Course No: CH21301CR
Title: Selected Topics in Inorganic Chemistry (04 Credits)

Max. Marks: 100 **Duration: 64 Contact hours**
Continuous Assessment: 20 marks **End Term Exam: 80 Marks**

Course Outcome: The students are expected:

- Learn the importance of inorganic elements in vital systems
- Discuss the chemistry and biology of specific bioinorganic systems and model metal complexes.
- Appreciate how Nature acquires and places trace elements for use in life processes.
- Recognize how the fundamental principles of inorganic chemistry apply to bioinorganicsystems.
- Understand the application of specialized methods used to study bioinorganic molecules.
- Understand metal ion binding to biomolecules and their functions.
- Demonstrate an advanced understanding of the key differences in the roles of metal-containing systems in biology.
- To know about magnetic properties of the transition metal ions.
- Identify molecular geometries associated with various d-orbital splitting patterns
- Predict electron configurations of split d orbitals for selected transition metal atoms or ions
- Explain spectral and magnetic properties in terms of CFT concepts

Unit-I Biological Inorganic Systems: (16 Contact hours)

Iron Storage, Transport and Oxygen carriers: Ferritin and Transferrin: Structure, Metal binding sites; incorporation and release of iron.

Haemoglobin and Myoglobin: Structure, oxygen saturation curves; Mechanism of oxygen transport and storage. Bohr Effect and cooperativity in haemoglobin. Dioxygen binding to Hemerythrin and Hemocyanin. Synthetic oxygen carrier model compounds: Vaska's iridium complex: Cobalt complexes with micro and macrocyclic ligands and Schiff base ligands.

Electron Carriers: Structure and biological role of Rubredoxin&Ferridoxin, Cytochromes as electron transfer proteins: structure, biological role and applications.

Biological Nitrogen Fixation: Nitrogenase enzyme; Fixation via nitride formation.

Unit-II Bonding models in Inorganic Compounds (16 Contact hours)

A. Bonding in main group compounds: Classification and topology of Boron clusters, types of bonds, isolobal analogy, empirical rules for bonding in boron clusters, Selected examples of bonding in higher boranes; CarboranesandMetallacarboranes.

Bonding in Boron–Nitrogen, Phosphorous–Nitrogen andSulphur-Nitrogen compounds ((Borazine, Cyclophosphazenes, phosphonitrillic halides, polythiazyls and Sulphur Nitrides)Bent's rule applications.

B. Bonding in Metal clusters and Polymetallates:

Factors favoring metal–metal bond, bonding in di- andtrinuclear metal clusters, cotton rationale and quadruple bonding, selected examples of bondingindinuclear metal clusters and hetero-polymetallates.

C.BondinginMetal Hydride Complexes: Hydride as ligand, Characterization & Chemical reactions, Classical and Non classical Hydrides: Bonding and significance of Kuba's type Dihydrogen complexes.

Unit-III Magnetic Properties and Electronic Spectra of TransitionMetalComplexes (16 Contact hours)

Types of magnetic behaviour, magnetic susceptibility and magnetic moment; methods of determining magnetic susceptibility; spin-only formula; L-S coupling, correlation of μ_s and μ_{eff} values; orbital contribution to magnetic moments; applications of magnetic moment data in investigation of nature of bonding and stereochemistry of first row transition metal complexes. High spin- low spin crossover. Magnetic Properties of Inner transition compounds.

Electronic spectra of Transition metal complexes: General features; Types of electronic transitions, theoretical aspects of d-d spectra, selection rules; spectral terms of d^1 - d^{10} metal ions.

Selected examples of d-d spectra. Spectra of distorted octahedral and square planar complexes. Charge transfer spectra (Factors affecting energies of LMCT and MLCT transitions.

Unit-IV NQR & Mossbauer Spectroscopy. (16 Contact hours)

(a) Mossbauer Spectroscopy: Basic principles, Nuclear Recoil and Mossbauer Effect, Spectral parameters such as isomer shift, quadrupole splitting and magnetic splitting, spectrumdisplay.Determination of Magnetic transition Temperature,Intermediate spin -- Determination of Spin crossover temperatures.Partial Isomer shift and partial Quadrupole splitting. Application of the technique to the studies of (i) bonding and structure of Fe^{2+} and Fe^{3+} compounds (ii) Sn^{2+} and Sn^{4+} compounds— nature of M—L bond, coordination number and structure, (iii) detection of oxidation state and inequivalent MB atoms.

(b) NQR Spectroscopy: NQR isotopes, Nuclear quadruple moment; Electric field gradient; nuclear quadruple coupling constant; Axial Symmetry, Asymmetric EFG, Effect of applied magnetic field, Application

Books Recommended:

1. Bioinorganic Chemistry- An introduction; Ochiai; Allyn and Bacon;1977.
2. Principles of Bioinorganic Chemistry; S. J. Lippard and J. M. Berg; University Science Books;1994.
3. The Inorganic Chemistry of Biological Processes; IIndedn.; M. N. Hughes; John Wiley;1973.
4. Bioinorganic Chemistry- A Short Course; R. M. Roat- Malone; Wiley Interscience;2003.
5. Electronic Spectra of Transition Metal Complexes - D. Sutton (McGraw-Hill,1968)
6. Elements of Magnetochemistry- R. L. Dutta, A.Syamal (Affiliated East -West, 1993).
7. Physical Methods for Chemistry; 2nd edn.,R.S.Drago ; Saunders ;1992.
8. Structural Methods in Inorganic Chemistry; 2nd edn. E. A. V. Ebsworth & D.W.H. Rankin; ELBS; 1991.
9. Spectroscopy in Inorganic Chemistry; Vols I& II; Rao, Ferraro;Academic;1970.
10. NMR, NQR and Mossbauer Spectroscopy in Inorganic Chemistry; R.V.Parish; EllisHorwood.

Course No: CH21302CR
Title: Organic Spectroscopy & Heterocyclic Chemistry (04 Credits)

Max. Marks: 100 | **Duration: 64 Contact hours**
Continuous Assessment: 20 marks | **End Term Exam: 80 Marks**

Course Outcome: On completion of the course the students will acquire knowledge of:

- IR range for functional groups, λmax for polyenes and α, β-unsaturated carbonyl compounds which are helpful in structural elucidation of organic compounds.
- Fragmentation pattern in Mass spectrometry and its application in structural elucidation.
- Chemical shift values and their significance in NMR.
- Solving structural problems based on UV-Vis, IR, ^{1}HNMR, ^{13}CNMR and mass spectral data.
- Importance, structural properties and synthesis of Heterocyclic compounds with emphasis on monocyclic and bicyclic Heterocycles.

Unit I UV, IR AND Mass Spectroscopy **(16 Contact hours)**

Principles and applications of Ultra Violet and Infra-Red Spectroscopy in structural elucidation of organic compounds.

Mass Spectrometry: Introduction, instrumentation, Ionization methods like EI, CI, SIMS, FAB, MALDI, ESI, MS/MS. Mass Analyzers like Magnetic Sector Mass Analyzer, Double Focusing Mass Analyzer, Quadrupole Mass Analyzer, Time-of-Flight. Determination of molecular formula, Role of Isotopes, Nitrogen Rule, Metastable Peak. Fragmentation pattern like Stevenson rule, initial ionization event, α-cleavage, inductive cleavage, two bond cleavage, Retro-Diels. Alder cleavage, McLaffertey Rearrangements. Fragmentation pattern of alkanes, alkenes, alcohols, phenols, aldehydes, ketones, Carboxylic acids, Amines, Problems based on Mass Spectrometry.

Unit II NMR Spectroscopy **(16 Contact hours)**

Basic concepts, Mechanism of Measurements, Chemical shift values for various classes of compounds. Fourier Transform (FT), Techniques and advantages, Nuclear overhouser effect (NOE). One bond coupling, two bond coupling, three bond coupling, second order spectra A2, AB, AX, AB2, ABX, AX2, A2B2. Proton exchange, deuterium exchange, Peak broadening exchange C-13 NMR: Carbon 13-chemical shifts, proton coupled and decoupled spectra. Off-Resonance De-coupling, A quick dip into DEPT-45, DEPT-90, DEPT-135. Introduction to two-dimensional spectroscopy methods, Cosy techniques, HETCOR technique, OESY.

Structure elucidation of organic compounds using combined spectroscopic methods.

Unit-III Nomenclature, Structure and General Synthetic Methodologies
(16 Contact hours)

Nomenclature of heterocycles (Hantzsch- Widman and replacement methods). Non-aromatic and aromatic heterocycles. Tautomerism in heterocycles, Meso-ionic systems. Spectroscopic properties of heterocycles (IR, UV-Visible and NMR).

Reactions most frequently used in heterocyclic ring synthesis like C-C bonding, C-heteroatom bonding, typical reactant combinations, Electrocyclic processes in heterocyclic ring synthesis, Nitrenes in heterocyclic synthesis. Hantzsch Pyridine, Skraup, Fischer-Indole synthesis.

Unit-IV Monocyclic and Bicyclic Heterocycles **(16 Contact hours)**

Structure, Synthesis and Reactions of Oxirane, Thirane, Azetidine, Pyrrole, Furan, Thiophene, Diazenes, Pyrimidines, Pyridine and Pyrans. Chemistry of five membered heterocycles with two heteroatoms like 1,3-Azoles, 1,2- Azoles.

Structure, Synthesis and reactions of Benzo-fused heterocycles like Benzo-pyrrole, Benzo-furan, Benzo-thiophene, Quinoline, Isoquinoline, Chromones and Coumarins.

Books recommended:

1. Spectrometric Identification of Organic Compounds. 5th Ed., R. M. Silverstein, G. C. Bassler and T. C. Morill. (Jhon Wiley-1991).
2. Introduction to NMR Spectroscopy, R. J. Abraham. J. Fisher and P. Loftus (Wiley-1991)
3. Applications of absorption spectroscopy of Organic Compounds, J. R. Dyer (Prentice Hall-1991).
4. Spectroscopic Methods in organic Chemistry, D. H. Williams; I. Fleming (Tata- McGraw Hill, 1988).
5. Heterocyclic Chemistry, 5th Ed. J.A.Joule and K.Mills, (Wiley-2010).
6. Essentials of Organic Chemistry, Paul M Dewick , (Wiley-2006).
7. Heterocyclic Chemistry, J.A. Joule and G.F.Smith , (Chapman and Hall-1996).
8. The Chemistry of Heterocycles Theophil Eicher and Siegfried Hauptmann, (George Thieme Verlag Stutt gart, New York -1995).
9. Heterocyclic Chemistry, Raj K. Bansal, (New Age International Publisher-2006).
10. Heterocyclic Chemistry, R. R. Gupta, M. Kumar, V. Gupta,(Springer-2006).

Course No: CH21303CR
Title: Physical Chemistry (04 Credits)

Max. Marks: 100 | **Duration: 64 Contact hours**
Continuous Assessment: 20 marks | **End Term Exam: 80 Marks**

Course outcome: After learning the contents of this course, the students shall:

- learn quantum mechanical reason of the aromaticity and hybridization process in molecules.
- get acquainted with the multielectron wavefunction and evaluation of energy by using approximation methods in the multielectron systems.
- be familiar with the types of surfactants, their aggregation behavior and structure of aggregates.
- be familiar with the applications of the surfactant systems in industries, catalysis, environment and pharmaceuticals.
- learn how solvents influence the thermodynamic and transport properties of electrolyte solutions
- learn how different theories can be used for the quantification of thermodynamic and transport properties of electrolyte solutions
- have a know-how of the structural/electrical aspects of electrode/electrolyte interfaces and their impact over the thermodynamics and kinetics of charge transfer reactions across these interface
- learn about the basic mechanism underlying corrosion, factors affecting the rate of corrosion and different approaches for monitoring and control of corrosion of metals

Unit-I Quantum Chemistry (16 Contact hours)

Chemical Bonding: Hybridization of orbitals (sp, sp^2&sp^3). Huckel's Pi-MO theory: Application to linear and cyclic polyenes. Pi-electron charge and bond-order. Alternant hydrocarbons, Naphthalene, heteroatomic conjugated systems. Limitations of Huckel theory. Extended Huckel Method.

Self consistent field method: Hamiltonian and wave function for multi-electron systems. Electronic Hamiltonian, antisymmetrized wave function, Slater determinant. Hartree and Hartree-Fockself consistent field method. Application of HatreeFock SCF method to He-atom.

Unit-II Self-Assembly of Surfactants and its applications (16 Contact hours)

Classification of Surfactants, Solubility of Surfactants: Kraft temperature and cloud point, Micellization of surfactants: critical micelle concentration (cmc), aggregation number, counterion binding, factors affecting cmc in aqueous media. Thermodynamics of micellization: pseudophase model and mass action models. Structure and shape of micelles: geometrical consideration of chain packing, variation of micellar size and shape transitions with surfactant concentration, temperature and pH.

Micellar solubilization: Solubilization of hydrophobic molecules (like PAHs) in micelles, factors affecting micellar solubilization: nature of solubilizate and surfactant, effect of additive and temperature. Its applications in environmental remediation and oil recovery processes. Micelles as carriers of hydrophobic drug molecules and their pH and temperature responsive controlled release.

Micellar catalysis: Oxidation reduction reactions, micelles as scaffolds for effective energy transfer phenomena.

Unit-III Ionics (16 Contact hours)

Ion solvent Interactions:Non structural (Born) treatment and an introduction to structural (Ion-dipole, Ion-quadruple)treatments of ion-solvent interactions.

Ion-Ion Interactions: Activity and activity co-efficient. Debye-Huckel theory of activity coefficients of electrolyte solutions; derivation of Debye-Huckel limiting law, validity and extension to high concentrations; ion-pair formation-Bjerrum model.

Conductance of electrolyte solutions: Mobility of ions, mobility and conductivity, Einstein relations, dependence of molar conductance on concentration, estimation of K and Λ_0 for weak electrolytes, Theories of Conductance: Debye-Huckel-Onsager conductance equation and brief idea of its extension.

Unit-IV Electrodics (16 Contact hours)

Electrified Interface: Metal-electrolyte electrified interface, concept of surface excess, thermodynamics of electrified interface, Lippman equation, electrocapillary curves. Methods for determination of surface excess.

Structural models of metal-electrolyte interface: Helmholtz-Perrin, Gouy-Chapman and Stern models, Structure of semiconductor/electrolyte interface.

Theories of Heterogeneous Electron Transfer: Electron transfer at electrified interface at and away from equilibrium. Butler-Volmer equation, low and high field approximations, significance of transfer coefficient, Marcus theory of charge transfer; basics and predictions.

Electrodics of Corrosion: Corrosion, types and mechanism of corrosion, corrosion current, corrosion potential, Electrodics of corrosion in absence of Oxide films, Corrosion and Evans diagrams, Monitoring and inhibition of corrosion; Cathodic and anodic protection, Passivation.

Books Recommended:

1. Physical Chemistry –P. W. Atkins, 9th Edition, ELBS , Oxford, 2009.
2. Physical Chemistry- A Molecular Approach - D. A. McQuarie& J. D. Simon, University Science Books, 1997.
3. Introduction to Quantum chemistry - A. K. Chandra, TataMcGraw Hill, 1997.
4. Quantum Chemistry - Ira. N. Levine, 7th Edition, Pearson, 2009.
5. Quantum Chemistry, R. K. Prasad, 2nd Edition, New Age Publishers, 2001.
6. Molecular Thermodynamics of Electrolyte Solutions, Lioyd L Lee, World Scientific, 2008.
7. An Introduction to Aqueous Electrolyte Solutions, Margaret Robson Wright, Wiley, 2007.
8. Modern Electrochemistry 1, 2A, 2B 2nd Edition, J. O`M. Bokris and A. K. Reddy, Kluwer Academic/Plenum Publishers, New York.
9. Electrochemical methods, Fundamentals and Methods, A.J. Bard, L.R. Faulkner, Wiley,1980.
10. Physical Electrochemistry- Fundamentals, Techniques and Applications, Eliezer Gileadi, Wiley-VCH 2011.
11. Electrochemistry, 2nd Edition, Carl H. Hamann, Andrew Hammett, Wolf Vielstich, Wiley-VCH.

Course No: CH21304CR
Title: Non-Equilibrium Thermodynamics (02 Credits)

Max. Marks: 50 **Duration: 32 Contact hours**
Continuous Assessment: 10 marks **End Term Exam: 40 Marks**

Course outcome: After learning the contents of this course, the students shall:

- understand the concept of entropy production and learn how the extent of entropy production associated with different processes can be estimated
- learn about Onsager' formalism of irreversible processes and how it can be used to account how it can be used to explain various empirical relations observed in electrokinetic phenomena, Thermal diffusion, Thermomechanical effects and thermoelectric phenomena.
- learn how solvents influence the thermodynamic and transport properties of electrolyte solutions
- learn about some unique specialties of far-from-equilibrium systems like possible generation of order and symmetry breaking.

Unit-I Fundamentals of Irreversible Thermodynamics (16 Contact hours)

Basic principles of non-equilibrium thermodynamics: Second law of thermodynamics for open system, law of conservation of mass, charge and energy. Irreversible processes and uncompensated heat, degree of advancement, reaction rate & affinity, Relation of uncompensated heat to other thermodynamic functions.

Gibb's equation, entropy production, entropy production due to matter flow, heat flow, chemical reactions, charge flow; entropy production and efficiency of galvanic cells.

Concept of forces & fluxes, Onsager's theory of irreversible processes, phenomenological laws, their domain of validity. Principle of microscopic reversibility and Onsager relations, Chemical reactions near equilibrium. Curie–Prigogine principle. Transformation properties of forces and fluxes.

Unit-II Applied Irreversible Thermodynamics (16 Contact hours)

Stationary non-equilibrium states, thermodynamic significance. Theorem of minimum entropy production. States of minimum entropy production, stability of stationary states, entropy flow in stationary systems. Stationary state coupling in irreversible processes. Variation of entropy production in stationery states, Glansdroff-Prigogine inequality. Electrokinetic phenomena and expressions for streaming potential, electro-osmotic pressure difference, streaming potential using the linear phenomenological equations. Dufour and Soret effects, Thermal Osmosis, Thermo mechanical effects, thermoelectric phenomena.

Self-Organization in physico-chemical systems, Dissipative structures, thermal convection, Symmetry breaking in biological systems.

Books Recommended

1. Thermodynamics of IrreversibleProcesses;DeGroot,Mazur;Dover;1986.
2. Introduction to Thermodynamics of Irreversible Processes; I.Prigogine; Wiley Interscience; 1967.
3. Thermodynamics for students of Chemsitry, Kuriacose, Rajaram, (S. ChandandCo., 1996).
4. Exploring Complexity, I.Prigogine, G. Nicolis, (Freeman, 1998).
5. Molecular Thermodynamics, D. A. McQuarrie, J. D. Simon, USB, 1998.
6. Understanding non-equilibrium thermodynamics. G. Lebon, D. Jon, J. Casas Vasques. Springer, 2008.
7. Non-equlibrium thermodynamics, 2nd ed. Yasar Demirel. Elsevier, 2007.

Course No: CH21305DCE
Title: Laboratory Course in Chemistry III (4 Credit)

Max. Marks: 50 **Duration: 32 Contact hours**
Continuous Assessment: 10 marks **End Term Exam: 40 Marks**

Course Outcome: On completion of the lab the student should be able to:

- Setup and monitor multistep synthesis in the laboratory.
- Monitor and analyze the progress of the reaction by TLC.
- Separate the mixture of compounds by column chromatography and their spectral analysis.
- Understand and develop the skills for extraction of natural products from plant or animal sources.

SECTION A-INORGANIC CHEMISTRY

A: **Separation by Column Chromatography and Estimations:**

Experiment_1: Separation of permanganate and dichromate ions on Alumina column and followed by estimation by *Permanganometry*

Experiment_2: Separation of Cobalt (II) and Nickel (II) on an anion exchange column followed by estimation through EDTA back titrations.

B: Spectrophotometry:

Experiment_3: Estimation of ferrous ions in a water sample with 1,10-Phenanthroline , spectrophotometrically

Experiment_4: Analysis of Ferrous Iron in a Vitamin Pill

Experiment_5: Estimation of inorganic Phosphorus in human serum, by Molybdenum blue method.

Experiment_6: Determination of stoichiometry of Iron Thiocyanate complex using Job's Continuous variation method.

Experiment_7: Determination of stoichiometry of Iron (II)—2,2-bipyridyl complex by Mole ratio method.

C: Nano-chemistry:

Experiment_8: Synthesizing of silver nanoparticles (Ag NP) via chemical reduction: Understanding the Impact of Size on Silver’s Optical Properties.

Experiment_9: Synthesis of CdSeS nano-crystals exhibiting controllable photo-luminescence.

SECTION B-ORGANIC CHEMISTRY

1 Multistep Organic Preparations (Synthesis)

(1) Synthesis of local anesthetics
(2) Synthesis of analgesics.
(3) Synthesis of sulpha drugs
(4) Synthesis using microwaves: Alkylation of diethyl malonate with benzoyl chloride.
(5) Skraup synthesis: Preparation of quinoline from aniline.
(6) Beckmann rearrangement.
(7) Aldol condensation: Dibenzal acetone from acetone and benzaldehyde.
(8) Cannizarro's reaction of 4-Chlorobenzaldelyde.
(9) Aromatic electrophilic substitutions in benzoic acid or aniline.

2 Column Chromatography

3 Thin Layer Chromatography

4 Extraction of Natural Products

(a) Caffeine from Tea leaves
(b) Lycopene and beta carotene from tomato

(c) Citric acid from lemon juice
(d) Keratin form human hair.

Spectral Analysis of synthesised/Isolated Compounds

SECTION C-PHYSICAL CHEMISTRY

A. Potentiometry

1. Determination of strength and pKa value of weak acid by titration with an alkali using quinhydrone electrode.
2. Titration of Fe (II) vs. $K_2Cr_2O_7$ and determination of standard redox potential of Fe^{2+}/Fe^{3+}.
3. Precipitation titration of KCl, KBr, KI and their mixture with $AgNO_3$.

B. pH-metry

1. Determination of pKa values of a tribasic acid by titration with an alkali.
2. Determination of H_3PO_4 content in a given sample of Coca-Cola.
3. Determination of degree of hydrolysis of a given salt using pH-metry.

C. Spectrophotometry

1. Determination of composition of a binary mixture of $K_2Cr_2O_7$ and $KMnO_4$ or Cobalt (II) and Nickel (II) ions.
2. Spectrophotometric titration of Fe(II) vs. $KMNO_4$.
3. To study the complexation reaction between Fe(III) & salicylic acid.
4. Recording Absorption spectra of a series of conjugated dyes-Application of the particle in one dimensional box. (Optional)

Books Recommended:

1. Vogel's quantitative analysis 6 Edn. Mendham, Denny; Pearson Education2002
2. Modern Analytical Chemistry, David HarveyMc Graw Hill.US
3. Analytical Chemistry. 7th edition ,Gary D. Christian, Purnendu K. (Sandy) Dasgupta, Kevin A. Schug, Wiley
4. Experiments and Techniques in Organic Chemistry - D. Pasto, C. Johnson and M. Miller (Prentice-hall, 1992.)
5. Microscale and Macroscale Organic Experiments- K.L. Williamson (D.C. Heath and Co., 1989).
6. Advanced Practical Organic Chemistry, 2nd ed. - N.K. Vishnoi (Vikas, 1999).
7. Vogel's Textbook of Practical Organic Chemistry, 5th ed.- A.R. Tatchell (ELBS, • 1996)
8. Comprehensicve Practical Organic Chemistry, V. K. Ahluwalia and Renu Aggarwal, (University Press-2000)
9. Practical Physical Chemistry, Findley, Kitchener, Longman, 1977.
10. Advanced Practical Physical Chemistry, Yadav , Goel Pub, 1994.
11. Experiments in Physical Chemistry, 5th ed., Schoemakeret al. , MGH, 1989.

Course No: CH21306DCE
Title: Chromatographic Techniques (02 Credits)

Max. Marks: 50 | **Duration: 32 Contact hours**
Continuous Assessment: 10 marks | **End Term Exam: 40 Marks**

Course Outcome: On completion of the course the students will acquire knowledge of:

- Classification and types of various chromatographic techniques and their principles.
- Thin Layer Chromatography, its stationary phase, mobile phase and principle of separation.
- Gas-Liquid chromatography, its principle, columns, stationary phase, resolution and instrumentation.
- High performance chromatography (HPLC), its importance and its versatility.

Unit-I Chromatographic Techniques I **(16 Contact hours)**

Introduction, Types and Classification, principles, differential migration, nature of partition forces, partition, Mobile phases, stationary phases, resolution, plate theory (concept), separation time, zone migration, column packing materials, development techniques, differential migration, partition coefficient, retention time and retention volume.

Thin layer chromatography: Theory, principle, adsorbents, preparation of plates, solvents, preparative TLC.

Unit-II Chromatographic Techniques II **(16 Contact hours)**

Gas-Liquid chromatography: Principle, columns and stationary phase, resolution and instrumentation.

HPLC: Theory, column efficiency, extra column and band broadening, temperature effects and diffusion. Chiral chromatography, chiral stationary phases. Applications of HPLC.

Ion exchange and size exclusion chromatography: Principle, mechanism of separation and applications.

Books recommended

1. Principles and Practice of Analytical Chemistry; 5th Edition; F. W. Fifield, D. Kealey; Blackwell Sciences Ltd.; 2000.
2. Modern Analytical Chemistry; David Harvey; McGraw-Hill; 2000.
3. Chromatographic Methods; 5th edn. ; A. Braithwaite and F. J. Smith; Kluwer Academic Publishers.
4. Fundamentals of Analytical Chemistry; 6th Indian Reprint; D. A. Skoog and D.M. West; Cenage Learning; 2012.
5. Thin layer Chromatography; E. Stahl and George Allen; Unwin Ltd. London.

Course No: CH21307DCE
Title: Bio-Physical Chemistry (02 Credits)

Max. Marks: 50 **Duration: 32 Contact hours**
Continuous Assessment: 10 marks **End Term Exam: 40 Marks**

Course outcome: After learning the contents of this course, the students shall:

- learn how to use the thermodynamic concepts and equations to explain the basis of different biological processes and quantify the different parameters associated with these processes.
- how basic thermodynamic equations can be used for estimation of thermodynamic parameters associated with biological processes
- how equilibrium thermodynamics can be used to understand the biological processes like protein folding, membrane potential and membrane transport, nerve conduction.

Unit-I Biophysical Chemistry-I **(16 Contact hours)**

Review of the basic concepts of Thermodynamics, Thermodynamics of living systems, Biochemists standard state, standard free energy changes in biochemical reactions, ATP as energy currency of cell, Principles of coupled reactions. Nernst equation, Standard potentials: Thermodynamic standard potentials, variation of potential with pH, the biological standard potential, converting standard potential to a biological standard value. Electron transfer in bioenergetics; Electron transfer reactions, oxidative phosphorylation. Biopolymers: Molecular forces and Chemical bonding in Bio-polymers, hydrophobic interactions, structure of proteins, protein folding and unfolding. Binding of Ligands and metal Ions to bio-macromolecules, one binding site per macromolecule, n equivalent binding sites per macromolecule, the Scatchard plot, binding of oxygen to myoglobin and haemoglobin.

Unit-II Biophysical Chemistry-II **(16 Contact hours)**

Biological membranes, Structure and functions of cell membrane, molecular motion across membranes, ion transport through cell membrane, Mechanism of Membrane Transport: Transport through cell membrane, active and passive transport systems. Irreversible thermodynamic treatment of membrane transport. Semipermeable membrane and Donnan membrane equilibrium, Donnan effect in Osmosis, its dependence on pH difference across the membrane. Membrane potential, Classical theory of membrane potentials; Nernst Equation, NernstPlanck equation, permeability of membranes, Goldman-Hodgkin Katz model, Goldman equation, Nerve conduction; Action potential, factors affecting speed of action potential propagation, Nerve impulse and cardiovascular problems, Mechanism of vision. An introduction to bio-electroanalysis.

Books recommended

1. Physical Chemistry for the Biosciences, Raymond Chang, University Science Books, 2005.
2. Physical Chemistry for the Life Sciences, 2nd Edition, Peter Atkins, Julio de Paula, Oxford University Press 2015.
3. Biophysical Chemistry Part III: The behaviour of biological macromolecules, Charles R. Cantor and Paul R. Schimmel, W. H. Freeman and Company, New York, 2002.
4. Fundamentals of Biochemistry, D. Voet, J. G. Voet, C. W. Pralt, Wiley, 1999.
5. Lehninger Principles of Biochemistry, 7th Edition, Albert L. Lehninger, D. L. Nelson, N. M. Cox. W.H.Freeman& Co Ltd.

Course No: CH21003GE
Title: Title: Bio-Organic Chemistry (02 Credits)

Max. Marks: 50 | **Duration: 32 Contact hours**
Continuous Assessment: 10 marks | **End Term Exam: 40 Marks**

Course Outcome: On completion of the course the student should be able to:

- Recognize the importance of bio-organic chemistry and Pre-Biotic Chemistry.
- Understand formation and synthesis of carbohydrates and amino acids under pre-biotic conditions.
- Understand the mechanism of the function of enzymes, specificity and inhibition.

Unit-I **(16 Contact hours)**

(a) Chemical Origins of Biology

Bio-organic chemistry: Introduction, Basic consideration, Proximity effects in Organic Chemistry, Molecular rearrangements.

Pre-Biotic Chemistry: Role of HCN and HCHO in biosynthesis, Nucleophiles and Electrophiles in solution of HCN, Formation of Purines and Pyrimidines from HCN under prebiotic conditions. Carbohydrates from Aldol reaction with HCHO, Formation of Amino acids under prebiotic conditions.

(b) Enzymes

Introduction, Nomeclature and Classification of enzymes.

Specificity of enzyme action: Types of specificity, The active sites; The Fischer 'lock and key' hypothesis, The Koshland 'induced fit' hypothesis, Hypothesis involving strain or transition state stabilization.

Enzyme Inhibition: Introduction, Competitive inhibition, UnCompetitive inhibition, Non competitive, Allosteric inhibition.

Unit-II **(16 Contact hours)**

(a) Coenzymes

Introduction, Types of coenzymes, Involvement of coenzymes in enzyme catalysed reactions: Introduction, Nicotinamide Nucleotides (NAD+ and NADP+), Flavin Nucleotides (FMN and FAD), Adenosine phosphate (ATP, ADP, AMP). Coenzyme A (CoA -SH), Thiamine Phosphate, Biotin, Tetrahydrofolate, Coenzyme B_{12} .

(b) Biosynthesis of Natural Molecules

Biosynthesis of Fatty Acids and Triglycerides, Biosynthetic Pathway of Terpenoids and Steroids, Inhibitors of Terpene biosynthesis, Biosynthesis of Flavonoids.

Books recommended

1. Introduction to Bioorganic Chemistry and chemical biology. D. V. Vranket and Gregary Weiss; Taylor and francis. 2013.
2. Bio-organicchemistry : Harman Dugas 3rd ed.Springer (2010) .
3. Bio-organic chemistry J.Rohr ,Springer (2000).
4. Enzymes 2nd ed. T. Palmer and P. Bonner (2008).
5. Biochemistry :DonaldVoet, Judith.G. Voet 2nded.Willey (1995)

Course No.: CH21003OE
Title: Medicinal Inorganic Chemistry

Max. Marks: 50 | **Duration: 32 Contact hours**
Continuous Assessment: 10 marks | **End Term Exam: 40 Marks**

Course Outcome: On completion of the course the students should be able to:

- Understand the sources of impurities and methods to determine the impurities in inorganic pharmaceuticals and know the mechanism of metal ion induced toxicity, metal ion promoted carcinogenesis and probable mechanism of action. Treatment of essential trace and ultra-trace element deficiencies and explain the method of preparation, assay, properties, medicinal uses of metal based complexes.
- Describe the properties, storage condition and application of radiopharmaceuticals

Unit-I Medicinal Inorganic Chemistry-I (16 Contact hours)

Metal toxicity and Homeostasis: sources of metal ion poisoning. Mechanism of metal ion induced toxicity(Pb, Cd, Hg, As, and Se) Toxicity of cyanide and nitrite ions. Metal ion promoted carcinogenesis and probable mechanism of action.

Metal based Therapeutic Compounds: Conditional stability constant, Stereochemistry, Lipophilicity. HSAB theory and Plasma mobilizing index(PMI). Therapeutic index of different chelating drugs in metal ion detoxification. Limitations and hazards of Chelation therapy

Unit-II Medicinal Inorganic Chemistry-II (16 Contact hours)

Treatment of essential trace and ultra-trace element deficiencies: Manganese, Iron, Copper, Cobalt, Zinc, Molybdenum, Silicon, Nitrogen and Phosphorus. Metal salts as anti-acids, antiseptics and diuretics.

Metal complexes as drugs: Vanadium based anti-diabetic drugs, Platinum based anticancer agents(cisplatin and its derivatives), non platinum based anticancer agents and Gold based anti-arthritic compounds and their mechanisms of action. Metal Complexes as anti-virals, anti-bacterials and anti-fungals;

Metal based Diagnostic agents: Tecnetium based radiopharmaceuticals. Gadolinium based MRI imaging agents. Radio protective chelating drugs.

Books recommended:

1. Bio inorganic Chemistry -An introduction; Ochai, Allyn and Bacon;1977.
2. Inorganic Aspects of Biological and Organic Chemistry; Hanzilik; Academic;1976.
3. The Inorganic Chemistry of Biological processes; 2nd edn.; Hughes ; Wiley;1973.
4. A Text book of Medicinal aspects of Bio inorganic Chemistry; Das; CBS;1990.
5. The Biological Chemistry of Elements; Frausto de Silva; Williams; Clarenden;1991.
6. Principles of Bio inorganic Chemistry; Lippard, Berg; Univ. Science Books; 1994.
7. Inorganic Chemistry in Biology; Wilkins C &Wilkins G; Oxford;1997.
8. Metal -Ions in Biochemistry; P. K. Bhattacharya; Narosa Publishing House;2005.
9. Bio-Inorganic Chemistry; Robert W. Hay; Ellis Horwood Ltd; 1984.
10. Concepts and Models in Bio-Inorganic Chemistry; Heinz-Bernhard Kraatz; Wiley; 2006.