hoffmann selection rules for cycloaddition reactions. Explanation for the mechanism of cycloaddition reactions by 1) Conservation of orbital symmetry and orbital symmetry correlation diagrams 2) Fukui Frontier Molecular Orbital (FMO) theory and (3) Huckel-Mobius aromatic and antiaromatic transition state method. Endo-exo selectivity in Diels-Alder reaction and it's explanation by FMO theory. Examples of cycloaddition reactions.

Sigmatropic reactions: [1,j] and [i,j] shifts. Suprafacial and antarafacial shifts. Selection rules for [i,j] shifts. Cope, degenerate Cope and Claisen rearrangements. Explanation for the mechanism of sigmatropic reactions by 1) symmetry properties of HOMO 2) Huckel-Mobius aromatic and antiaromatic transition state method. Introduction to chelotropic reactions and the explanation of mechanism by FMO theory.

UNIT-III Photochemistry-I

Photochemistry of (π , π^*) transitions: Excited state of alkenes, cis-trans isomerisation, photochemistry state, electrocyclisation and Sigmatropic rearrangements, di π -methane rearrangement.

Intermolecular reactions: photocycloadditions, photodimerisation of sample and conjugated olefins, addition of olefins to α , β unsaturated carbonyl compounds, excimers and exiplexes. Photoaddition reactions. Excited states of aromatic compounds, photodimerisation of benzene, photosubstitution reactions of aromatic compounds and Photo-Fries rearrangement.

UNIT-IV Photochemistry-II

Photochemistry of (n , π^*) transitions: Excited state of carbonyl compounds, hemolytic cleavage of α -bond-Norrish type I reaction in acyclic, cyclic ketones and strained cycloalkanediones.

Intermolecular abstraction of hydrogen: Photo reduction and photo oxidation-influence of temperature, solvent, nature of hydrogen donors and structure of the substrate.

Intramolecular abstraction of hydrogen: Norrish type II reaction in ketones, esters and 1, 2-diketones.

Addition to C-C multiple bonds: Paterno-Buchi reaction, photodecarboxylation, photochemistry of alkyl peroxides, hypohalites and nitriles. Barton reaction. Photochemistry of azo compounds, diazo compounds, azides and diazonium salts. Singlet oxygen-photo oxygenation reactions. Ene reaction, formation of dioxetanes and endoperoxides. Chemiluminescent reactions. Oxidative coupling.

UNIT-V *Free radical reactions:*

Introduction, generation, stability, reactivity, characteristics, structural and stereo chemical properties of free radicals. Persistent free radicals.

Reaction of free radicals: Addition, substitutions, fragmentations (Norrish-I, II, McLafferty rearrangement), Oxidations and reductions, Neighbouring group assistance. Detection of free radicals, Homolysis and free radical displacement. Radical chain reactions, Addition and rearrangements, radical cyclization, reactivity of aliphatic and aromatic substrates at bridgehead, Coupling of alkynes and arylation of aromatic compound by diazonium salt, Sandmeyer reaction, Hunsdieker reaction, Allylic halogenations, McMurry reaction, Acyloin condensation, Birch reduction, Bouveault-Blank reduction.

Reference Books:

1. Advanced Organic Chemistry Part A & Part B: F. A. Carey & R. J. Sundberg
2. Advanced Organic Chemistry: Jerry March
3. Organic Chemistry: Clayden, Greeves, Warren & Wothers.
4. Organic Chemistry: Stanley H. Pine
5. Organic Synthesis: W. Carruthers
6. Organic Synthesis: Norman and Coxon

Organic Synthesis: Retrosynthetic Approach**UNIT-I Disconnection Approach**

Introduction to:

- (i) Grounding of organic chemistry for understanding retrosynthesis;
- (ii) Retrosynthetic analysis and designing of the synthesis;
- (iii) Disconnection approach: An introduction to synthons, synthetic equivalents, disconnection approach, functional group interconversions, importance of order of events in organic synthesis, one and two group C-X disconnections, selective organic transformations: chemoselectivity, regioselectivity, stereoselectivity, enantioselectivity, Reversal of polarity, cyclization reactions, amine synthesis.

UNIT-II Protecting Groups

Protection and deprotection of hydroxyl, carbonyls in aldehydes and ketones, amines, carboxylic acids, **alkenes and alkynes**.

UNIT-III C-C Disconnections**(i) One group C-C Disconnections:**

Alcohols (including stereoselectivity), carbonyls (including regioselectivity), Alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis.

(ii) Two group C-C Disconnections:

Diels-Alder reactions, 1,3 difunctionalized compounds and α , β -unsaturated compounds, control in carbonyl condensations, 1,5 difunctionalized compounds, Michael addition and Robinson annelation.

UNIT-IV Ring Synthesis

Introduction to ring synthesis, saturated heterocycles, synthesis of 3, 4, 5 and 6 membered rings, rearrangements and photochemistry in synthesis, aromatic heterocycles.

UNIT-V Complex molecules

Synthetic routes based on retrosynthetic analysis for following molecules:

Longifoline, Reserpine, Juvabione, Amphidicoline, Taxol.

Reference Books:

1. Organic Synthesis: The Disconnection Approach: Stuart Warren
2. Designing Organic Synthesis: Stuart Warren
3. Organic Synthesis: Strategy and Control: Paul Wyatt and Stuart Warren
4. The Logic of Chemical Synthesis: E. J. Corey and Xue-Min Chelg
5. Classics in Total Synthesis I, II and III: K. C. Nicolaou and others
6. Organic Synthesis Concepts, Methods, Starting Materials: J. Fuhrhop, G. Penzlin
7. Some Modern Methods of Organic Synthesis: W. Carruthers
8. Organic Synthesis: M. B. Smith
9. Principles of Organic Synthesis: R. Norman and J. M. Coxan.
10. Advanced Organic Chemistry: Jerry March
11. Organic Chemistry: Clayden, Greeves, Warren and Wothers

--

Advanced Organic and Heterocyclic Chemistry

PART A: *Advanced Organic Chemistry***UNIT-I Rearrangements**

Pummerer, Payne, Eschenmoser fragmentation, Brook, Anchimeric assistance (Neighbouring group participation) related rearrangement, Wagner-Meerwein, Wolf, Semipinacol, Epoxide rearrangement with lewis acid, Dienone-Phenol rearrangement, Tiffeneau-Demjanov, Favorskii, von Richter, Wittig, Neber, Smiles, Fries, Curtius, Lossen, Schmidt, Steven, Hofmann, Iodolactonisation.

UNIT-II Name Reactions

Arndt-Eistert, Hunsdiecker reaction, Baeyer-Villiger, Dakin, Gabriel synthesis, Michael, Darzen, Prins, Henry, Reimer-Tiemann, Hoffmann-Löffler-Freytag, Dieckmann cyclization, Chichibabin, Vilsmeier, Ene, Ullmann reaction, Mannich, Strecker amino acid synthesis. Bamford-Stephen, Baylis-Hillmann, Corey-Fuchs Reaction, Julia Olefination, Mukaiyama aldol, Mitsunobu, Peterson olefination, Corey-Winter olefination, Woodward and Prevost dihydroxylation, Shapiro, Ritter, Stille, Heck, Sonogashira, Suzuki, Duff, Chugaev, Petasis, McMurry reaction and Coupling. Ring closing metathesis (Grubb's metathesis), Aldol-Tishchenko reaction (Evans-Tishchenko reaction), Ugi, Passerini, Biginelli, Hantzsch condensation.

Reference Books:

1. Organic Chemistry: Clayden, Greeves, Warren and Wothers
2. Organic Synthesis: W. Carruthers
3. Organic Synthesis: M. B. Smith
4. Advanced Organic Chemistry; Part A and B: F. A. Carey & R. J. Sundberg
5. Modern Organic Synthesis: An Introduction: G. S. Zweifel & M. H. Nantz
6. Organic Synthesis Concepts, Methods, Starting Materials: J. Fuhrhop, G. Penzlin
7. Name Reactions and Reagents in Organic Synthesis: B. P. Mundy, M. G. Ellerd, F. G. Favaloro
8. Organic Chemistry: An Intermediate Text: Robert V. Hoffmann
9. Multicomponent Reactions: J. Zhu, H. Bienayme (Wiley-VCH)
10. Advanced Organic Chemistry: Jerry March
11. Organic Synthesis: R. O. C. Norman and Coxan
12. Name Reactions: Jie Jack Li

PART A: Heterocyclic Chemistry

UNIT-I Nomenclatures of all types of heterocycles, Classification of heterocycles: as aromatics based upon various membered ring systems.

UNIT-II .General synthetic routes based on name reactions, reactivities, utilities and wherever possible spectral analyses of the following class of heterocycles. **Four membered:** Azetidines, including β - lactams. **Five membered:** Thiazoles, Oxazoles, Pyrazoles and Imidazoles.

Six membered: Pyridines, Pyrimidines. **Fused heterocycles:** Flavones, Chromones, Coumarines, Indoles, Quinolines, Benzodiazepines, and Phenothiazines.

Reference Books:

1. Heterocyclic Chemistry: vol. I, II, III: R. R. Gupta, M. Kumar and M. Gupta
2. Heterocyclic Chemistry: Joules and Mills
3. Modern heterocyclic Chemistry: L. A. Paquette (Benjamin)
4. Organic Chemistry: Jonathan Clayden

UNIT-I *Terpenoids & Carotenoids*

Classification, Nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule

Structure determination, stereochemistry, and synthesis of the following representative molecules: Citral, Geraniol, α -Terpineol, Menthol, Farnesol, Zingiberene, Phytol, Abietic acid and β - Carotene.

UNIT-II *Alkaloids*

Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants.

Structure, stereochemistry and synthesis of the following:

Ephedrine, (+)-coniine, nicotine, atropine, Quinine and Morphine.

UNIT-III *Steroids*

Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry. Isolation, structure determination and synthesis of Bile acids, Androsterone, Testosterone, Estrone, Progesterone.

UNIT-IV *Anthocyanins and Flavones*

Occurrence, nomenclature and general methods of structure determination.

Synthesis of cyanidin chloride, cyanin, Hirsutidin chloride, Flavones (Kostanecki and Baker-Venkataraman approaches), Flavonols, Quercetin, and Isoflavones.

UNIT-V *Biogenesis*

The building blocks and construction mechanisms of the following

- (a) Terpenoids: Mono-, Sesqui-, Di-, Tri-Terpenoids and steroids.
- (b) Alkaloids: pyridine alkaloids, Benzyl Isoquinoline alkaloids, morphine alkaloids and Indole alkaloids.
- (c) The Shikimic acid pathway.

Reference Books:

1. The Organic Chemistry of Drug Design and Drug Action: R. B. Silverman, Academic press.
2. Natural Products: Chemistry and Biological Significance: J. Mann, R. S. Davidson, J. B. Hobbs, D. V. Banthrope and J. B. Harborne, Longman, Essex.
3. Organic Chemistry: Vol. II, I. L. Finar, ELBS.
4. Introduction to Flavonoids: B. A. Bohm, Harwood Academic Publishers
5. New Trends in Natural Product Chemistry: Atta-ur-Rahman and M. I. Choudhary, Harwood Academic publishers.
6. Biogenesis of Natural Products: Baldev Kumar and Harishkumar Chopra (Narosa Publication)

UNIT-I Basic consideration of drug activity

Definition and Introduction of following terms-Drug, Prodrug, Hard and Soft drugs, agonists, antagonists, affinity, efficacy, potency, isosterism, bioisosterism, pharmacophores, lead molecule, lethal dose (LD50) and effective dose (ED50) (i) Factors affecting bioactivity, (ii) Theories of drug activity, (iii) Structure activity relationship (SAR), QSAR (2D and 3D method) and Hantzsch equation (iv) Drug receptor mechanism.

UNIT-II Pharmacokinetics

- (i) Drug absorption, Distribution and deposition of drugs.
- (ii) Excretion and elimination of drugs, Bioavailability.

UNIT-III Pharmacodynamics

(i) Mechanism of drug action: Enzyme stimulation and enzyme inhibition, antimetabolites, membrane active drugs, chelation; (ii) Drug metabolism and inactivation: Factors affecting drug metabolism, pathways of drug metabolism [Metabolic reaction (Phase I) and conjugation reaction (Phase II)].

UNIT-IV Classification of Drugs

The detail contents of the each class of the drugs.

UNIT-V

Synthesis and Utilities of the following drug molecules (at least one convenient synthetic route with possible mechanism) from following classes:

I. Anti inflammatory Drugs: (a) Naproxen (b) Ibuprofen (c) Oxaprozin (d) Diclofenac Sodium (e) Rofecoxib (f) Celecoxib.

II. Anti-hypertensive Drugs: (a) Verapamil (b) Captopril (c) d-sotalol (d) Atenolol (e) Diltiazem (f) Semotiadil fumarate.

III. Drugs acting on CNS: (a) CNS Stimulant : Dextro-amphetamine

(b) Respiratory Stimulant : Doxapram

(c) CNS anti-depressant : (i) Chlorpromazine (Antipsychotic) (ii) Diazepam (Anxiolytic) (iii) Phenobarbitol (Antiepileptic)

IV Anesthetic Drugs:

(a) General : Ketamine (b) Local : (i) Lidocaine (ii) Procaine

V. Antibiotics: (a) Chloramphenicol (b) Ampicillin (c) Amoxycillin (d) Cefepime (e) Cefpirome (f) Antimycobacterial: Ethambutol (g) Antiviral: Acyclovir (h) Antimicrobial: Sulfamethoxazole

VI. Antidiabetics : (a) Troglitazone (b) Chlorpropamide (c) Tolbutamide

VII. Antineoplastic Drugs: (a) Antagonist: Fluorouracil (b) Alkylating agents: i) Chlorambucil (ii) Cis-Platin

Reference Books:

1. FOYE'S Principles of Medicinal Chemistry VIth Edition: Thomas L. Lemke, David A. Williams, Victoria F. Roche and S. William Zito.
2. Introduction of Medicinal Chemistry: A. Gringuage, Wiley-VCH.
3. Synthesis of Essential Drugs: R. S. Vardanyan and V. J. Hruby.
4. Volumes of Burger's Medicinal Chemistry: M. E. Wolf, JohnWiley.
5. Medicinal Chemistry: David J. Triggle.
6. Essentials of Medicinal Chemistry IInd: Andrejus Korolkovas, WileyVCH.

**Organic Chemistry
LABORATORY COURSES**

CHEO-421 Duration: 4.5 Hrs/Week Credits: 4.5

Qualitative analysis of ternary mixtures.

In a mixture at least one liquid, one water soluble compound be given.

CHEO-422 Duration: 4.5 Hrs/Week Credits: 4.5

Organic multistep preparations.

Preparations involving at least two stage based on name reactions, condensations, cyclocondensations, reagents and rearrangements (as covered under the theory). Separation, purification of the product by column is desired.

CHEO-423 Duration: 4.5 Hrs/Week Credits: 4.5

- (A) Preparations involving one stage based upon the green synthetic protocols (as covered in theory syllabus).
- (B) Structure elucidation of organic compounds by spectral analyses.

CHEO-424 Duration: 4.5 Hrs/Week Credits: 4.5

Project work: Dissertation be prepared and should contain literature survey, aim, scope of the project, experimental details and concluding discussions.

Reference Books:

1. Textbook of Practical Organic Chemistry: Vogel
2. Organic Synthesis Collective Volumes: Blatt
3. Research Periodicals including internet services.

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
AURANGABAD
Department of Chemistry

Revised Syllabus

M.Sc. III and IV Semester Physical Chemistry

Effective from June 2014

Effective from June 2014

The following will be the structure for revised syllabus for M. Sc. Physical Chemistry III & IV semester effective from June 2014.

Semester	Paper Nos.	Title of Paper	Durations (hr)	Max. Marks	Credits
III- Semester	CHE-313	Structural elucidation by spectral methods	60	50	4
	CHEP- 314	Solid State Chemistry	60	50	4
	CHEP: 315	Thermodynamics	60	50	4
	CHEP -316	Advanced Electrochemistry	60	50	4
IV semester	CHEP: 417	Nano Chemistry	60	50	4
	CHEP -418	Macromolecules and Biophysical Chemistry	60	50	4
	CHEP -419	Surface and Magnetochemistry	60	50	4
	CHEP-420	Chemical Dynamics and Catalysis	60	50	4
III and IV semester Laboratory Course	CHEP - 421	Laboratory Course (Physical)	135	50	4.5
	CHEP - 422	Laboratory Course (Physical)	135	50	4.5
	CHEP - 423	Laboratory Course (Physical)	135	50	4.5
	CHEP - 424	Project Work (Physical)	135	50	4.5

**DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
AURANGABAD**

Department of Chemistry

M. Sc. III Semester Physical Chemistry

Solid State Chemistry

Paper CHEP-314

Lectures:60

Credits: 04

1 Solid State Reactions:

12 L

General Principles, Classification, Wagner reaction mechanism, Laws governing nucleation, Growth of nuclei, Improving reactivity of solids, coprecipitation as a precursor to solid state reactions, Kinetics of solid state reactions, factors affecting the reactivity of solid state reactions. General principles of growing single crystals, General conditions for crystal growth, solvent properties and saturated solutions, methods for growing crystals, slow evaporation, slow cooling, variation on slow evaporation and slow cooling, solvent diffusion, reactant diffusion, sublimation and seed crystals.

2 Imperfections in solids:

12 L

Perfect and imperfect crystal, Point defects, Stiochiometric defects, Schottky and Frenkel defects. Thermodynamics of their formation, colour centers. Nonstoichiometric defects. Metal excess and metal deficiency defects. Line imperfections, edge dislocation and screw dislocation, Burger's circuits. Surface imperfection, grain boundaries and stacking faults.

3 Semiconductors and their devices:

12L

Intrinsic and extrinsic semiconductors, semiconductors materials and their fabrication, semiconductors devices p-n junctions, properties of p-n junctions, semiconductors diode as rectifier, Filters circuits, Zener diode as avoltage stabilizer, transistors transistor as an amplifier

Super conductivity: conventional super conductors, organic super conductors (organic metals), fullerece, high temperature super conductors, organic charge transfer complexes Applications.

4 Theories of solid state and properties of solids:

12 L

Free electron theory, Counduction by free electrons, Band theory, refinement to simple band theory, band structure of metals. Insulator and semiconductors.

Generation of x-rays, interaction of x-rays with matter, scattering and diffraction, Bragg's law, Miller indices, General instrumentation, Bragg's method, single crystal method, Debye-Scherrer method, Identification of unit cells from systematic absences, x-ray intensities and structure determination, structure factor and its relation to electron density and intensity, Phase problem. Indexing of lattice planes in a cubic system, structure of NaCl and KCl, Avogadro's number from cubic lattice dimensions, applications of x-ray diffraction.

5 Ceramics:

12 L

Introduction, major component of ceramics, clays, silica, feldspar, clay minerals, classification of clay minerals, properties of clay minerals, pillared clays, principal of pillaring, variety of pillaring species, modification of pillared clays, preparation of pillared clays, catalytic applications.

Reference Books

1. Solid State chemistry and its Applications-A. R. West (John Wiley and sons)
2. 2 Principles of Solid State –H.V. Keer (Wiley Eastern Limited)
3. Material science and Engineering-V.Raghavan (prentice Hall of India)
4. Principles of Electronics- V.K.Metha (S.Chand and co.)
5. Engineering chemistry –P.C. Jain and M. Jain (Shanpat Rai and Sons)
6. Industrial chemistry –B.K. Sharma (Goel publishing House)
7. Selected topics in solid state physics vol.12 The growth of crystals from liquids
8. J.C. Brice, North Hollond/American Elesvier(1973)
9. Chemistry of imperfect crystal-F.A. Krogen
10. Crystals and Crystal Growing, Alan Holden and Phylis Singer, Anchor Books Doubleday, New York, 1960
11. X-ray Structure Determination A Practical Guide, 2nd edition George H. Stout and Lyle H. Jensen, John Wiliey & Sons, New York, 1989.

**DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
AURANGABAD**

Department of Chemistry

M. Sc. III Semester Physical Chemistry

Thermodynamics

Paper CHEP-315

Lectures: 60

Credits: 04

Statistical Thermodynamics

Unit I Introduction

12hrs

Ensembles-canonical, grand canonical and micro canonical Combinatorial problems, Thermodynamics probability and most probable distribution, Stirlings approximation, distribution laws, the law of equipartition of energies. Quantum statistics- Max Well-Boltzmann, Bose-Einstein and Fermi-Dirac, limit and applicability of various distribution laws.

Unit II Molecular Partition function

12hrs

Partition function, Expression for translational, rotational, vibrational and electronic partition functions, Third law of thermodynamics and partition function, Numerical problems.

Unit III Application to chemical systems

12hrs

Partition function and Thermodynamic functions, Sackur-Tetrode equation (derivation), determination of equation of state of an ideal gas. Internal rotation, residual entropies, heat capacity of solids: Einstein model, Debye modification (model), characteristic temperature, statistical mechanics of solutions ideal and nonideal.

Unit IV Applications to quantum systems

12hrs

Nuclear spin statistics, ortho and para nuclear states, ortho and para hydrogen. Fermi energy, Fermi energy of electron gas in metals, Planck's distribution law and radiation, Bose-Einstein degenerate gas (He gas).

Unit V Irreversible Thermodynamics

12hrs

Postulates, entropy production in heat, entropy production in matter flow, entropy production in chemical reactions, Onsager's theory, microscopic reversibility and Onsager's reciprocity, stationary states and entropy production, Prigogine's principle of minimum entropy, application to thermoelectric effects-Seebeck and Peltier effect.

Books Suggested:

- 1) Statistical Thermodynamics, Donald A. Mc Quirrie, Harper & Row, New York 1973.
- 2) Statistical Thermodynamics, M.C. Gupta, Wiley Eastern Ltd. New Delhi.
- 3) Elements of Statistical Thermodynamics, L. K. Nash Addison Wesley, Menlo Park, 1972.
- 4) Physical chemistry, P. W. Atkins, ELBS
- 5) Non Equilibrium Thermodynamics, Prologine Kalyani Publication.
- 6) Thermodynamics and Non Equilibrium Thermodynamics, Gurudeep & Raj.

**DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
AURANGABAD**

**Department of Chemistry
M. Sc. III Semester Physical Chemistry**

**Advanced Electrochemistry
Paper CHEP-316**

Lectures: 60

Credits: 04

Unit -1: Oxidation - Reduction Systems:

12 Hrs.

Oxidation potentials, reversible ox-red systems, determination of standard ox-red potentials, variation of ox-red potential, ox-red equilibria, ox-red systems in analytical chemistry, ox-red indicators, two stage ox-red, semiquinone formation constant. Numericals.

Unit-2: Bio- electrochemistry and Electrocatalysis :

12 Hrs.

Donnan membrane equilibrium, membrane potential, theories of membrane potential, introduction to electrocatalysis, relative power of electrocatalysts, mechanism of electrocatalysis, bioelectro catalysis, immobilization, application of enzymes on electrodes.

Unit-3: Electrodeposition :

12 Hrs.

Introduction, the electrogrowth of metals on electrodes, the reaction pathway for electro deposition, surface diffusion of ions, cathodic deposition of metals from solutions, factors affecting cathodic deposition of metals, electrochemical dissolution and passivity of metals, anodic dissolution of metals, film and adsorption theories of passivity.

Electroplating of metals, mechanism, throwing power of an electroplating bath, factors affecting throwing power, typical electrodeposition processes, applications of electroplating of metals. Numericals.

Unit-4: Polarisation and Overpotentials :

12 Hrs.

Polarisation, concentration polarization, decomposition potentials, over voltage, hydrogen, oxygen and metal overvoltages, types of overvoltages, factors affecting overvoltages, experimental determination of decomposition potential and overvoltage, Tafels theory and Tafel equation, simultaneous deposition of metals. Numericals.

Unit -5: Conversion and storage of electrochemical energy:

12 Hrs.

Introduction of storage cells, fuel cells, solar cells Types of storage cells (batteries), measure of cell performance, charging and discharging, introduction of classical batteries, modern batteries –zinc-air, nickel-metal oxide and lithium batteries.

Brief history of fuel cells, efficiency of fuel cells, hydrogen-oxygen fuel cell, phosphoric acid fuel cell, direct methanol and biochemical fuel cells; Solar cells introduction, principle and working of solar cells, advantages.

Reference Books :

- 1) Modern Electrochemistry, Vol 1,2A and 2B, John O" M Bokris
- 2) An Introduction to Electrochemistry, Samuel Glasstone.
- 3) Theoretical Electrochemistry, L.Antropov.
- 4) Advanced Physical Chemistry, Gurtu and Gurtu.
- 5) Principles of Physical Chemistry, Puri,Sharma and Pathania.
- 6) Text Book of Physical Chemistry, S. Glasstone
- 7) Physical Chemistry, Robert J. Silbey.
- 8) Physical Chemistry, G.K.Vemulapalli.
- 9) Physical Chemistry, Maron and Pruton.
- 10) Physical Chemistry, P.W. Atkins

**DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
AURANGABAD**

Department of Chemistry

M. Sc. IV Semester Physical Chemistry

Nanochemistry

Paper CHEP-417

Lectures: 60

Marks : 50

Credits: 04

I) General introduction & synthesis of nanomaterials by physical methods: [12]

Objective of study, synthesis of nanoparticles by physical method, mechanical methods-high energy ball milling, melt mixing, method based on evaporation, physical vapour deposition with consolidation. Ionized cluster beam deposition. Laser vaporization, Laser pyrolysis, sputter diposition, electric arc deposition, Chemical Vapour Deposition (CVD).

II) Synthesis of Nanomaterials by Chemical Methods [12]

Introduction, colloids and colloids in solution, interaction of colloids and medium, colloids in vacuum, colloids in medium, effect of charge on colloids, stearic repulsion, synthesis of colloids, growth of nanoparticles, synthesis of metal and semiconductor nanoparticles by colloidal route, Langmuir-Blodgett (L-B) method, sol gel method, electrochemical method.

III) Analysis Technique : [12]

Introduction, microscopes, electron microscopes, SEM, TEM, Scanning probe microscope (SPM), Scanning Tunnelling microscope, Atomic force microscope, X-ray diffraction, UV-visible and IR spectroscopy.

IV) Properties, types and application of Nanomaterials: [12]

- i) Properties of nanomaterials – Mechanical, electrical, optical, magnetic, semiconductor.
- ii) Some special nanomaterials – Carbon nanotubes, porous silicon, Arogels, Zeolites.
- iii) Application – Electronic, energy automobiles, sport and toys, textile, cosmetics, domestic appliances, biotechnology, medical, space, defence & environment.

V) Thin films: [12]

Introduction, deposition by chemical reactions, deposition by electrochemical reaction, chemical vapor deposition of inorganic Thin films, chemical etching.

Reference Books:

- 1) Nanotechnology: Principles and practices- Sulabha K. Kulkarni (capital Pub. Co.)
- 2) NANO- The next revolution –Mohan Surendra Rajan(Natioinal book Trust, India)
- 3) The British Glass Website- Types of Glass://www.britiglass.org.uk.
- 4) Fundamental of Nanotechnology – Gabor L. Hornyak, John J. Moore, Harry F. Tibbals, Joydeep Dutta.
- 5) Recent advances in the liquid phase synthesis of Inorganic Nanoparticles- B. LCushing,

V. L. Kolesmichenko & C.J.O".Connor Chemical Review 104, 3893-3946.(2004)

- 6) Hand book of Thin film technology- H. R. Khan.
- 7) Thin film phenomenon- K. N. Chopra. Mcgrawa Hill publication
- 8) Material Science deposition & structure –Milton.

**DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
AURANGABAD**

Department of Chemistry

M. Sc. IV Semester Physical Chemistry

Macromolecules and Biophysical Chemistry

Paper CHEP-418

Lectures: 60

Marks : 50

Credits: 04

Chapter 1. Fundamentals of Biological Macromolecules.

Chemical bonds in biological systems; Properties of water; Thermodynamic principles in biological systems; Properties and classification of amino acids; Structures of nucleic acids, Protein structure and function, Properties of nucleosides and nucleotides, Composition of nucleic acids, Electrophoresis, Factors affecting on Electrophoretic Mobility; Types of Electrophoresis; Free electrophoresis and Gel electrophoresis; Electrophoresis in genetic analysis; DNA Sequencing and DNA foot Printing.

Chapter 2. Macromolecules.

Introduction, Formation of synthetic high polymers classification, Polymerization reactions: Chain and Step. Average molecular weight, Number average weight, Methods of determination of molar masses of polymers; Viscosity, Osmometry, Molar mass of charged macromolecules, Donnan membrane equilibrium, Ultracentrifugation, light scattering, Diffusion.

Chapter 3. Chemistry of Polymerization.

Chain polymerization: free radical polymerization, ionic polymerization, co-ordination polymerization, Ziegler-Natta catalysts.

Step Polymerization: polycondensation, polyaddition, ring opening, electro chemical polymerization, group, Transfer polymerization, Polymerization techniques.

Chapter 4. Kinetics of Polymerization:

Free radical chain polymerization, Anionic polymerization, Cationic polymerization, Copolymerization, Free radical copolymerization, Ionic copolymerization, Copolycondensation.

Chapter 5. Electronically Conducting Polymers.

Introduction, Theories of electronic conduction; Band theory of conduction, Hopping conduction, Super conduction, Mechanism of conduction, Doping mechanism, p-type, n-type, auto doping, Stimuli sensitive (smart) polymers, pH and temperature sensitive smart polymers,

Applications: Photovoltaic devices, Sensors, LED and Solar cells, Electro chemical devices, Batteries etc.

Recommended Texts:

1. Cantor, C. R. and Schimmel Biophysical Chemistry Vols. 1-3, W. H. Freeman (1980).
2. Lehninger, A.L., Nelson, D. L. and M. M. Lehninger, Principles of Biochemistry 4th Ed., W. H. Freeman (2004).
3. U. Satyanarayana; Biochemistry.
4. Upadhyay; Biophysical Chemistry.
5. L. Stryer, Biochemistry, 5th Edition, (2002) Freeman and Co. New York.
6. D. Voet, J. G. Voet, Biochemistry 3rd Edition (2004), Wiley International Publication.
7. D. L. Nelson and M. M. Cox, Lehninger Principles of Biochemistry 3rd Edition (2002) McMillan North Publication.
8. Polymer Science. By V. R. Gowariker, N. V. Viswnathan, Jayadev Sreedhar.
9. Polymers and Resins. By Brage Golding.
10. Electrical Properties of Polymers. By Tony Blythe and David Bloor.
11. Self doped conducting polymers. By Michael S. Freund and Bhavana Deore.
12. Polymer Science and Technology. By Premamoy Ghosh.

**DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
AURANGABAD**

**Department of Chemistry
M. Sc. IV Semester Physical Chemistry**

**Surface and Magnetochemistry
Paper CHEP-419**

Lectures: 60

Marks : 50

Credits: 04

Unit-1: Surface chemistry :

[12hrs]

Adsorption, adsorption isotherms ,Langmuirs unimolecular theory of adsorption statistical derivation of Langmuirs adsorption isotherm , BET theory of multilayer adsorption ,derivation of BET equation, determination of surface area of adsorbent ,heat of adsorption and its determination

Unit-2: Colloidal state of matter :

[12hrs]

Introduction to colloids, classification, properties, specific properties like,electrical properties, charge on colloidal particals, origin of charge, electrical double layer, electrokinetic properties,electrophoresis, electroosmosis, streaming potential, sedimentation potential, determination of size of colloidal particals, applications of colloids, Numericals.

Unit-3: Introduction to magnetochemistry :

[12hrs]

Definition of magnetic properties, types of magnetic behaviour, sources of paramagnetism, Pascals constants and it's applications, Determination of magnetic susceptibility. Numericals.

Unit-4: Valence theories :

[12hrs]

Valence bond theory, crystal field theory, octahedral, tetrahedral, square planar, trigonal bipyramidal and square pyramidal stereoisomerism, John -Teller effect. Magnetic properties based on crystal field model. Limitations of crystal field theory. Molecular orbital theory.

Unit-5: Dielectric Materials:

[12]

Polarization, Temperature and frequency effects, electric breakdown, ferroelectric materials, problems

REFERENCES:

1. K.J.Laidler, J.H.Meiser and B.C. Sanctuary, Physical Chemistry, Houghton Mifflin Company, New York, 2003.
2. A.W. Adamson, Physical Chemistry of Surfaces, 4 th edition, Interscience, New York, 1982.
3. G.K.Vemulapalli, Physical Chemistry, Printice Hall of India.
4. Gurtu and Gurtu , Advanced Physical Chemistry.
5. S.Glasstone, Text book of Phycal Chemistry.
6. Gurdeep and Raj, Advanced Physical Chemistry.
7. A.R.West, Solid State Chemistry and its Applications, John Wiley and Sons, 2003(reprint 2009)
8. H.V.Keer, Principles of Solid State.
9. A.Earn Shaw, Introcuction to Magnetochemistry, Academic Press.
10. J.Sharma, Magnetochemistry.
11. R.I.Dutta and Syamal, Elements of magnetochemistry.
12. Oliver Kahn,Molecular Magnetism, VCH Weinheim(1993)
13. S. Pahari, Physical Chemistry ,vol.II.
14. Puri, Shrma, Pathania, Principles of Physical Chemistry.
15. Charles Kittle, Introduction to Solid State Physics 7th edition, John Wiley and Sons,2004 (reprint 2009)

**DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
AURANGABAD**

**Department of Chemistry
M. Sc. IV Semester Physical Chemistry**

**Chemical Dynamics and Catalysis
Paper CHEP-420**

Lectures: 60

Marks : 50

Credits: 04

Unit-1: Kinetics of Complex Reactions:

Opposing or reversible reactions, parallel and competitive reactions, consecutive reactions, chain reactions, branched chain reactions and explosions, hydrogen-oxygen reactions, kinetics of polymerization-step wise and free radical polymerization Effect of temperature on rates of simple and complex reactions. Numericals

Unit-2: Reactions in solution:

Diffusion controlled reactions, substitution and correlation effect, Hammett equation, Taft effects, compensation effect. Electron transfer reactions, proton transfer reactions. Ion dipole and dipole-dipole interactions. Influence of pressure on rate in solution. Numericals

Unit-3: Photochemical Reactions:

Introduction, law of photochemical equivalence, photocatalytic reactions, types of photocatalytic reactions, photooxidation, photoreduction, photosensitization, photocatalytic degradation. Chemiluminescence, photosynthesis. Numericals

Unit-4: Homogeneous Catalysis:

Introduction, mechanism of catalysis, Acid-base catalysis, effect of pH on rate constant. Micellar catalysis, enzyme catalysis, factors governing rate of enzyme reactions, kinetics of enzyme catalysed reactions. Autocatalysis and oscillatory reaction, Lotka-Volterra mechanism, the Brusselator, the Oregonator, bistability, chemical chaos. Numericals

Unit-5: Surface reactions and Heterogeneous catalysis:

Unimolecular surface reactions, bimolecular surface reactions, effect of temperature on heterogeneous reactions, transition state theory and the rates of surface reactions, theory of heterogeneous catalysis, structure of solid surfaces, absolute rates of desorption's, electronic

theories of chemisorption and heterogeneous catalysis. Preparation and characterization of catalysts, applications.

Reference Books

1. Chemical kinetics E.S.Laidler pearson Education
2. Chemical kinetics and Reaction dynamics Bul Houston
3. Chemical kinetics and Reaction Mechanism F-Wilkinson-VanNostral Reinhdd
4. kinetics and Mechanism Of Chemical Transformations J. Rajaram Macmillan India Ltd
5. Atkins physical chemistry Atking and Oxford University press D.Paula
6. Physical chemistry Berry, Rice, Ross Oxford University press
7. Physical chemistry-principles And Appllication in Biological Sciences Tinoco, Sauer Pearson Education.
8. Physical chemistry W.J.Moore.

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD

DEPARTMENT OF CHEMISTRY
Physical Chemistry Laboratory Course
M. Sc. III and IV Semester
(Effective from June 2014)

CHEP-421 Laboratory course (Physical)

Duration : 135 Hr

Marks 50

Credits : 4.5

Spectroscopy

- 1) To determine the indicator constant pK_{in} of an indicator by using half height method (Bromo cresol purple) (DVJ-200)
- 2) To determine the stability constant of metal complex between 5-SSA and Fe^{+3} with help of Job's curve and Bent and French method (for weak complex)(DVJ-204)
- 3) To determine the concentration of Fe(II) and Cu(II) by spectrophotometric titration with EDTA.
- 4) To investigate the effect of ionic strength on pK_a of bromo cresol green and thus determine pK_{in} (DVJ-211)
- 5) To investigate the reaction kinetics between $K_2S_2O_8$ and KI by spectrophotometrically (TKC-223)
- 6) To determine simultaneously the dichromate and permagnate ions in the given solution.

Polarimetry

- 7) Determine the percentage of two optically active substances in a mixture.(TKC-194)
- 8) To investigate the complex ion formation between Fe(II) and thiocyanate ion.
- 9) To study Kinetics of hydrolysis of sucrose by Hammett-Zuckerman approach.(DVJ)
- 10) Investigate the effect of substitution of chloride ions on rate constant of inversion of cane sugar by using mono, di and trichloro acetic acid as catalyst.

Refractometry

- 11) Determine the refractive indices of series of solution of a salt and determine the concentration of the salt in the given unknown solution.

- 12) Determine the molar refraction of ethyl, propyl and butyl acetate and show the constancy of contribution to the molar refraction made by CH_2 group.
- 13) Determine the molar refraction of methyl acetate, ethyl acetate, n-hexane and carbon tetrachloride and calculate the atomic refraction of C, H and Cl atoms.
- 14) Study the variation of refractive indices with composition of mixture of carbon tetrachloride and ethyl acetate and determine the composition and molar refraction of the given unknown mixture.

Viscosity

- 15) Determine the variation of viscosity with composition of I) ethanol-water, II) methanol-ethylidene chloride, III) nitric acid- chloroform and confirm the formation of compound.(TKC-250)
- 16) Determine the molecular weight of macromolecules.(TKC-251)
- 17) Determine the iso-electric point of gelatin and examine the effect of aging by viscometric methods.(DVJ-29)

Flame Photometry

- 18) Estimation of Na, K, Li & Ca by flame photometry.

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD

DEPARTMENT OF CHEMISTRY
Physical Chemistry Laboratory Course
M. Sc. III and IV Semester
(Effective from June 2014)

CHEP-422 Laboratory course (Physical)

Duration : 135 Hr

Marks 50

Credits : 4.5

Potentiometer

- 1) Titrate ferrous ammonium sulphate with ceric sulphate and find out formal redox potential of $\text{Fe}^{+2}/\text{Fe}^{+3}$ and $\text{Ce}^{+3}/\text{Ce}^{+4}$ system
- 2) Titrate potentiometrically phosphoric acid solution against NaOH and calculate pK_1 , pK_2 and pK_3 of the acid.
- 3) Titrate potentiometrically NaCl solution against AgNO_3 and find out the concentration of NaCl and hence determine the solubility product of AgCl.
- 4) To determine the standard free energy changes ΔG° and equilibrium constant for reaction $\text{Cu} + 2\text{Ag}^+ \longrightarrow \text{Cu}^{++} + 2\text{Ag}$ (TKC-167)
- 5) Determine the activity coefficient of silver ions using a concentration cell without transference. (TKC-154)

pH metry

- 6) To determine the proton-ligand stability constant of an organic acid and the metal-ligand stability constant of its complex by pH measurements. (TKC-176)
- 7) Determine the Hammett constant of a given substituted benzoic acid by pH measurements. (TKC-170)
- 8) Determine the pH values of various mixtures of sodium acetate and acetic acid in aqueous solution and hence find out the dissociation constant of the acid. (TKC-173)
- 9) To determine the hydrolysis constant of aniline hydrochloride by pH measurements. (TKC-174)

Conductometry

- 10) To determine the thermodynamic dissociation constant of weak acid conductometrically.
- 11) Investigate the kinetics of basic hydrolysis of ethyl acetate conductometrically.
- 12) Conductometric titration of a mixture of strong acid, weak acid and a salt.(DVJ)
- 13) To determine the degree of hydrolysis and hydrolysis constant of sodium acetate conductometrically.
- 14) To determine the ΔG , ΔH and ΔS of silver benzoate by solubility product method.
- 15) Determine the amount of trichloroacetic acid, monoacetic acid and acetic acid in a given solution by conductometric titration against sodium hydroxide solution.

Magnetochemistry

- 16) To determine the magnetic susceptibility and number of unpaired electrons in given compound.
- 17) Verification of Weidemann's law using nickel chloride solution.

Surface Tension

- 18) Study the effect of surfactant (n-propyl alcohol) at various concentrations on the surface tension of water and hence determine the limiting cross sectional area of alcohol molecule by stalagmometer.
- 19) Determine the parachor of a solid by stalagmometer.
- 20) To study the effect of surfactant on surface tension of water by parachor of a solid by stalagmometer.

**DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
AURANGABAD**

**DEPARTMENT OF CHEMISTRY
Physical Chemistry Laboratory Course
M. Sc. III and IV Semester
(Effective from June 2014)**

CHEP-423 Laboratory course (Physical)

Duration : 135 Hr

Marks 50

Credits : 4.5

Section(A):

Chemical Dynamics

- 1) Investigate the influence of ionic strength on the rate constant of the reaction between $K_2S_2O_8$ and KI.(TKC-335)
- 2) Determine the order of a reaction by 1) substitution method, (II) fractional change method and (III) differential method.
- 3) Investigate the reaction between bromic acid and hydrochloric acid.(TKC-335)
- 4) To investigate the reaction between H_2O_2 and KI kinetically.
- 5) Investigate the kinetics of iodination of acetone.

Phase equilibria

- 6) Determine the critical solution temperature of phenol and water in presence of 1) 1% NaCl 2) 0.5% naphthalene 3) succinic acid
- 7) Construct the phase diagram of three-component system containing ethanol benzene and water.
- 8) Determine the equilibrium constant of the tri-iodide formation in aqueous solution by distribution method.
- 9) Study the influence of ionic strength on the solubility of $CaSO_4$ and hence determine its thermodynamic solubility product and mean ionic activity.
- 10) Determine the formula of the complex formed between cupric ion and ammonia by distribution method.
- 11) Study the variation of solubility of $Ca(OH)_2$ in presence of NaOH solution and hence determine the solubility product at room temperature.

Adsorption

- 12) Investigate the adsorption of acetic / oxalic acid by activated charcoal and test the validity of Freundlich and Langmuir's isotherm.

Thermodynamics

- 13) Determine the partial molar volume of ethanol and water in a given composition by density measurements.
- 14) To determine heat of neutralization of strong acid and heat of ionization of weak acid calorimetrically.
- 15) To determine the integral heat of solution of KNO_3 .
- 16) To determine the heat of dissociation of benzoic acid in water.
- 17) To determine heat of precipitation of BaSO_4 .
- 18) Determine the energy of activation of the reaction between potassium persulphate and potassium iodide.
- 19) Study the rate of reaction between ethyl bromo-acetate and sodium thiosulphate kinetically.

Turbidimetry

- 20) Determine the molecular weight of a given polymer by turbidimetry

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD

DEPARTMENT OF CHEMISTRY
Physical Chemistry Laboratory Course (Project Work)
M. Sc. III and IV Semester
(Effective from June 2014)

CHEP-424 Project Work (Physical)

Duration: 135 Hr

Marks 50

Credits: 4.5

In this course the students are expected to complete one project, the title of project should be finalized after discussion with their respective project guide.

The scheme of marking is as follow:

A) Project Work:

30 marks

1. Literature survey
2. Finalization of Project Title
3. Experimental Work
4. Material Characterization and Interpretation of data
5. Conclusion
6. References

B) Project Report:

20 marks

1. Project report preparation
2. Project presentation
3. Viva- Voce

SCHEME OF MARKING

For paper CHEP (Pr)-421, CHEP (Pr)-422 & CHEP (Pr)-423

Record book & Viva: 05

Experiment (I)		Experiment II
1) Observation :	10	08
2) Calculation:	05	04
3) Graph:	05	04
4) Accuracy & Result:	05	04
Total:	25	20

NOTE: STUDENT WILL NOT BE ALLOWED FOR PRACTICAL EXAMINATION IF HIS/HER RECORD BOOK IS NOT COMPLETED AND CERTIFIED.

**Dr. Babasaheb Ambedkar Marathwada University,
Aurangabad
Department of Chemistry**

Revised Syllabus

M. Sc. III & IV Semester Analytical Chemistry

Effective from June 2014

The following will be the structure for revised syllabus for M.Sc. III & IV Semester

Analytical Chemistry.

Semester	Paper No	Title of papers	Durations (Hrs.)	Marks Allotted	Credits
III Semester Theory Courses	CHE-313	Structural Elucidation By Spectral Method	60	50	4
	CHEA-314	Electro analytical Techniques	60	50	4
	CHEA-315	Environmental Analysis and Monitoring	60	50	4
	CHEA-316	Advanced Analytical Techniques	60	50	4
IV Semester Theory Courses	CHEA-417	Analysis of Ores, Alloys & Explosive	60	50	4
	CHEA-418	Food, Fertilizer & Pesticides Analysis	60	50	4
	CHEA-419	Petrochemical & Polymer Analysis	60	50	4
	CHEA-420	Pharmaceutical, Clinical & Forensic Analysis	60	50	4
III & IV Semester Laboratory Courses	CHEA- 421	Laboratory Course (Analytical)	135	50	4.5
	CHEA- 422	Laboratory Course (Analytical)	135	50	4.5
	CHEA- 423	Laboratory Course (Analytical)	135	50	4.5
	CHEA- 424	Project work (Analytical)	135	50	4.5

--

Structural Elucidation by Spectral Method- CHE-313**60hrs****Credits: 04****UNIT-I Nuclear Magnetic Resonance Spectroscopy (^1H NMR)****[12hrs]**

Elementary ideas (Recapitulation); Spin-spin couplings, Different types of couplings, factors affecting on coupling constants, Karplus equation, Spin systems (AB, AX, ABX, AMX), Rate processes, spin decoupling, shift reagents, Nuclear Overhauser effect (NOE), INEPT and INADEQUATE.

UNIT-II ^{13}C Nuclear Magnetic Resonance Spectroscopy**[12hrs]**

Elementary ideas, instrumental problems, chemical shifts (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbons); Effect of substituents on chemical shifts.

UNIT-III Mass Spectroscopy**[12hrs]**

Introduction, ion production (EI, CI, FD and FAB), ion analysis, ion abundance, factors affecting on fragmentation, fragmentation of different functional groups, molecular ion peak, isotopic peaks, metastable peak, Nitrogen rule, McLafferty rearrangement, Retro-Diels-Alder reaction.

UNIT-IV**[12hrs]**

Problems based on joint applications of UV, IR, ^1H NMR, ^{13}C NMR and Mass spectroscopy.

UNIT-V**[12hrs]**

Mossbauer spectroscopy: Principle, factors affecting the line position and shape, isomer effect and Quadrupole splitting iron salt like compounds, complexes, carbonyl compounds (temperature dependence of isomer shift and Quadrupole splitting in simple compound and coordination, polynuclear complexes), Numericals.

Electron Spin Resonance Spectroscopy: Introduction, principle of ESR spectroscopy, presentation of spectrum, hyperfine splitting in various structures, hyperfine splitting digram of representative examples, factors affecting the magnitude of 'g' values, Zero field splitting, Kramer's degeneracy, Anisotropy in the hyperfine coupling constant, electron delocalization, instrumentation and applications.

Reference Books:

1. Introduction to Spectroscopy: D. L. Pavia, G. M. Lampman, G. S. Kriz
2. Spectrometric Identification of Organic Compounds: R. M. Silverstein & F. X. Webster
3. ^{13}C NMR Spectroscopy: G. C. Levy, R. L. Lichter, G. L. Nelson
4. Spectroscopic Methods in Organic Chemistry: D. H. Williams & I. Flemming
5. Absorption Spectroscopy of Organic Compounds: V. M. Parikh
6. Mass Spectrometry: K. G. Das & James
7. Coordination Chemistry by Experimental Methods: K. Barger
8. Coordination Chemistry vol. I: E. Martell
9. Physical Methods for Chemistry: R. S. Drago
10. Structural Methods in Inorganic Chemistry: E. A. V. Ebsworth & D. W. H. Rankin
11. Organic Structure Analysis: Philips Crews

Electro analytical Techniques- CHEA-314**60hrs****Credits: 04****Unit-I General Introduction****[12hrs]**

Overview of Electrode Processes, Electrocapillary curve and electrocapillary maximum potential, exchange current, Ion selective electrodes: Types and construction of electrode, Glass electrode, Solid state electrode and precipitate electrode, Liquid-liquid membrane electrodes, Enzyme and gas electrode, Applications of ion selective electrodes, Reference electrodes, Mercury electrodes (DME, SME, HMDE), numericals.

Unit – II Potentiometry and Coulometry**[12hrs]**

Potentiometry: Introduction, Instrumentation, Various electrodes in potentiometry:- Ion selective electrode, Liquid membrane electrode, Weston cell. Potentiometric titrations:- Types of potentiometric titrations, Variations in potentiometric titrations, Limitations, Numericals. **Coulometry:** Introduction, Principle, Technique, Coulometry at constant current and coulometry at controlled potential, Coulometric titration, Flowing stream coulometry, Applications, Stripping analysis.

Unit- III Polarography and Cyclic Voltammetry**[12hrs]**

Theory and origin of polarography, Interpretation of polarographic curves, Instrumentation of polarography, Differential pulse polarography, Factors affecting on polarographic wave.

Introduction and beginning of cyclic voltammetry Range of cyclic voltametric techniques, Limitations. The acceptable sweep rate range, The shape of the peak in potential sweep curves, The role of non- aqueous solution in cyclic voltammetry, Criteria of reversibility of electrochemical reactions Quasi reversible and irreversible processes, Qualitative and quantitative analysis by cyclic voltametric techniques, Linear sweep voltammetry for reactions that include simple adsorbed intermediates and Numericals.

Unit-IV**[12hrs]****High frequency titration and Related Techniques:**

Introduction, Theory and instrumentation, High frequency titrimetry, Types of cells, Advantages of high frequency methods and applications. Amperometric titration, Chronoamperometry, Chronopotentiometry and others

Unit-V**[12hrs]**

Electro-Gravimetry: Introduction, Theory of electrogravimetry, Terms used in electrogravimetric analysis. Completeness of deposition, Electroanalytical separation of metals, Applications. **Electrophoresis:** Introduction, Paper electrophoresis technique, Factors affecting migration of ions, Capillary and zone electrophoresis, Applications, Numericals.

Reference Books:

1. Quantitative analysis -. Alexeyev. V
2. Instrumental methods of analysis – Chatwal and Anand.
3. Introduction to instrumental analysis – R. D. Braun.
4. Instrumental methods of analysis – Willard, Meritt, Dean and Settle.
5. Standard methods of chemical analysis – F. G. Welcher, Vol III, Part A& B.
6. Electroanalytical chemistry – H. W. Neurenberg.
7. Principles of electrochemistry – D. A. MacLaines.
8. Ion selective electrodes – (John Wiley) Stulic.
9. Vogel's textbook of quantitative chemical analysis V edition by Jeffery Bassett Mendham Denney.
10. Modern Electrochemistry vol. I - John O'M Bockris
11. Modern Electrochemistry vol. II - John O'M Bockris
12. Analytical Chemistry – Gary D. Christian, 6th edition
13. Principles of Instrumental Analysis–Skoog, F. J. Holler & J. A. Nieman.
14. Instrumental Methods of Chemical Analysis–Galen W. Ewing. 5th edition

Environmental Analysis and Monitoring- CHEA-315**60hrs****Credits: 04****Unit-I Air Pollution****[12hrs]**

General considerations: polluted air, Types of pollution and units of measurements. Air quality standards, Sampling, Monitoring, Analysis of CO, Sources and sinks of CO pollution, Effects of CO on plants and humans, Control of CO pollution, Analysis of oxides of nitrogen, NO_x sources and sinks of NO_x pollution, Control of NO_x pollution, Hydrocarbons and photochemical smog and its control, Analysis of hydrocarbon in exhaust gasses, Petrol and air, Sulphur di oxide sources, Analysis and control, Acid rain particulates and their effects on human and climate, Control of particulates.

Unit-II**[12hrs]**

- a. **Water Pollution:** Aquatic environment, Water pollutants, Sampling of water and its preservation Trace metals in water, Chemical speciation with special reference to Copper, Lead, Mercury and Arsenic. Water quality standards Water quality parameters.
- b. **Oxygen Demanding Wastes:** Dissolved oxygen, Biological oxygen demand, Monitoring techniques and methodology with special reference to ammonia, Nitrates, Nitrites, Fluorides, Cyanides, Total hardness, Lead, Cadmium and Mercury. Detection and control of Detergents, oils, Pesticides, Sewage treatment.

Unit-III**[12hrs]**

- a) **Chemical toxicology :**Toxic chemicals in environment, Impact of toxic chemicals on enzymes, Biochemical effects of Arsenic, Cadmium, Lead, Mercury, Carbon monoxide, Sulphur dioxide, Pesticides and Carcinogens.
- b) **Soil analysis:**Sampling of soil, Determination of water holding capacity, Determination of total nitrogen, phosphorous and sulphur in soil.

Unit-IV**[12hrs]**

Industrial pollution: Pollution due to cement industry, Distillery, Pharmaceutical (Drug) industries, Sugar industry, Paper and pulp industries, Thermal power plants, Nuclear power plants, Metallurgical industries, Polymer industries. Recycle, reuse, recovery, disposal, and management of solid industrial waste.

Unit-V :**[12hrs]**

Green Chemistry: Principle and concepts of Green Chemistry: Sustainable development and green chemistry, Atom economy, examples of atom economic and atom un-economic reactions, reducing toxicity.

Organic solvents: environmentally benign solutions, solvent free systems, supercritical fluids, ionic liquids as catalysts and solvents.

Emerging green technologies: Photochemical reactions (Advantages and challenges), examples, chemistry using microwaves, sonochemistry, electrochemical synthesis.

Designing greener processes: Inherently safer design (ISD), Process intensification (PI), in-process monitoring.

Reference Books:

1. A. K. De, Environmental Chemistry, Wiley Eastern Ltd. New Delhi.
2. S. L. Chopra and J. S. Kanwar, Analytical, Agricultural Chemistry, Kalyani Publishers, New Delhi.

3. R. K. Trivedy and P. K. God, Chemical and biological methods for water pollution studies, Environmental publications, co. New Delhi.
4. L. A. Richards, Diagnosis and improvement of saline and alkali soils. Oxford IBH publications co. New Delhi.
5. S. M. Khopkar, Environmentalchemistry, Environmental pollution analysis.
6. M. S. Creos and Morr, Environmental chemical analysis, American publications.
7. M. Sitting, Resources, Recovery and Recycling, Handbook of industrial waste.
8. Standard methods of water and waste water analysis, American public health association Washington D. C.
9. R. Gopalan and AmruthaAnand, "Environmental chemistry laboratory manual Emerald Publication.
10. Standards for water for drinking and other purposes, Beaurau of Indian Standards India.
11. Guideline for drinking water quality recommendations of world health organization, Geneva.
12. B. K. Sharma and H. Kaur, Environmental Chemistry, Guel publishing house Meerut.
13. Thomas G. Spiro and Willian M. Stigliani, Chemistry of environment.
14. Green Chemistry: An Introductory Text, Mike Lancaster, Royal Society of Chemistry,(2002)
15. New Trends in green Chemistry, V.K.Ahluwalia and M. Kidwai, Anamaya Publishers New Delhi, (2004)

Advanced Analytical Techniques- CHEA-316**60 hrs****Credits: 04****Unit-I Molecular Luminescence Spectrometry: [12hrs]**

Theory of fluorescence and phosphorescence, Instruments for measuring fluorescence and phosphorescence, Applications and photoluminescence methods, Chemiluminescence

Unit-II Surface Characterization by Spectroscopy and Microscopy: [12hrs]

Introduction to the study of surfaces, Spectroscopic surface methods, Ion spectroscopic techniques, Surface photons spectroscopic methods, Electron stimulated microanalysis methods, Scanning probe microscopes

Unit-III [12hrs]

- a) Properties of Supercritical Fluids, Supercritical Fluid Chromatography, Supercritical Fluid Extraction.
- b) Principle, Instrumentation and Application of the following-
High performance thin layer chromatography, Ultra performance liquid chromatography, Advanced flash chromatography

Unit-IV [12hrs]

- a) Radioactive Nuclides, Instrumentation, Neutron activation methods, Isotope dilution methods
- b) Atomic X-ray spectrometry- Fundamental principles, Instrument components, X-ray fluorescence methods, X-ray absorption methods

Unit-V [12hrs]

- a) Introduction, Need for hyphenation, Possible hyphenation, Interfacing devices and applications of the following: LC-MS, GC-IR, GC-MS, ICP-MS, MS-MS.
- b) Principle of automation, Flow – injection Analysis, Microfluidics, Discrete automatic systems

Reference Books

1. Instrumental Methods of Analysis–Willard, Merritt, Dean & Settle.
2. Instrumental Analysis- Skoog, Holler, Crouch.
3. Principles of Instrumental Analysis–Skoog, F.J.Holler & J.A.Nieman
4. Instrumental Methods of Chemical Analysis–Galen W. Ewing.
5. Analytical Chemistry – Gary D. Christian, 6th edition
6. Handbook of Instrumental Techniques for Analytical Chemistry –Frank Settle, Editor
7. Introduction to Instrumental Analysis-R.D. Braun, McGraw Hill.
8. Fundamental of Analytical Chemistry, -D.A. Skoog, D.M. West and F.J. Holler.
9. Wilson and Wilson Comprehensive Analytical Chemistry. Ed. G. Svehla, A series of volumes.
10. Instrumental methods of analysis – Chatwal and Anand.
11. Instrumental methods of analysis – B. K. Sharma.

--

Analysis of Ores, Alloys & Explosive : CHEA-417

60 Hrs.

Credits: 04

Unit-I**[12hrs]**

- a. **Analysis of ores** Composition and analysis of Dolomite, Bauxite, Ilmenite, Zinc blend and calcite for their major constituents using one of the standard methods of analysis.
- b. **Analysis of alloys.** Composition, Properties, uses and analysis of : Brass, Bronze . Solder, Steel, Monel-metal, Silver coin for their major constituents using one of the standard methods of analysis.

Unit-II**[12hrs]**

Analysis of Paints and Pigments. Introduction, Determination of non-volatile and volatile components, Flash point, Separation of pigments and thinner of solvent type coating, Pigment type, Identification of binders , Analysis of Vehicle and drying oils, Analysis of pigments: Classification of organic and inorganic pigments, White tinted pigments.

Unit-III**[12hrs]**

Analysis of Cement and building materials.: Types of cement, Sampling, Analysis of- Silicon dioxide, Aluminum oxides, Ferric oxides, Calcium oxide, Magnesium oxide, Sodium and potassium oxide.

Analysis of Glass: Types of glasses, Determination of lead and lead glass.

Unit-IV Explosive :**[12hrs]**

Explosion, Detonation, Classification of explosives, Propellant, Fulminates, Detonators, Blasting-cap, Thermochemistry, Hygroscopicity of explosives, Moisture by Karl-Fisher titration, Isolation from debris, Qualitative test, Cation & anion analysis by capillary electrophoresis, EDXRF, Analysis by TLC, HPLC, IR, GC-TEA method.

Unit-V Cosmetic Analysis.**[12hrs]**

- a) Introduction to cosmetics.
- b) Evaluation of cosmetic materials-raw materials, additives, colours, perfumes.
- c) Legislation and recent amendments with respect to cosmetic materials.
- d) Analysis of Physical and chemical constituents of : Skin powder , Creams , Lipsticks , Lotions

Reference books.

1. Hillenbrand Lhundel, Bright and Hoffman, Applied inorganic analysis, John Wiley.
2. Snell and Biffen, Commercial methods of analysis.
3. P. G. Jeffery, Chemical methods of rock analysis, pergamon.
4. Rieche, Outline of industrial organic chemistry, Butter worth.
5. Kent, Rieg's Industrial chemistry, Rain hold
6. P. G. Jeffery and. J. Hatchinson, Chemical methods of rock analysis.
7. F. J. Welcher Standard methods of chemical analysis, A series of volume Robert and Krigegeger Publishing Company.
8. Metallurgical analysis by S. K. Jain and K. K. Jain.
9. www.dghs.gov.in

Unit-I General concepts of food analysis.

[12hrs]

Nutrient value of food., Physical characteristics & chemical constituents , Proximate composition of food, Legislation related to food and recent amendments, Standards and public health, General idea regarding food processing and preservation, Food contamination and spoilage , Food safety considerations., Adulteration-Introduction,Types,Tests for adulterants, control

Unit-II Analysis of food-

[12hrs]

Study of followings with their estimation methods : Food preservatives, Food emulsifiers, Food stabilizers, Food thickener, b). Introduction, Standard composition and Analysis of the following foods.:Milk and milk products, Tea, Coffee, Cereals & Flour, , Honey, Soft drinks & Alcoholic beverages.

Unit- III

[12hrs]

Analysis of Oils, Fats Soap and Detergents

Introduction to natural oils and fats, Analysis of oils and fats, Softing point, Congent point, Titer point, Cloud point, Iodine, Saponification, acid, Hydroxyl, R-M and polenske values, Elaiden test. Introduction to soaps, Analysis of soaps, for saponification, Unsaponifiable and unsaponified matter in soaps, Estimation of free alkali and phenol in soap, Classification of detergents (in Brief), Analysis of active ingredients from detergents (methelene blue and hyamine 1622 method), Estimation of CMC, Chlorides, Total phosphates

Unit-IV

[12hrs]

Analysis of fertilizers.Classification of fertilizer, NPK value, Chemical composition of superphosphate, Lime and Potash fertilizer, Analysis of commercially available fertilizers for N, P & K. **Analysis of pesticides.** :Legislation and recent amendments with respect to pesticides materials. Names of pesticides and their chemical structures. , Application dosage of different pesticides. , Analysis of specific pesticides.

Unit-V Analysis of Vitamins

[12hrs]

Analytical techniques of determination of water and fat soluble vitamins including , microbiological techniques. **Human nutrition:** Biological values and estimation of enzymes, Carbohydrates, essential amino acids, proteins and lipids.

Reference Books:-

1. Chemical analysis of food By Pearson.
2. Introductions to food science and technology , food science and technology series by G.F.Stewart and M.A. Amerine Academic process.
3. Cosmetics by W.D. Poucher (Three volumes)
4. Applied chemistry .A Text book for Engineers and technologists by H.D.Gesser.
5. Food analysis by Nielson.
6. Food additives by S.N.Mahindry (APH) publication
7. Analytical chemistry by Dr.Alka Gupta (pragatiprakashan)
8. Jacob(M.B) chemical Analysis of food and food products, (Van Nostrand co. New York)
9. Analytical chemistry of foods (C.S.James) Blackie Academic and professional
10. Food Analysis principles and techniques D.W.Gruenwedel and J.R.Whitaker, Merceel Dekker
11. Food analysis Theory and practice Y.pomeranz and C.E.Meloan, Chapman and Hill
12. Food Analysis ,2nd edition S.S Nelsen, Aspen publishers
13. Chopra S.L and Kanwar:J.S.1991 Analytical agricultural chemistry,Kalyanipublishera,New Delhi Ludiana India
14. Food analysis, A. G. Woodman, McGraw Hill

Unit-I polymer:-

[12hrs]

Introduction, classification of polymer, condensation polymerization, Addition polymerization. Mechanism, and stereochemistry of addition polymerization, Free radical addition polymerization, Cationic addition polymerization, Anionic addition polymerization Chain transfer reaction, Branching and cross linking in free radical addition polymerization, Ionic copolymerization, co-polycondensation Ring opening polymerization, Group transfer polymerization. Co-ordination polymerization. Molecular mass, Number and mass average molecular mass, Molecular mass determination by osmometry, Viscometry, light scattering and Sedimentation methods, Kinetics of polymerization Numericals

Unit-II Study of individual polymers:-

[12hrs]

Preparation and applications of following polymers:- polyethylene, polystyrene polyacrylonitrile polyesters polyparaphenylene polycarbonates polyamides, polyethylene glycol polypropylene alcohol, polyvinyl chloride polytetrafluoroethylene, silicone polymers.

Unit-III Polymer degradation:-

[12hrs]

Introduction,

Types of degradation .Thermal degradation, Mechanical degradation, photo degradation, Degradation by high energy radiation .Degradation by ultrasonic wave. Oxidative degradation. Ozone oxidation degradation .oxidative degradation of saturated polymers. Oxidation of phenol, formaldehyde. Antioxidants.

Unit-IV. Fuels:-

[12hrs]

Introduction, calorific value. Determination of calorific value. Modern concept of fuels. Classifications of fuels , criterion of selection of fuels , properties of fuels. Method of processing. Solids fuels , Natural solid fuels, Artificial solid fuels , Industrial solids fuels .Formation of coal properties of coal , Classification of coal., coking and non-coking coals. pulverised coal. .Role of sulphur and ash in coal , approximate analysis , Ultimate analysis. .Numerical.

Unit-V Petroleum:-

[12hrs]

Occurrence, mining of petroleum. Prospecting colour and consistency. Origin composition, classification , terms related to petroleum. .Distillation of crude petroleum. Treatment of the residual liquid, Determination of flash point. Determination of aniline point .Knocking and Anti-knocking compounds. Octane number .Cetanenumber, Numericals.

Reference Books:-

1. Text Book of polymer science By F.W. Billmeyer, New York: Wiley
2. Physical polymer science by L.H. Sperlingwiley –Interscience New York
3. Fundamentals of polymer science & Engineering By A Kumar & S.K. Gupta, Tata McGraw Hill
4. Introduction to polymer science , V.R. Gowarnikar, N.V. Vishwanathan & J.
5. Industrial Chemistry, B. K. Sharma, Goel publishing House Meerut.
6. Kent, Rieg's Industrial chemistry, Rain hold.
7. Handbook of Instrumental Techniques for analytical chemistry. Frank Settle, editor 1st Indian print 2004.
8. Polymer science by Vasant Govarikar, Wiley Earstewen. New York.
9. Principle of polymer science, Behadhar and Sastri, Narosa Publishing house.

Unit-I Pharmaceutical Analysis-I

[12hrs]

General idea regarding pharmaceutical industry. Definition and classification of drugs, types of dosage forms. Introduction to pharmaceutical formulations, Sources of impurities in pharmaceutical chemicals, raw materials & Products,. Standardization of finished products& their characteristics. Limit tests of As, Hg, Cu, Pb, Fe, Cl and SO₄, Solubility tests, disintegration tests, stability studies.

Unit-II

[12hrs]

Pharmaceutical legislation: Introduction to drug acts, drug rules, FDA and ISO standards & their amendments , ISO-9000, an overview, Clauses / requirement of ISO-9000, Significance and scope. Steps for ISO-9000, implementation, Series of ISO, Case studies of ISO. ISI, Agmark and other standard for goods & cosmetics particularly w.r.t. the testing of drugs, and raw material concerned. Pharmaceutical standards BP/IP/USP/NE/EP. Documentation, Record Keeping. Contents of labels ,Types of packaging materials

Unit-III

[12hrs]

Clinical Analysis.:Introduction: Body fluids: Composition, Collection and Preservation of body fluids and detection of abnormal levels of certain constituents leading to diagnosis of diseases and disorders. Analysis of constituents of physiological fluids, viz.1.Blood -PH, Glucose, Urea. 2.Serum-uric acid, total protein,albumin, globulin&A/G ratio, barbiturates, alkaline phosphatase, acid phosphatase, bilirubin, cholesterol, amylase, creatinine carbohydrates. Urine-Immunological methods: General process of immune response, Antibody-Antigen ratio, Precipitation reactions, Enzyme and fluoro-immune assays radioimmunoassay, ELISA

Unit-IV

[12hrs]

Forensic Analysis.Introduction, Special features of forensic analysis, Sampling, Sample storage, Sample dissolution. Toxicology: Classification of poisons and poisoning, Lethal Dose, Significance of LD50 and LC50. Extraction methods in toxicology: Isolation, Identification and determinations of: Narcotics: Heroin, Morphine, Codeine. Stimulants: Caffeine, Cocaine, Amphetamines. Despressant: Benzodiazepines- Diazepam, Oxazepam, Nitrazepam. Barbiturates- Phenobarbitone, Amylobarbitone, Pentobarbitone, Thiopentone. Hallucinogens: LSC and Cannabis. Analysis of biological stains and materials including blood, semen and saliva (qualitative and quantitative). Viscera, Stomach wash, Vomit and post mortem blood for poisons like cyanides, As, Hg, Insecticides and Pesticides.

Unit-V Pharmaceutical Analysis-II

[12hrs]

Assay of main classes of drugs with reference to Introduction, Type, Properties, Mode of action and Methods of Analysis.

Reference Books:

1. General Microbiology- R. V. Stainer 6th edition
2. Principle of microbiology- A. J. Salle
3. Microbiology- Pleczar
4. Isolation and Identification of drug-n E. G. Clarke vol.- I
5. Laboratory procedure manual-Forensic Toxicology- Directorate of forensic science, MHA Govt. of India.
6. Analytical Biochemistry, D. J. Holme and H. Peck, Longman
7. Bioanalytical Chemistry, S.R. Mikkelsen and E. Corton, John Wiley and Sons.
8. Immunoassay – a practical guide Eds, D.W. Chan and M.T. Perlstein, Academic Press.
9. Hawk's Physiological Chemistry, McGraw Hill.
10. Pharmaceutical Analysis Edited by David C. Lee, and Michael Webb.
11. An Introduction to Practical Biochemistry, David Plummer.
12. Biochemical methods, S. Sadasivam, A. Manickam.
13. Standard Methods of Biochemical Analysis, S.R. Thimmaiah

Laboratory Course (Analytical) CHEA- 421

135 Hrs

Credits: 4.50

Name of experiment.

1. Determination of COD, BOD and dissolved oxygen from waste water sample.
2. Determine the amount of magnesium of from Neem plant leaves sample by
3. volumetric method.
4. Separate and estimate the amount of cadmium and zinc using ion exchange resin
5. Removal of dyes by column chromatography method using activated charcoal
6. Estimation of Nitrogen from given sample of fertilizer by Kjaldal method.
7. Determination of acid and Iodine value of an oil.
8. Determination Vitamin –C from given sample of Juice/ tablet using dichlorophenol indophenols by volumetric method.
9. Estimation of blood glucose by Folin Wu method.
10. Estimation of API in the pharmaceutical sample.
11. Determine the molecular weight of high polymer by viscosity measurement.
12. Estimation of phenol / aniline by bromination method.
13. Estimation of chloride from food sample by Volhard titration method.
14. Determination of sodium carbonate in washing soda .
15. Determination of volume strength of commercial hydrogen peroxide using KMnO_4
16. Estimation of Nickel in the given solution by EDTA titration method.
17. Estimation of tannine from tea sample
18. Estimation of Iron by 8- hydroxyl quinoline by solvent extraction .
19. Estimation of nickel using 1,10 phenanthroline and dithiazone by solvent extraction
20. . Separation and estimation of bromophenolblue ,congo red and phenol red in a mixture by thin layer chromatography.

Reference Books

1. Quantitative Inorganic Analysis including Elementary Instrumental Analysis by A. I. Vogels, 3rd Ed. ELBS (1964)
2. Experiments in chemistry by D. V. Jahagirdar, Himalaya publication
- 3: Practical Pharmaceutical Chemistry, 4th Ed. part-2, Beckett, Stenlake

Laboratory Course (Analytical) CHEA- 422

135 Hrs

Credits: 4.50

Name of experiment.

1. Estimation of potassium and sodium from given sample of fertilizer using flame photometric method.
2. Estimation of calcium from given sample of milk using flame photometric method.
3. . Determine the strength of acetic acid and sulphuric acid from mixture of acid solution using conduct metric method.
4. Analysis of commercial vinegar by conductometric titration method.
5. Determination of relative strength of acetic acid, chloroacetic acid and trichloro acetic acid K_a value by conductometric metric method.
6. Determination of boric acid by conductometric method.
7. Determination of commercial vinegar by potentiometric titration and its confirmation by conductometric method.
- 8..Determination of percentage of sodium carbonate from soda ash by P^H metric titration method.
9. Determine the percentage of phosphoric acid in cold drink sample by spectrophotometric method.
- 10.. Determine the amount of phosphate from given sample of fertilizer/ detergent using spectrophotometric method.
11. Estimation of Cu(II) and Fe(III) by specrophotometric method using EDTA .
12. Determine the amount of alcohol from given sample of by Spectrophotometric method.
13. Estimate the reducing sugar by 3,5dinitrosalicylic acid in the given food sample by Spectrophotometric method..
14. Determination of protin by biureate method using by Spectrophotometric method.
15. Determination of moisture contain in food sample using Karl fischer titration method.
- 16.. Determine the specific and molar refraction of given liquid by refractometric method.
17. Analysis of mixture of alcohols by Gas chromatography
18. Monitoring of nitration of organic compound by gas chromatography.
19. Determine the lactose sugar by HPLC method
20. Analysis of binary mixture of simple organic compound by HPLC method.
21. Determine the Hammett constant of substituted benzoic acid by pH metric method.

Part – I Name of experiment

1. Estimate the amount of copper and Tin from bronze alloy
2. Estimate the amount of lead and Tin from solder alloy
3. Estimate the amount of copper and Nickel from coin
4. Estimate the amount of copper and Zinc from brass alloy
5. Estimate the amount of Iron Tin from hematite ore.
6. Estimate the amount of calcium, Magnesium and silica material from dolomite ore.
7. Estimate the amount of SiO₂, calcium Iron Magnesium and aluminium from cement.
8. Determine the amount of Nickel and Iron from NiFe₃O₄ ferrite sample.

Part B- Analytical Data interpretation and Structure Elucidation

- i). UV Visible, IR, PMR, CMR mass Spectrum of organic and inorganic compounds
- ii). XRD data analysis of organic and inorganic compounds
- iii). TGA, DTA data analysis of inorganic compounds

References books for CHEA422-to 424

1. Systematic experimental physical chemistry – S. W. Rajbhoj & T. K Chondhekar
2. Quantitative Inorganic Analysis including Elementary Instrumental Analysis
3. by A. I. Vogel, 3rd Ed. ELBS (1964)
4. 3: Standard methods of chemical analysis by F. J. Welcher
5. 4: Indian Pharmacopoeia volume –I, II III
6. British pharmacopoeia -
7. Experiments in chemistry by D. V. Jahagirdar, Himalaya publication
8. 7: Practical Pharmaceutical Chemistry, 4th Ed. part-2, Beckett, Stenlake
9. 8: Standard Instrumental methods of Chemical Analysis, F. J. Welcher

M. Sc. III & IV semester Anal. Chem
Project work (Analytical Chemistry) CHEA- 424

135 Hrs

Credits: 4.50

Tentative topic for projects

Projects to be based upon convenient analytical protocol for analysis of one of the following materials

- i) Drugs/ Medicines
- ii). Dyes/ Paints/ cosmetics
- iii). Milk product/ vegetable oils/ beverages
- iv). Plastics and polymers
- v) Ores & alloys
- vi) Fertilizer, insecticide, Pesticide , Plant material analysis
- vii). Environmental samples, air, water, soil

Scheme of marking

Project work Evaluation : 25 marks

- i. Literature survey
- ii. Experimental procedures, photographs
- iii. Characterizations techniques : Fundamentals principles of respective techniques
- iv. Spectrum / images of prepared materials
- v. Data analysis / applications of synthesized materials
- vi. Conclusion
- vii. Reference citations
- viii. Holistic response of students (scientific thinking, power of imagination, Punctuality, efforts, curiosity,)

Power point presentation of Project work : 25 marks

- i. Self-preparation PPT
- ii. Skill of presentation
- iii. Contents of presentation
- iv. subject knowledge
- v. Manuscript preparation/acceptance/publication

Reference : Internet search

