Department of Chemistry

Course Name: **Catalysis - Principles and Applications**
Course Code: **CY-301**
Course Type: **Open Elective**

Contact Hours/Week: **3L**Course Credits: **03**

Course objectives

- To impart knowledge about catalysis and its applications
- To introduce the fundamental concepts relevant to kinetics of various catalytic processes.
- To enable the students to understand the mechanism of catalytic reactions

Unit Number	Course Contents	Contact Hours
UNIT-01	**Basic principles of catalysis**: Introduction, types of catalysis, adsorption isotherms (Freundlich Isotherm, Langmuir adsorption isotherm, BET isotherm), chemisorption isotherms, determination of surface area by using BET equation, pore size measurements.	**06L**
UNIT-02	**Kinetics of surface reactions**: rate determining step, various types of reactions: unimolecular surface reactions, bimolecular surface reactions, Kinetics of complex reactions-reversible reactions, side or parallel reactions and consecutive reactions.	**08L**
UNIT-03	**Selection, preparation and evaluation of catalysts**: Criteria for selection of catalyst, preparation methods, test reactions, promoters, carriers and stabilizers.	**04L**
UNIT-04	**Mechanism of catalytical reactions**: General considerations, reasons for selecting transition metals in catalysis (bonding ability, ligand effects, variability of oxidation state and coordination number), basic concepts of catalysis (molecular activation by coordination and addition), proximity interaction (insertion/inter-ligand migration and elimination, rearrangement), hydrogenation, dehydrogenation and dehydration.	**12L**
UNIT-05	**Applications:** Petrochemical industry - reforming and refining, value added chemicals, environmental protection, autoexhaust catalysts	**06L**

Course Outcomes

Upon successful completion of the course, the students will be able to
C01: Identify key points of catalytic processes
C02: Describe the kinetics of various surface reactions
C03: Apply principles of catalysis in petrochemical industry, environmental protection etc.
C04: Assess the mechanism and suitability of catalytic processes

Books and References

1. Introduction to the Principles of Heterogeneous Catalysis by J. M. Thomas and W. J. Thomas, Academic Press, (1967).
2. Catalysis by C. Kuriacose, Macmillan India Limited, 1991.
3. Adsorption and Catalysis by Solids by D. K. Chakrabarty, Wiley Eastern Ltd., 1990.
4. Physical chemistry of solid surfaces by A. W. Adamson, Academic Press, 1995.
5. Homogeneous Transition Metal Catalysis by Christopher Masters, Springer Netherlands, 1981

Department of Chemistry

Course Name: **Polymer Science**
Course Code: **CY-302**
Course Type: **Open Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart detailed knowledge about various natural, commercial polymers.
- To enable the students for characterization and analysis of polymers.
- To educate students about selection of polymers based on the point of application.
- To increase the awareness among students regarding various electrical, mechanical properties of synthetic polymers.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction to polymer science** Basic concepts (classification, nomenclature, molecular weight and distribution, glass transition, morphology, viscosity vs. molecular weight and mechanical property vs. molecular weight relationship), Methods of determination of molecular weight, distribution, size and shape of macromolecules, Mark-Houwink relationship.Polymerization Techniques - bulk, solution, emulsion- description of the process, progress of polymerization, rate of polymerization, degree of polymerization, suspension, living radical polymerization technique.	**14 L**
UNIT-02	**Synthetic polymers and additives** Manufacture, properties and applications of major thermoplastic and thermosetting polymers: polyethylene, polypropylene, polyvinyl choloride, polystyrene and other styrenics, polyamides, polyesters, acrylics, ABS, polycarbonate, polyamides, polyurethanes, polyphenylene oxide, polyphenylene sulfide, PEEK. Thermosets such as USP, Epoxy, phenolics and aminoplasts. additives for plastics: stabilizers, fillers, plasticizers, lubricants, flame retarders, foaming agents, crosslinking agents.	**08 L**
UNIT-03	**Selection of polymers for various applications** Materials selection for engineering plastics for various applications based on mechanical properties, high temperature stability, electrical properties, oxidative, UV, hydrolytic and chemical stability.	**06L**
UNIT-04	**Speciality polymers** Processing and application of engineering plastics, definition and characteristics of speciality polymers, important speciality polymers such as fluropolymer, silicone, liquid crystalline polymers,conducting polymers, polymeric hydrogels, processing and application of speciality polymers.	**08 L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand the unique properties and applications of polymers.
CO2: Design experimental protocols for commercially relevant synthetic polymers.
CO3: Choose an appropriate polymer for different applications.
CO4: Understand the recent advances in polymers to be utilized in electronics, textile and pharmaceutical industries.

Books and References

1. Introduction to Physical Polymer Science, L.H.Sperling, Wiley Interscience, New York, 1986.
2. Principles of Polymerization, G.Odian, Third edition, Wiley Interscience. New York, 1992.
3. Principles of Polymer Chemistry, P.J. Flory, Cornell University, Press Ithaca, 1953.
4. Textbook of Polymer Science, F.W. Billmeyer, 3rd Edition, John Wiley, London, 1994.
5. Polymer Science, Gowariker et al, Wiley Eastern, New Delhi, 1990.

Department of Chemistry

Course Name: **Bionanotechnology**
Course Code: **CY-303**
Course Type: **Open Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the fabrication and characterization of different nanomaterials.
- To familiarize the students with the underlying principles that governs the structure and function of nanomaterials for harnessing their unique properties for novel applications.
- To make the students enable for the understanding of technical applications of nanomaterials in diverse filed of engineering and sciences such as imaging, biosensors, sustainable energy, biomedical engineering, drug delivery etc.

Unit Number	Course Content	Cotact Hours
UNIT-01	**Introduction:** Nanotechnology and Bionanotechnology– an overview, significance of nanodomain, nanostructures and nanosystems, Opportunities and challenges of Bionanotechnology, Growth potential of Bionanotechnology, Bionanotechnology today and its future	**03L**
UNIT-02	**Fabrication and Characterization Techniques:** General techniques of fabrication of nanomaterials — Physical, Chemical and Biological methods,Microscopictechniques for characterization (Scanning Electron, Transmission Electron, Scanning Near-field optical, Scanning Tunneling, Atomic Force Microscopy), Spectroscopic and Diffraction techniques for characterization.	**07L**
UNIT-03	**Nano-structured Biomaterials and their Applications:** Silica based nanomaterials, Inorganic materials, Bio-templated/bio-inspired fabrications and their applications, bionanomaterials for gene delivery.	**05L**
UNIT-04	**Nanotubes and their Biological Applications:** Preparation, properties and application of carbon nanotubes, Specific application of ferromagnetic filled carbon nanotubes in cancer, Nanotube membranes.	**04L**
UNIT-05	**Bionanotechnology for Drug delivery, Biomedical engineering and Sensor development:** Conventional drug delivery, nanosized carriers for drug delivery, targeted drug delivery by Bionanomaterials and their applications, advantages of targeted drug delivery systems, Nanomedicine, proteoliposomes and their uses as vaccine adjuvants, gene and drug delivery systems with soluble inorganic careers, nanotechnology for cancer therapy, Bionano chips for cardiac diagnostics, local cancer therapy using magnetic nanoparticles, applications in Implant materials, *In vitro* clinical diagnosis by nanoparticles, Magnetic nanoparticles for MR imaging, Semiconductor quantum dots for molecular and cellular imaging, Ultrasound contrast agents, Nanomaterials based Biosensors for sensing of glucose, alcohol, food quality etc. Applications of bionanotechnologyin Stem Cell Biology.	**17L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand the concept of nanoscience/nanomaterials and its role in bionanotechnology.
CO2: Explore various nano and bionanostructures for diverse applications in different fields.
CO3: Apply the principles of bionanotechnology for the development of tools and techniques for biomedical engineering.

Books and References

1. BioNanotcchnology by Elisabeth S. Papazolou and Aravind Parthasarathy, Morgan & Claypool Publishers.
2. Nanotechnology: Principles and Practices by S. K. Kulkarni, Springer
3. Bionanotechnology: Global prospects by David E. Reisner (Ed.), CRC Press.
4. Nanobiotechnology: Bioinspired devices and materials of the future by Oded Shoseyov& Ilan Levy (Ed.), Springer

Department of Chemistry

Course Name: **Chemical Kinetics and Equilibrium**
Course Code: **CY-304**
Course Type: **Open Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To develop an in-depth understanding of kinetics of chemical processes and its equilibria.
- To enable the students to determine the kinetic parameters and equilibrium constant experimentally.
- To familiarize the students about determination of reaction mechanism from kinetics.
- To increase the awareness among students regarding various industrial and biochemical reactions.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction to Chemical Kinetics** Rate of reactions, Difference between Initial, instantaneous and average rates, Law of mass action, order of reaction, rate constants and their units, Elementary steps and molecularity of reactions, Differential and integrated rate laws of zero, first and second reactions, Half-life calculation in various reactions, Various experimental methods for order determination.	**11 L**
UNIT-02	**Reaction mechanism and its role in kinetics** Types of elementary reactions – Reversible, concurrent and consecutive chemical reactions, Principle of microscopic reversibility, steady state approximation, prediction of reaction mechanism by kinetics and vice-versa, Kinetics of chain reactions and occurrence of various explosion limits, Kinetics of polymerization reactions.	**08 L**
UNIT-03	**Theories for molecular interpretation of reactions** Collision theory of bimolecular gaseous reactions, Activated complex theory, correlation of reaction rate constant with thermodynamic parameters such as entropy and Gibbs free energy change of reaction.	**06L**
UNIT-04	**Kinetics of complex reactions** Usage of various types of catalysts (Acids, Bases, Enzymes, hetrogeneous catalysts) for faster chemical reactions.Kinetics of photochemical processes, fluorescence quenching and Stern-Volmer equation, resonance energy transfer, kinetics of electron transfer reactions, Usage of ultrafast laser techniques for studying reaction dynamics.	**06L**
UNIT-05	**Chemical equilibria** Chemical equilibria of homogeneous systems, derivation of expression of equilibrium constants, Relation between Kp, Kc and Kx, Le Chatelier's principle of dynamic equilibrium. Effect of change of concentration, pressure, temperature and catalyst on equilibrium constant.	**05L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand the fundamental terms for explaining the kinetics of reactions and its equilibria.
CO2: Analyze experimental data from reactions, equilibrium, and kinetic parameters.
CO3: Study ultrafast chemical processes.
CO4: Understand molecular level mechanism of different chemical reactions.

Books and References

1. Barrow, G. M.; Physical Chemistry, Tata McGraw-Hill, 2007.
2. Castellan, G. W.; Physical Chemistry, Narosa, 2004.
3. Laidler, K. J.; Chemical Kinetics, Prentice Hall, 3rd Ed., 1997.
4. Atkins, P.; Paula, J. D.; Physical Chemistry, Oxford, 8th Ed.,
5. G. W. Castellan, Physical Chemistry, Addison Wesley Publishing Company, 1983.