Semester-II

Second Semester
Core Course
Course Title: Metal Clusters and Electronic Spectra of Metal Complexes
Course Code: CHM551C

Credits = 4
M.M. = 100
L T P=3 1 0

Prerequisites: B. Sc. Chemistry
Course Learning Outcomes: After completion of this course, the students will be able to:

CLO 1:	Know about the characterization, reaction and bonding of pi-acid complexes
CLO 2:	Understand bonding of inorganic metal clusters and metallocenes
CLO 3:	Understand electronic and magnetic properties of coordination complexes
CLO 4:	Learn about the basic concept of symmetry, point groups and construction of character tables

Unit I: Pi-Acid Complexes (Contact hours: 16)
Introduction, Synthesis of metal carbonyls, Structure and bonding (Synergic interactions), Vibrational spectra of metal carbonyls for bonding and structural elucidation (mononuclear and polynuclear metal carbonyls), Identification of isomers, Reactivity of metal carbonyls.
Preparation, bonding, structure and important reactions of transition metal nitrosyl complexes. Nature and bonding of dinitrogen and dioxygen complexes.

Unit II: Metal Clusters (Contact hours: 16)
Occurrence and classification of metal clusters, Pre-requisites for the formation of metal-metal bond, Trinuclear, Tetranuclear, Polynuclear clusters, Lower halides and oxides, Metal only clusters, Bonding in metal clusters, Metal carbonyl and metal carbonyl halide clusters, Structure and bonding of compounds with metal-metal multiple bonds, Isolobal analogy, Structure of some carbonyl metallocenes.

Unit III: Electronic Spectra and Magnetic Properties of Transition Metal Complexes (Contact hours: 16)
Spectroscopic ground states, Term Symbol, Free ion terms (d^1-d^9 system). Splitting of terms in Octahedral Field (Weak Field and Strong field splitting), Hole Formalism and inverse energy relationship, Inverse energy relationship in Tetrahedral – octahedral geometries, Correlation (for d^2 system), Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1-d^9 states), Calculations of Dq, B and β parameters, Charge transfer spectra,
Types of magnetic bodies, orbital and spin effect, Curie equation and Curie Weiss law, Determination of magnetic susceptibility, quenching of orbital Contribution, Anomalous magnetic moments, Magnetic exchange coupling and spin crossover.

Unit IV: Symmetry and Group theory (Contact hours: 12
Symmetry elements and operations, Combination of symmetry operations, Groups, Subgroups, Classes, Group multiplication tables, Symmetry point groups, Identification of point groups, Systematic procedure for assignment of point groups to molecules, Symmetry classes and their geometrical significance reducible representations and Irreducible representations, Great orthogonally theorem (GOT), character table (C_{2v}, $C_{3v,}$ C_{2h}, D_{3d}).

Books Recommended:

1. Inorganic Chemistry; G.L. Miessler & D. A. Tarr; 3rd Edn; Pearson Edn. Inc; 2004.
2. Inorganic Chemistry, J. E. Huhey, Harpes & Row. 4th Edn.; 2008.
3. Elements of Magnetochemsitry, R. L. Datta & A. Syamal, EWP, 2nd Edn.; 2015
4. Symmetry and Spectroscopy of Molecules, K. Veera Reddy, 2nd Edn.; 2009

Reference Books

5. Molecular Symmetry and Group Theory: Approaches in Spectroscopy and Chemical Reactions, R. C. Maurya and J.M. Mir, De Gruyter, 1st Edn.; 2019
6. Advanced Inorganic Chemistry, F. A. Cotton and G. Wilkinson, John Wiley 6th Edn.; 1999.
7. Inorganic Chemistry; Shriver & Atkins; 5th Edn; Oxford University Press; 2010.
8. Chemical Applications of Group Theory, F. A. Cotton, Wiley NY, 3rd Edn.; 1990
9. Inorganic Electronic Spectroscopy, A. B. P. Lever, Elsevier. 2nd Edn.; 1997
10. Molecular Symmetry and Group Theory, Robert L. Carter, John Wiley & Sons, 1997

Second Semester
Core Course
Course Title: Named Reactions, Reagents, and Molecular Rearrangements
Course Code: CHM552C

Credits = 4
M.M = 100
L T P=3 1 0

Course Learning Outcomes: After completion of this course, the students will be able to:

CLO 1:	To learn about various reagents and their synthetic applications to achieve functional group transformations
CLO 2:	To understating fundamental concept in heterocyclic chemistry including nomenclature importance and detailed description in synthesis of different hetrocylces
CLO 3:	To acquire knowledge about various molecular rearrangements, their mechanistic aspects and application in organic synthesis
CLO 4:	To acquire the knowledge of structural conformation of organic scaffolds to elucidate the output of stereo chemical reactions.

Unit-I: Reagents-1 **(Contact hours: 16)**
CrO3 (Jones reagent) PDC, PCC, KMnO4, MnO2, Swern, SeO2, Pb(OAc)4, Pd/C, OsO4, mCPBA, O3, NalO4, HIO4, R3SiH, Bu3SnH, Boranes & Hydroboration reactions, MVP, H2/ catalyst, Wilkinson's catalyst, NaCNBH3, NH2NH2, DIBAL.
Addition of Grignard Reagent, Organo Zinc, Organo Copper, and Organolithium reagents to Carbonyl and unsaturated Carbonyl compounds.

U**nit-II: Heterocyclic Compounds** **(Contact hours: 14)**
Nomenclature of heterocycles (Hantzsch-Widman nomenclature, Replacement nomenclature), non-aromatic and aromatic heterocycles. Structure of five-membered, six-membered and bicyclic heteroatomic systems. Reactivity of aromatic heterocycles. Five membered heterocycles (Pyrrole, Thiophene and Furan). Fused heterocycles (Indole, quinoline and isoquinoline)
Preparation: Knorr synthesis, Paal Knorr synthesis, Hantzsch synthesis, Hinsberg thiophene synthesis. Fisher indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis and Guareschi synthesis.
Reactions: Mechanism of electrophilic, nucleophilic and radical substitution.

Unit-III: Rearrangements and Elimination reactions **(Contact hours: 16)**
Mechanism to nucleophilic, electrophilic, and free radical molecular rearrangements, migratory aptitude
Beckmann, Hofmann, Curtius, Schmidt, Wolf, Lossen, Baeyer –Villiger, Sommelet, Favorskii, Pinacol – Pinacolone, Benzil – Benzillic acid, Baker-Venkataraman, Brook, Carroll, Dienone-Phenol and Rupe rearrangement (problem solving).
Elimination reactions: E1, E2, E1cb Mechanisms, Orientation and stereochemistry in elimination, competition between substitution & elimination, syn eliminations.

Un**it-IV: Conformational Analysis** **(Contact hours: 14)**
Conformation of acyclic compounds, conformational effects on reactivity and stability.
Conformational analysis of mono, di and tri-substituted cyclohexanes and their stereochemical features (geometrical and optical isomerism). Effect of different groups on the conformational inversion. Distinguishing axial and equatorial protons using low temperature NMR.
Conformational analysis of cyclohexenes, cyclohexanones, halo cyclohexanones. Effect of conformation on reactivity.
Conformation and stereochemistry of cis and trans-decalin, 9-methyldecalin, decalols and decalones.

Books/References

1. Modern Synthetic Reactions, H.O. House, W.A. Benjamin.
2. Some Modern Methods of Organic Synthesis, W.Carruthers, Cambridge Univ. Press.
3. Advanced Organic Chemistry, Reactions Mechanisms and Structure, J. March, JohnWilley.
4. Stereochemistry of Organic Compounds, D. Nasipuri. 3rdEdn. 2011
5. Organic Synthesis- concept, methods and Starting Materials, J. Furhop and G. Penzlin; 1. Verlage VCH;1986.
6. Principles of Organic Synthesis R. O. C. Norman; Chapman and Hall; 2nd edn;. 1978.
7. Heterocyclic Chemistry Vol. 1-3, R.R. Gupta, M. Kumar and V. Gupta, Springer Verlag.
8. The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme
9. Stereochemistry of Organic Compounds, Samuel H. Wilen, Ernst L. Eliel

Second Semester
Core Course
Course Title: Quantum Chemistry and Chemical Kinetics
Course Code: CHM553C

Credits = 4
M.M. = 100
L T P=3 1 0

Course Learning Outcomes: After completion of this course, the students will be able to:

CLO 1:	Understand the solution of one electron Schrodinger equations and its implications and the role of theory of angular momentum in explaining experimental phenomena.
CLO 2:	Understand various approximate methods and chemical bonding theories in quantum mechanics
CLO 3:	Understand microkinetic analysis of reaction rates and theories of chemical reactions
CLO 4:	Understand theories of surface reactions, reaction in liquid solutions and enzyme catalysis

Unit I: Quantum Chemistry-II **(Contact hours: 16)**

Born-Oppenheimer approximation, Solution of the Hydrogen-like atom problem- radial and angular wave functions. Angular momentum and electronic structure of atom, General theory of angular momentum, Eigen functions and eigenvalues of angular momentum operators, Ladder operators, Spin angular momentum, Anti-symmetry, and Pauli's principle. Atomic term symbols, Term separation of p^n and d^n configurations, Spin-Orbit coupling.

Unit II: Quantum Chemistry-III **(Contact hours: 16)**

Variation theorem, Linear variation principle, Application to Hydrogen atom and Helium atom, Perturbation theory-first order (non-degenerate and degenerate), Application of perturbation method to Helium atom, Chemical bonding, LCAO-MO approximation, H_2^+ molecular ion, Brief introduction to H_2, Molecular term symbols, Valence bond treatment of H_2, Comparison of MO and VB methods in the light of H_2 molecule, Hybridization of orbitals (sp, sp^2 and sp^3).

Unit III: Chemical Kinetics-I **(Contact hours: 16)**

Micro kinetic analysis of reaction rates and orders. Fast reactions: General features of fast reactions, Study of fast reactions by flow method, Relaxation method and flash photolysis.
Theories of chemical reactions: Arrhenius theory, Collision theory and its limitations, Potential energy surfaces, Activated complex theory of reaction rates, Statistical and thermodynamic formulations, Comparison with collision theory.
Theories of unimolecular reactions (Lindman and Hinshelwood theories, RRK theory).

Unit IV: Chemical Kinetics–II **(Contact hours: 16)**

Surface Reactions: Unimolecular& bimolecular surface reactions, Langmuir-Hinshelwood and Langmuir-Riedel mechanism, Classical and Statistical treatments.
Reactions in liquid solutions: Diffusion controlled reactions (partial and full microscopic diffusion control), Ionic reactions: Single and double sphere models of ionic reactions, Ionic strength effect, Catalysis: introduction to catalysis, Mechanism of catalysis, Use of solvents as catalysts, Enzyme catalysis, Michaelis–Menten Equation, Inhibition, Effects of pH and Temperature on enzyme catalysis reactions.

Books Recommended:

1. Quantum Chemistry, D. A. McQuarie, Viva Books Pvt Ltd, Student Edn.; 2018.
2. Quantum Chemistry, R. K. Prasad, New Age Publishers, 4th Edn.; 2010 (Reprint 2014).
3. Chemical Kinetics, K. J. Laidler, Mcgraw-Hill, 4th Edn.; Revised, 2002
4. Chemical Kinetics and Catalysis, R. I. Masel, Wiley, 2001.

Reference Books:

5. Quantum Chemistry- Ira. N. Levine, Prentice Hall, 7th Edn.; 2013.
6. Molecular Quantum Mechanics- P. W. Atkins and R. S. Friedmann, Oxford, 5th Edn.; 2010.
7. Chemical Kinetics and Dynamics, J. I. Steinfeld, J. S. Francisco, W. L. Hase, 2nd Edn.; 1998.
8. Physical Chemistry, P. W. Atkins, J. D, Paula, Oxford, 2010
9. Physical Chemistry- A Molecular Approach- D. A. McQuarie & J. D. Simons, 1997.

Second Semester
Core Course
Course Title: Chromatographic Techniques
Course Code: CHM554C

Credits = 4
M.M. = 100
L T P=3 1 0

Course Learning Outcomes: After completion of this course, the students will be able to:

CLO 1:	Explain the principles of the most important liquid and gas chromatographic techniques
CLO 2:	Learn the working of the different chromatographic techniques like HPTLC, IEC, SEC, HPLC and GC
CLO 3:	Evaluate strengths and limitations of the most important chromatographic separation and detection methods
CLO 4:	Choose and plan the use of suitable chromatographic techniques for actual analytical problems

Unit I: Introduction to Chromatography (Contact hours: 16)

Separation techniques and their importance, Introduction and importance of chromatography, Classification of Chromatographic Techniques (On the basis of Type of mobile and stationary phase, According to development procedure, on basis of mode of separation), Chromatographic behavior of solutes (Distribution coefficient, Retention time, retention volume) Retention factor, Selectivity factor, Peak width, Column efficiency, Plate theory, Rate theory, Van-Deemter-Equation, Resolution, Retention time and other basic parameters. Review of thin layer chromatography, (Types and selection of stationary phases (adsorbents) and mobile phases). Detection of spots; Performance characteristics of thin-layer plates, Retardation and retention factor, Plate heights, 2D TLC and HPTLC, Application

Chiral chromatography: Chiral derivatization, Chiral mobile-phase, Chiral stationary phases, Mechanism of chiral interactions, Applications

Unit II: Size Exclusion and Ion Exchange Chromatography (Contact hours:16)

Principle; Gels, Theoretical basis, Exclusion limit, Total permeation, and selective permeation regions. Relation between elution volume and molecular weight, Molecular weight determination. Fractionation in a complex mixture, Packing materials and applications,

Introduction to ion-exchange chromatography, Types of ion exchange materials, Mechanism of ion exchange, Ion exchange equilibrium, Total, Apparent and volume ion exchange capacity, Ion chromatography. Distinction between ion-exchange and ion chromatography, Ion suppressor Column, Applications of IEC for separation of biological molecules (amino acids).

Unit III: High Performance Liquid Chromatography (HPLC) (Contact hours:16)

Principle, Theory and instrumentation, Basic difference between HPLC and conventional liquid-chromatography, Packing materials and equipment, Detectors (UV-Vis, RI, Florescence, electrochemical) Advantages and Applications HPLC, Reverse phase HPLC and normal phase HPLC, Brief Introduction to hyphenated LC-MS technique.

Unit IV: Gas Chromatography and Supercritical Fluid Chromatography (Contact hours:16)

Principle, Instrumentation: Columns and stationary phases, Detectors: TCD, FID and Electron Capture Detector, Factors affecting the efficiency of the column, Qualitative and quantitative analysis based on peak height and peak area, Advantages and Applications of GC, Brief introduction to hyphenated GC-MS technique.

Supercritical fluid chromatography Properties of supercritical fluids, SF chromatography, Instrument and operating variables, comparison of SFC to other types of chromatography, Applications.

Books Recommended:

1. Analytical Chemistry by G. D. Christian, John Wiley & Sons Inc, Singapore., 7th Edn.; 2013.
2. Gas Chromatography and Mass Spectrometry: A Practical Guide, O David Sparkman, Zelda Penton and Fulton G. Kitson, Elsevier, 2nd Edn.; 2011.
3. Introduction to Modern Liquid Chromatography: L. R. Snyder& J. J. Kirkland (John Wiley & Sons, New York). 3rdEdn.; 2009
4. Chromatography: Concepts and Contrasts, James M. Miller, Wiley, 2ndEdn.; 2009.

References Books

5. Principles of Instrumental Analysis, Skoog, Holler, Nieman, 6thEdn.; 2006
6. Principles and Practice of Analytical Chemistry by F. W. Fifield and D. Kealey, Blackwell Science Ltd, New Delhi 5thEdn.; 2004.
7. Handbook of Instrumental Techniques for Analytical Chemistry, Editor, F. Settle, Pearson Education Inc, New Delhi. Low Price Edn, 2004.

Second Semester
Core course
Course Title: Laboratory Course in Organic Chemistry
Course Code: CHM555C

Credits = 2

M.M. = 100

L T P= 0 0 2

Course Learning Outcomes: After completion of this course, the students will be able to:

CLO 1:	Acquire the knowledge to determine the purity of organic compounds by melting point and boiling point, purification, and isolation of some natural products
CLO 2:	Separate organic compounds from binary and ternary mixtures.
CLO 3:	Identify the nature and functional groups in organic compounds from qualitative organic analysis
CLO 4:	Prepare biologically important organic motifs

A. Techniques (Demonstration)

1) Determination of melting point and boiling point of pure compounds
2) Purification of solvents and reagents: Distillation, Vacuum distillation, Steam distillation, Drying and storage of solvents, Sublimation, Crystallization
3) Chromatography (Thin Layer chromatography and Column chromatography)
4) Solvent Extraction: Cold and hot extraction of some natural products.

B. **Separation of Mixtures**

1) Separation of binary mixtures and their qualitative organic analysis.
2) Separation of ternary mixtures and their characterization (melting point, UV-Visible and IR-Spectroscopy analysis).

C. Multistep organic preparations

1) Synthesis of local anesthetics (Butamben)
2) Synthesis of sulpha drugs.
3) Synthesis using microwaves: Alkylation of diethyl malonate with benzoyl chloride.
4) Benzoin to benzyl to benzylic acid.
5) Skraup synthesis: Preparation of quinoline from aniline

Books Recommended:

1. Experimental Organic Chemistry, Sonia Ratnani and Shriniwas Gurjar, PHL Learning Private Limited, New Delhi, 2012.
2. Vogel, A. I. A Text-Book of Practical Organic Chemistry. Ed 3; Longman, London, 1957
3. Organic Chemistry Lab Manual N. S. Gnanapragasam and B. Ramamoorthy, S. Visvanathan Printers & Publishers, 2010.
4. Comprehensive Practical Organic Chemistry; V. K. Ahluwalia and Renu Aggarwal; University Press; 2000
5. Advanced Practical Organic Chemistry; N. K. Vishnoi; Vikas; 2ndEdn.; 1999.

Reference Books

1. R. L. Shriner, R. C. Fuson and D.Y. Curtin, Systematic Identification of Organic Compounds, alab. manual, 6thedition Wiley, New York.
2. Experimental Organic Chemistry: A small scale approach, Charles F. Wilcox, Jr and Mary F. Wilcox, Prentice Hall, 1995.
3. Pavia, D.L.; Lampman, G.M.; Kriz, G.S.; Engel, R.G. A small-scale approach to Organic Laboratory Techniques. 3rd *Ed.*; Brooks/Cole, USA, 2011.
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.

Second Semester
Core Course
Course Title: Laboratory Course in Analytical Chemistry
Course Code: CHM555C

Credits = 2
M.M. = 100
L T P=0 0 2

Course Learning Outcomes: After completion of this course, the students will be able to:

CLO 1:	Introduce students to principle and theory of instrumental analysis
CLO 2:	Perform experiments related to different chromatography techniques and their practical application in separation of different types of compounds
CLO 3:	Perform titrimetric / volumetric analysis and spectrophotometric analysis
CLO 4:	Use a spreadsheet to manipulate qualitative information and evaluating the design of chemical experiment

pH-metry

6. Titration of a dibasic acid with alkali to find its pKa values.
7. Determination of strength of commercial phosphoric acid by pH-metric titrations using standard solution of sodium hydroxide

Ion Exchange

8. Determination of Ion-exchange capacity of resin (cationic and anionic).
9. Separation of Zn and Cd ions by ion-exchangers.

Chromatography

10. Column chromatographic separation of cis and trans azobenzene and o- and p-nitroanilines determined spectrophotometrically
11. Separation of amino acids by thin layer and paper chromatography.
12. Separation of amino acids by HPLC

Spectroscopy

13. Extraction of caffeine from tea leaves, characterization by IR spectroscopy
14. Determination of iron in pharmaceutical samples by visible spectrophotometry**.**

Quantitative analysis

15. Determination of iodine value and saponification value of edible oils.
16. Determination of Cu and Fe or Cu and Bi ions from the given mixture by spectrophotometric titration using standard EDTA solution.
17. Determination of metal ions by flame photometry (sodium, potassium, sodium and potassium in a mixture).
18. Estimation of BOD and DO in Wastewater Sample.
19. Estimation of acid value of oil.

Synthesis

20. To synthesis polymer-based hydrogel and determine its hydration.
21. To synthesize ion exchange material and determine the ion exchange capacity for Na ions

Books Recommended:

1. Environmental Chemistry, A. K. De, 7thEdn.; 2010.
2. Fundamental of Analytical Chemistry, Skoog and Wesst, 9thEdn, 2014.
3. Practical Pharmaceutical Chemistry, part-2, Beckette, Stenlake, 4thEdn.; 2001.
4. Analytical Chemistry Theory and Practice, R. M. Verma. CBS Publishers, 3rdEdn.; 2000.

Reference Books

5. Vogel's Quantitative Analysis Mendham, Denny; Pearson Education 6thEdn.; 2000
6. A textbook of Practical Organic Chemistry, A. I. Vogel, 5thEdn.; 1996.
7. Standard methods of Chemical Analysis, F. J. Welcher, 6thEdn.; 1962.
8. Experiments in Chemistry, D. V. Jagirdar, Himalaya publication.

Second Semester
Discipline Centric Course
Course Title: Bioinorganic Chemistry
Course Code: CHM557E

Credits = 3
M.M=100
L T P=3 0 0

Course Learning Outcomes: After completion of this course, the students will be able to:

CLO 1:	Understand the role of metal ions, adverse effects and their storage and transport in the biological systems
CLO 2:	Understand the transport/storage of atmospheric oxygen and electron transport agents in the biological systems for carrying out the fundamental biological reaction for energy production (respiration)
CLO 3:	Understand the fundamental biological reaction (solar energy conversion/Photosynthesis) for the survival of the living systems and some non-heme and copper based electron transport proteins
CLO 4:	Understand the role of metalloproteins in protein degradation, in the removal of toxic substances from the biological systems and in biological nitrogen fixation

Unit I: Metal ions in Biochemical Systems **(Contact hours: 12)**
Introduction to bio-inorganic chemistry, Concept of essentiality, Criteria and classification of essential elements as per their role in living systems, Bulk metals and trace metals, Biochemistry of some important metals with respect to their storage, transport and activity (Fe, Cu, Zn, Ca, Mg), Metal ion toxicity, Ion transport, Na^+-K^+ pump, Transport and storage of Iron (Ferritin, Transferrin and siderophores)

Unit II: Metalloporphyrins and Respiration **(Contact hours: 12)**
Properties of dioxygen, thermodynamic and kinetic aspects, Metalloporphyrins, Cytochromes (Cytochromes C, Cytochrome C-oxidase, Cytochrome P-450). Dioxygen transport (haemocyanin and hemoerythrin), Structure and physiological role of hemoglobin and myoglobin, Bohr Effect and cooperativity, Chloride effect, Synthetic oxygen carriers

Unit III: Electron Transport in Biosystems **(Contact hours: 12)**
Electron transport in biosystems, Electron carriers in oxidation of fuel molecules, Iron-Sulfur proteins, Rubredoxin, Ferredoxins, Copper proteins, Photosynthesis (PS I and PS II), Z-scheme, Structure of chlorophyll a and b, Superoxide dismutase-A

Unit IV: Enzymes and medicinal Chemistry **(Contact hours: 12)**
Enzymes and co-enzymes, Structure and function of carboxypeptidase A, Carbonic anhydrase, Xanthine oxidase, Vitamin B-12, Nitrogen fixation-thermodynamic and kinetic aspects, Nitrogenase, Biochemical basis of essential metal deficient diseases and their therapies (Iron, Zinc, Copper and Manganese), Anticancer drugs (cisplatin and carboplatin)

Books Recommended:

1. Principles of Bio inorganic Chemistry; Lippard, Berg; Univ. Science Books; 1994.
2. Bioinorganic Chemistry; Asim K. Das, Books and Allied (P) Ltd; 2007.
3. Bioinorganic Chemistry; Wolfgang Kaim, Brigitte Schwederski, Axel Klein; 2nd Edn.; Wiley, 2013.
4. Bio inorganic Chemistry; K. Hussain Reddy; New Age International (P) Ltd; 2005.

Reference Books:

5. Metal Ions in Biochemistry; P. K. Bhattacharya; Narosa Publishing House; 2005.
6. Inorganic Chemistry; J. E. Huhey, Harpes & Row. 4th Edn.; 2008.
7. Inorganic Chemistry; G.L. Miessler & D. A. Tarr; 3rd Edn; Pearson Edn. Inc; 2004.
8. The Inorganic Chemistry of Biological processes; Hughes; Wiley; 2nd Edn.; 1973
9. Inorganic Chemistry in Biology; Wilkins C & Wilkins G; Oxford; 1997.
10. Inorganic Aspects of Biological and Organic Chemistry; Hanzilik; Academic; 1976

Second Semester
Discipline Centric Course
Course Title: Conducting Polymers
Course Code: CHM558E

Credits = 3
M.M=100
L T P=3 0 0

Course Learning Outcomes: After completion of this course, the students will be able to:

CLO 1:	Will understand the mechanism of conduction in polymers
CLO 2:	Will able to synthesize the conducting polymers
CLO 3:	Will able to characterize the conduction in polymers
CLO 4:	Will understand the application of conductivity polymer in various devices

Unit: I Introduction to Conducting Polymers **(Contact hours: 10)**

Introduction to conducting polymers – Need of conducting polymers, Classification of conducting polymer, Discovery of polyacetylene as conducting polymer, Concept of doping-Type, p-Type, Electrochemistry of electronically conducting polymers-source of electronic conduction in polymers, polaron, bipolaron, conduction mechanism.

Unit: II Synthesis Conducting Polymers **(Contact hours: 10)**

Synthesis of conducting polymers – Chemical synthesis – electrochemical synthesis -template synthesis – precursor synthesis – soluble polymers (colloids and dispersions) -advantages and disadvantages of various synthesis methods.

Unit: III Characterization of Conducting Polymers **(Contact hours: 12)**

Characterization methods – elemental analysis for dopants – IR – UV (electro chemical) scanning electro microscopy (SEM) – electro chemical characterization – cyclic voltometry electro chemical quartz crystal microbalance (EQCM) – probe beam deflection (PBD) – Langmuir – blodgett technique.

Unit: IV Characterization of Conducting Polymers **(Contact hours: 12)**

Applications Rechargeable batteries, o-LED, Gas sensors, Bio sensors, Photovoltaic energy device, Microelectronics, PCB fabrication, Electro catalyst. Application proposed antistatic coating, electrochemical mechanical device, super capacitor, Telecommunication system, Electromagnetic screening material, Analytical sensor. Recent trend in conducting polymer, functionalized conducting polymer (Second generation polymer), Super conductor (Inorganic, organic hybrid structure), Conducting polymer based on nano composite.

Recommended Books

1. R. G. Linford, Electro Chemical Science and Technology of Polymers – 1&2, ed., elsevier applied sciences, London, 1987 and 1990.
2. M. Schlvxinger and M. Paunovic, (eds.) Modern Electro Plating, john Wiley and sons Inc., New York, 2000.
3. Reference Books:
4. Hand book of Conducting Polymers: Terje A. Skotheim (Vol.l), Dekker (668.42)
5. Hand book of Polymer Synthesis (Part B): Hans Kricheldorf, Dekker (668.9).

Reference Books

6. Sensors: Principles and Applications: Peter Hauptmann, Prentice Hall
7. Polymer Science and Technology: Premamoy Ghosh, Tata McGraw Hill (668.42).
8. Hand book of organic conductive molecules and polymers, Hari singh Nalwa (ed.), 4-Volume set, John wiley and sons, England 1997.