| B. Tech. IV (CH), Semester –VIII | L | T | P | C |
|---|---|---|---|---|
| **CH 424: NEW SEPARATION TECHNIQUES** | **3** | **0** | **0** | **3** |

- **Fundamentals of Separation Processes** **(4 hours)**
  Basic definitions of relevant terms, Separation process in chemical and Biochemical Industries, Categorization of separation processes, equilibrium and rate governed processes. Introduction to various new separation techniques e.g. Membrane separation, Ion-exchange foam Separation, supercritical extraction, liquid membrane permeation
- **Crystallization and Reactive separations** **(10 hours)**
  Concept, Different types of crystallization, phase equilibrium, different techniques, commercial applications, Ultrasound and its application in crystallization, Reactive crystallization
- **Membrane based separation processes:** **(15 hours)**
  Historical background, physical and chemical properties of membranes, Techniques of membrane preparation, membrane characterization, various types of membranes and modules. design of Reverse osmosis, Ultrafiltration, Microfiltration, Electrodialysis and Pervaporation.

- **External field induced membrane separation processes for colloidal particles:** **(6 hours)**.
  Fundamentals of various colloid separation. Derivation of profile of electric field strength. Coupling with membrane separation and electrophoresis.

- **Surfactant based separation processes:** **(8 hours)**
  Cloud point extraction, Micellar enhanced separation processes, Liquid membranes

- **Supercritical fluid extraction.** **(2 hours)**
  Working Principal, Advantage & Disadvantages of supercritical solvents over conventional liquid solvents, commercial applications of supercritical extraction, Applications under research

**(Total contact time: 45 hours)**

**BOOKS RECOMMENDED**


1. Kaushik Nath, Membrane Separation Processes, PHI pvt.Ltd.,2008
2. J. D. Seader, Ernest J. Henley, D. Keith Roper, SEPARATION PROCESS PRINCIPLES, John Wiley & Sons, Inc.
3. Henry, J. D. and Li, N. N., "New Separation Techniques", AICHE Today Series, AICHE (1975).
4. Schweitzer P.A. (Ed.), "Handbook of Separation Techniques for Chemical Engineers", 3rd Edition, McGraw-Hill, New York, 1997.
5. Kulprathipanja S. "Reactive Separation Processes", Taylor and Francis, New York, 2002.

**B-TECH.IV (CHEMICAL) 8th SEMESTER** **L T P C**

**CH 414: Advances in Chemical Engineering** **3 0 0 3**

**Advance separation techniques** **(12 Hours)**

Reverse osmosis, Forward osmosis (FO), Pressure retarded osmosis (PRO), Osmotic microbial fuel cell (OMFC), benthic microbial fuel cell (BMFC), Osmotic Membrane bio reactor (OsMBR).

**Advance characterisation methods** **(6 Hours)**

XRD, SEM, TGA, FT-IR, EDX, Gel permeation chromatography (GPC) etc

**Advance Polymer** **(10 Hours)**

Smart polymer, advanced polymer nanocomposite, Conductive polymer, bio-route prepared nano polymer, Blended polymer, self-cleaning polymer surfaces

**Recent advances in membrane** **(12 Hours)**

Principles of membrane separation, Membrane Materials, Transport phenomena of species, molecular and ionic, in porous or dense, charged or not, membranes, Layer by layer membrane, Proton exchange membrane, biopolymer based membrane, nanocomposite membrane, coated membrane, different subtract and active layer membrane.

**Smart Hydrogels** **(5 Hours)**

Hydrogel, Core and shell hydrogel, shell and core hydrogel, green hydrogel, stimuli responsiveness hydrogel

**(Total contact time: 45 hours)**

**Reference Books**


1. Filtration and purification in biopharmaceutical industry, second edition by Miak Jornitz and Theodore Meltzer, Informa Healthcare, Vol. 174.
2. Bungay P.M., Lonsdale H.K. & de Pinho M.N. (Eds.), "Synthetic Membranes: Science, Engineering and Applications", NATO ASI Series, Vol.181, D.Reidel Publishing Company, Dordrecht, Holland,1986.
3. Schweitzer P.A. (Ed.), "Handbook of Separation Techniques for Chemical Engineers", 3rd Edition, McGraw-Hill, New York, 1997.
4. Gowariker, V.R. Viswanathan, N.V., and Sreedhar, J., Polymer science, Halsted Press (John Wiley & Sons), New York, 1986.
5. Ghosh, P. polymer science & technology of plasic, rubber, blends and composites second addition, Tata McGraw-Hill, New delhi,2008.
6. Recent literature from Journals on separations, membranes, polymers and hydrogels.

**ES - 2 CH418: Fluidization Engineering**
**B. Tech. IV (CH), Semester VIII**

| Sr. No. | CONTENTS | No. of Lectures |
|---|---|---|
| 1 | **INTRODUCTION:** Introduction to Phenomenon of Fluidization; Types of Fluidization Operations; Effects of Different Parameters, Typical Industrial Applications of Fluidized Beds. | 2 h |
| 2 | **PARTICLE CHARACTERIZATION AND DYNAMICS:** Review of Measurements of Particle Size, Shape, and Particle Size Distribution. Correlation of Bed Voidage and Sphericity, Geldart's Powder Classification, Particle Hydrodynamics, Packed Bed Hydrodynamics. Terminal Velocity of Particles and Richardson-Zaki Equation for Fluidized Bed | 4 h |
| 3 | **FLUIDIZED BED HYDRODYNAMICS:** Estimation of Minimum Fluidization Velocity, Effects of Different Particle and Fluid Properties, Mapping of Fluidization Regimes, Transition to Different Fluidized Conditions, Gas Distributor Types; Fluidity and Power Consumption. | 5 h |
| 4 | **LIQUID-SOLID FLUIDIZATION** Typical Behaviour of Smooth Homogenous Fluidization, Estimation of Bed Expansion and Bed Voidage in Fluidized Conditions | 2 h |
| 4 | **GAS-SOLID FLUIDIZATION: BUBBLING BED BEHAVIOUR AND BUBBLE DYNAMICS:** Bubbles in Liquid and Fluidized Bed, Jet Penetration and Bubble Formation, Bubble Rise Velocity in Quiescent Liquid and Fluidized Bed, Estimation of Bubble Shape, Size and Stability, Models of Bubbling Beds, Davidson's Isolated Bubble Model, Wake and Bubble Cloud, Two Phase Theory of Fluidization, Coalescence and Splitting of Bubbles, Kuni-Levenspiel Model, Slugging Conditions In Fludized Bed | 10 h |
| 5 | **ELUTRIATION IN FLUIDIZED BED:** Basics of elutriation, Estimation of Transport disengaging height (TDH). Empirical correlations for estimation of elutriation rate. Estimation of TDH for Geldart's A group powder. | 2 h |
| 6 | **HEAT AND MASS TRANSFER IN FLUIDIZED BED:** General characteristics and correlations of heat transfer in fluidized bed, Heat transfer between gas-particle and bed surfaces, Effects of parameters on rate of heat transfer, General characteristics and correlations of mass transfer in fluidized bed, Mass transfer between different phases of fluidized bed. | 4 h |
| 7 | **FLUIDIZATION OF MICRONIC POWDERS AND NANOPARTICULATE ASSEMBLIES:** Effects of long range and short range forces, Modified Richardson-Zaki equation for nanoparticles fluidization, Nanoparticle fluidization, | 3 h |
| 8. | **FLUDIZED BED REACTOR DESIGN:** Basics of reactor design, Different approaches of reactor design, Reactor design using Kuni-levenspiel model. | 6 h |
| 9. | **SCALE UP OF FLUIDIZED BED:** Generalized scaling laws for fluidized bed system | 3 h |
| 10. | **Introduction to Turbulent, Fast and Circulating Fluidized Bed** | 4 h |
| **TOTAL LECTURES** | | **45 Hours** |

**RECOMMENDED BOOKS:**


1. Kunii, D. and Levenspiel, O., "Fluidization Engineering", 2nd ed., Elsevier, New delhi, 2005.
2. Wen –Ching Yang, Handbook of fluidization and fluid-particle systems,Marcel dekker
3. Davidson, J.F. and Harrison, D., "Fluidized Particle", Cambridge University Press.
4. Gililaro, L. G., Fluidization Dynamics, The formulations & applications of predictive Theory for the fluidized state