

• **INTRODUCTION** (2 hours)

Introduction to Colloids, Colloidal systems, Thin Films, Surfaces and Interfaces, Characteristics of colloidal systems, Industrial applications.

• **PHENOMENOLOGY OF COLLOIDAL MATERIALS** (4 hours)

Forces in colloidal systems, Hydrophobic interaction, Stability, Association colloids, DLVO theory, Non-DLVO forces, Brownian motion and Brownian flocculation.

• **INTER-MOLECULAR AND INTER-PARTICLE FORCES** (8 hours)

Charge-charge interaction, Dipole-dipole interaction, Ion-dipole interaction, van der Waals interaction, Hamaker's approach, Deryaguin's approximation, Lifshitz continuum theory of forces between macroscopic bodies.

• **SURFACTANTS, MICELLES AND SELF ASSEMBLY SYSTEMS** (5 hours)

Classification of surfactants, Factors affecting behavior of surfactants, Vesicles, Micelles, Reverse micelles, Mixed surfactant systems, Monolayers, Bilayers, Applications.

• **EMULSIONS, FOAMS AND GELS** (6 hours)

Characteristics and applications of Emulsions, Gels, Microemulsions, Stability of Emulsions, Applications of foams, Hydrotropy: theory and applications, Foam stability and foamability, applications

• **ELECTROKINETIC PHENOMENA** (3 hours)

Electroosmosis, Electrophoresis, etc.

• **INTERFACES AND THIN FILMS** (8 hours)

Interfaces, Curved interfaces, Interfacial tension and its measurement, Thermodynamics of interfaces, Interfacial rheology, Friction, Lubrication, Adhesion, Macromolecular Surface Films, Charged Films, and Langmuir-Blodgett Layers

• **WETTING AND SPREADING** (4 hours)

Contact angle, Surface characteristics, Modification of wetting, Capillarity, Thermodynamics of wetting and spreading.

• **SELECTED TOPICS FROM CURRENT LITERATURES** (5 hours)
(Total contact time: 45 hours)

BOOKS RECOMMENDED

1. Miller, C. A. and P. Neogi, "Interfacial Phenomena : Equilibrium and Dynamic Effects", 2nd Edn., Marcel Dekker, NY, 2007.
2. Hiemenz, P. C., and R. Rajgopalan, "Principles of Colloid and Surface Chemistry", 3rd Edn., Marcel Dekker, NY, 1997.
3. Adamson, A. W. and Gast, A., "Physical Chemistry of Surfaces", 6th edition, John Wiley and Sons, 1997.
4. Stokes, R. J. and Evans, D.F., "Fundamentals of Interfacial Engineering", Wiley-VCH, N.Y., 1996.
5. Slattey, J.C., Sagis, L., and Oh E.-S., "Interfacial Transport Phenomena", 2nd Edn., Springer, NY., 2007.
6. Israelachvili, J., "Intermolecular and Surface Forces", Academic, Press, 1992.
7. Edwards, D. A., Brenner, H., and Wasan, D.T., "Interfacial Transport Processes and Rheology", Butterworth, Heinmen, 1991.
8. Hunter, R.J., "Foundations of Colloid Science", Vols. I & II, Oxford Science Publications, 1989.
9. Levich, V.G., "Physicochemical Hydrodynamics", Prentice Hall Inc., 1962.
10. Selected Current Literature.

B.Tech. IV (CH), Semester – VII**L T P C****ES-1: Fundamentals of Biochemical Engineering**
(Elective Subject from Department)**3 0 0 3**

• INTRODUCTION (06 Hours)

Scope and possibilities; Characteristics and classification of biological matter; Basics of microbial growth;

• OVERVIEW OF BIOSEPARATIONS (02 Hours)

An Overview of bioseparations; Cell disruptions; Genetically modified organism;

• SEPARATION METHODS (25 Hours)

Filtration; Centrifugation; Adsorption; Extraction; Membrane separation processes; Concepts of precipitation, Chromatography – Basic concepts; Gel filtration; Ion exchange chromatography; Hydrophobic chromatography; Affinity chromatography; Suitable examples; Electrokinetic methods of separations; Finishing operations and formulations

• INDUSTRIAL APPLICATIONS (12 Hours)

Biomass to Biofuels; Bioremediation; Biocatalysts; Biofouling; Microbial Polymer and plastics; Natural resources recovery

(Total Contact Hours: 45)

BOOKS RECOMMENDED:

1. Shuichi Aiba, Arthur E. Humphrey, Nancy F. Millis, “Biochemical Engineering”, 2nd Ed., Academic Press, New York, 1973.
2. James E. Bailey, David F. Ollis, “Biochemical Engineering Fundamentals”, 2nd Ed., McGraw hill, 1986.
3. L. Weatherley, “Engineering Processes for Bioseparations”, Butterworth-Heinemann Ltd., Oxford, 1995.
4. D.L. Pyle, “Separation for biotechnology”, Royal Society of Chemistry, Cambridge, 1994
5. A. Scragg, “Environmental Biotechnology”, 2nd Ed., Oxford University Press, 2005.

B. Tech. IV (CH)**CH 421: INDUSTRIAL WASTE MANAGEMENT CONTROL**

L	T	P	C
3	0	0	3

- **INTRODUCTION** (03 Hours)
Industrial waste, types of industrial waste, sources of industrial Waste, Characteristic of industrial waste, Effects of waste on sewage treatment plants, Waste reduction alternatives.
- **WASTEWATER TREATMENT** (02 Hours)
Types of wastewater, Significance of wastewater contaminants, Discharge limit of wastewater, handling and storage of wastewater.
- **TREATMENT OF WASTEWATER** (20 Hours)
Preliminary or primary treatment of wastewater:-Different physical and chemical treatments, Secondary treatment:-Aerobic and anaerobic treatment, BOD, COD, MLSS MLVSS, Attach growth, Suspended growth, Activated sludge process, Up flow anaerobic sludge blanket reactor (UASB), trickling filter, Rotating biological contactor (RBC) etc. Various post treatment ie., lagoon, stabilizing pond, facultative pond etc. Tertiary treatment or advanced treatment:-Membrane separation process, membrane bioreactor (MBR), nitrogen removal process, phosphorus removal process, Disinfection. Examples of different industrial wastewaters treatment of, Common effluent treatment plant (CETP)
- **SLUDGE TREATMENT AND DISPOSAL.** (05 Hours)
Introduction, sludge
- **SOLID WASTE TREATMENT** (15 Hours)
Definition, Types of solid waste, storage and handling of solid waste, Different treatment of solid waste, E-waste treatment, Hazardous waste management.

(Total Contact Hours: 45)

BOOKS RECOMMENDED:

1. Board, NIIR “Modern Technology of Waste Management: Pollution Control, Recycling, Treatment and Utilization”, Asia Pacific Business Press Inc., 2004.
2. Hammer, M.J. and Hammer M.J. Jr.” Water and Wastewater Technology”, 6th Ed. Prentice Hall Inc., 2008.
3. Bhatia, S.C., “Managing Industrial Pollution”, Macmillan India Ltd., 2003.
4. Rao, C.S. “Environmental pollution control engineering”, New Age International, 2011.
5. Nag, A. and Vizayakumar, A. “Environmental education and solid waste management”, New Age International, 2005.

B. Tech. IV (CH)**CH 422: INTRODUCTION TO NANOTECHNOLOGY
IN CHEMICAL ENGINEERING**

L	T	P	C
3	0	0	3

- **INTRODUCTION** (04 Hours)
What is the nanoscale and what makes it different from other scales, history of nanotechnology, Scope of nanotechnology applications
 - **ENHANCED PROPERTIES AT NANOSCALE** (06 Hours)
Enhanced properties at nanoscale, Case studies demonstrating non-classical behavior at nanoscale in successful and emergent nanotechnologies.
 - **INTRODUCTION TO TOP-DOWN MANUFACTURE** (06 Hours)
Attrition or Milling. The benefits and limitations.
 - **INTRODUCTION TO INSTRUMENTATION AND CHARACTERIZATION** (08 Hours)
Transmission electron microscope (TEM), Scanning electron microscope (SEM), Atomic force microscope (AFM), scanning tunnelling microscope (STM), Dynamic light scattering (DLS), Spectroscopy
 - **INTRODUCTION TO BOTTOM-UP MANUFACTURE** (12 Hours)
Chemical reduction methods, self assembly on surfaces, nanolithography and nano manipulation, Molecular machines, nanofactories
 - **APPLICATION OF NANOTECHNOLOGY** (09 Hours)
Applications in chemical engineering like nanocatalysts, nanocomposites, bio-analytical tools, nano/microarrays, nanodevices, lab-on-a-chip etc.
- (Total Contact Hours: 45)**

BOOKS RECOMMENDED:

1. Poole C., and Owens F., Introduction to Nanotechnology, John-Wiley, New Jersey, 2003.
2. Ratner M., Ratner D., Nanotechnology: A gentle introduction to the next big idea, Prentice-Hall, New Jersey, 2002.
3. Singh Nalwa, 10 volume Encyclopedia of Nanoscience and Nanotechnology, 2004.
4. Catherine Brechignac, Philippe Houdy, Marcel Lahmani (Editors), Nanomaterials and nanochemistry, Springer-Verlag Berlin Heidelberg, 2007
5. Ozin G. A, Andre C. Arsenault, Nanochemistry A chemical approach to nanomaterials, Royal society of chemistry, UK, 2005.

B. Tech. IV (CH)	L	T	P	C
CH 425: SUSTAINABILITY AND GREEN CHEMISTRY	3	0	0	3

- **INTRODUCTION** (02 Hours)
Chemistry- from past to future, importance of sustainability, need of green chemistry.
- **SUSTAINABILITY** (08 Hours)
Fundamentals of sustainable development, growth, consumption and natural wealth, sustainable development at different scales, ten commandments.
- **GREEN CHEMISTRY** (03 Hours)
Principles and applications
- **SYNTHESIS AND GREEN CHEMISTRY** (04 Hours)
Micro-reactor technology, Solvent-less reactions, Use of green solvents, brief about Combinatorial chemistry.
- **ALTERNATE SOLVENTS** (04 Hours)
Green solvents, Water as a solvent; Amphiphilic compounds.
- **CONVENTIONAL PROCESS AND OPERATIONS** (04 Hours)
Current status and modification.
- **NEW DEVELOPMENT IN PROCESSES** (10 Hours)
Overview of green separation processes, distillation, chromatography, fluid extraction, membrane processes, pressurized hot water extraction, nanotechnology in separation.
- **LIFE CYCLE ASSESSMENT OF THE TECHNOLOGY** (06 Hours)
- **INDUSTRIAL EXAMPLES** (04 Hours)

(Total Contact Hours: 45)

BOOKS RECOMMENDED:

1. Doble M. and Kruthiventi A. K., Green Chemistry and Processes, Academic Press, 2007, London, UK.
2. Stanley E. Manahan, Green Chemistry and The Ten Commandments of Sustainability, 2nd Ed.
3. Chem Char Research, Inc Publishers, 2006, Missouri U.S.A.
4. Afonso C. A. M., Crespo J. G., Green Separation Processes, Wiley-VCH Verlag GmbH & Co., 2005, Weinheim, Germany.
5. Clark J., Macquarrie D., Handbook of Green Chemistry and Technology Blackwell Series, 2002, UK.
6. Atkinson G., Dietz S., Neumayer E., Handbook of Sustainable Development Edward Elgar Publishing Limited, 2007, Cheltenham, UK.
7. Rothenberg G., Catalysis: Concepts and Green Applications, Wiley-VCH Verlag GmbH & Co., 2008, Weinheim, Germany.
8. Selected articles from Literature.