B. Tech. III(CH), Semester –V
EIS: Elective Interdisciplinary Subjects (Group-1)#

	L	T	P	C
CH 309: Bioprocess Engineering	**3**	**0**	**0**	**0**

Principles of enzyme catalysis **(08 Hours)**

Proteins as enzymes; Michaelis-Menten kinetics; Inhibition; Effect of various parameters; Immoblized enzymes: methods and mass transfer considerations; Industrial enzymes and its applications.

Microbial growth **(12 Hours)**

Characteristics and classification of biological matter; Introduction to metabolism; Nutrient transport; Glycolysis; TCA cycle; Control of metabolism; Factors affect microbial growth; Growth kinetics; measurement of growth.

Bioreactors **(10 Hours)**

Introduction to bioreactors; Batch and fed-batch bioreactors; Continuous bioreactors; Bioreactor operation; Sterilization; Aeration; Sensors; Instrumentation.

Bioseparations **(09 Hours)**

Biomass removal; Biomass disruption; Membrane based techniques; Extraction; Adsorption and Chromatography.

Industrial Processes **(06 Hours)**

Description of industrial processes; Process flow-sheeting; Process economics.

(Total contact time: 45 hours)

REFERENCE:

1. S. Aiba, A.E. Humphrey, and N.F.Mills, "Biochemical Engineering", 2nd edition, Academic Press, New York, 1973.
2. J.E.Bailey, D.F. Ollis, "Biochemical Engineering Fundamentals", 2nd edition, McGraw Hill, 1986.
3. M.L. Shuler & F.Kargi, "Bioprocess Engineering: Basic concepts", Prentice Hall, 2001.
4. B. Atkinson," Biochemical Reacrtors", Pion Ltd., London, 1974.
5. D.L.Pyle, " Separation for biotechnology", Royal society of chemistry, Cambridge, 1994.

B Tech III	L	T	P	C
CH 309: ENERGY TECHNOLOGY	3	0	0	3

- **INTRODUCTION** **(02 Hours)**
  Energy sources - conventional & non-conventional, different forms of energy, energy chain, energy demand, energy management, energy audit & conservation, types of fuels, thermodynamics and basic energy calculations, units & conversion factors.

- **SOLID FUELS (COAL)** **(08 Hours)**
  Rank of coal, composition of coal, analysis & properties of coal, Coal preparation, Clean Coal Technology, gasification of Coal.

- **SOLAR ENERGY** **(06 Hours)**
  Introduction, applications of solar energy, solar radiation & related terms, measurement of solar radiation, solar energy collectors, applications & advantages of various collectors, solar energy storage systems, Solar Thermal Energy conversion systems and power plants.

- **WIND ENERGY** **(03 Hours)**
  Basic principles, wind energy conversion, site selection, basic components of wind energy conversion systems (WECS), classification of WECS, wind energy collectors, applications of wind energy.

- **ENERGY FROM BIOMASS** **(04 Hours)**
  Introduction, biomass conversion technologies, biogas generation, factors affecting biogas generation, classification & types of biogas plants (including those used in India), thermal gasification of biomass, pyrolysis, alternative liquid fuels.

- **GEOTHERMAL ENERGY** **(04 Hours)**
  Introduction, applications of geothermal energy, Geothermal resource types, Classification and types of geothermal power plants.

- **HYDRO ENERGY** **(02 Hours)**
  Introduction, Merits and demerits, Energy conversion systems, Power plants.

- **ENERGY FROM OCEANS** **(02 Hours)**
  Energy from Tides, Methods of utilization of tidal energy, storage, components of tidal power plants, ocean waves, wave energy conversion devices.

- **FUEL CELL** **(05 Hours)**
  Introduction, types of fuel cells, Principle and operation of fuel cells, advantages & disadvantages, conversion efficiency, applications of fuel cells.

- **HYDROGEN** **(02 Hours)**
  Properties of Hydrogen, production of hydrogen via different methods, storage & transportation, safety & management.

- **NUCLEAR ENERGY** **(05 Hours)**

Fission, fuel for nuclear fission reactor, Nuclear Fuel Cycle, storage & transportation, different types of reactor, reactor control, nuclear reactor power plants, Nuclear waste management.

- **URBAN WASTE TO ENERGY** **(02 Hours)**
  Introduction, various processes, applications.

(Total Contact Hours: 45)

BOOKS RECOMMENDED:

1. Mathew S., Wind Energy-Fundamentals, Resource Analysis and Economics, Springer-Verlag Berlin Heidelberg 2006
2. Heinloth K., Energy Technologies: Renewable Energy, Springer-Verlag Berlin Heidelberg 2006.
3. Gasification, C. Higman, M. Burgt, Gulf Professional Publishing, 2003, Elsevier Science (USA).
4. Rao & Parulekar, Khanna Energy Technology - Publications, New Delhi, 2007.
5. Begamudre R. D. Energy Conversion Systems, New Age International Ltd. 2000.
6. Twidell J. & Weir T. Renewable Energy Resources, 2nd Ed, Taylor & Francis, 2006.

Journals:

1. Applied Energy
2. Renewable Energy
3. Energy & Fuels
4. Energy Conversion & Management

	L	T	P	C
B.Tech. III (Chemical), Semester-VI	**3**	**0**	**0**	**3**
CH 322: Petroleum Refinery Engineering	**3**	**1**	**2**	**5**

- **INTRODUCTION** **(02 Hours)**
  Overall Refinery Flow
- **PRODUCTS**
  (03 Hours)
  Low-Boiling Products, Distillate Fuels, Heating Oils, Residual Fuel Oils and their specification and applications.
- **REFINERY FEEDSTOCKS** **(03 Hours)**
  Crude Oil Properties, Composition of Petroleum, Crudes Suitable for Asphalt Manufacture, Crude Distillation Curves like ASTM, TBP, EFV
- **CRUDE DISTILLATION** **(04 Hours)**
  Desalting Crude Oils, Atmospheric Topping Unit, Vacuum Distillation, Auxiliary Equipment
- **COKING AND THERMAL PROCESSES** **(04 Hours)**

  Types, Properties, and Uses of Petroleum Coke, Process Description—Delayed Coking, Flexicoking, Fluid Coking, Yields from Flexicoking and Fluid Coking, Visbreaking
- **CATALYTIC CRACKING** **(04 Hours)**
  Fluidized-Bed Catalytic Cracking, Cracking Reactions, Cracking Catalysts, FCC Feed Pretreating, Process Variables, Heat Recovery
- **CATALYTIC HYDROCRACKING** **(04 Hours)**
  Hydrocracking Reactions, Feed Preparation, Hydrocracking Process, Hydrocracking Catalyst, Process Variables, Hydrocracking Yields
- **HYDROPROCESSING AND RESID PROCESSING** **(04 Hours)**
  Composition of Vacuum Tower Bottoms, Processing Options, Hydroprocessing, Expanded-Bed Hydrocracking Processes, Moving-Bed Hydroprocessors, Solvent Extraction
- **HYDROTREATING** **(03 Hours)**
  Hydrotreating Catalysts, Aromatics Reduction, Reactions, Process Variables, Construction and Operating Costs
- **CATALYTIC REFORMING AND ISOMERIZATION** **(04 Hours)**
  Reactions, Feed Preparation, Catalytic Reforming Processes, Reforming Catalyst, Reactor Design, Yields and Costs, Isomerization
- **ALKYLATION AND POLYMERIZATION** **(04 Hours)**
  Alkylation Reactions, Process Variables, Alkylation Feedstocks, Alkylation Products, Catalysts, Hydrofluoric Acid Processes, Sulfuric Acid Alkylation Processes, Comparison of Processes, Alkylation Yields and Costs, Polymerization
- **PRODUCT BLENDING** **(03 Hours)**
  Reid Vapor Pressure, Octane Blending, Blending for Other Properties
- **SUPPORTING PROCESSES** **(03 Hours)**
  Hydrogen Production and Purification, Gas Processing Unit, Acid Gas Removal, Sulfur Recovery Processes

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(Total contact time: 45 hours)

BOOKS RECOMMENDED:

1. James H. Gary, Glenn E. Handwerk, "Petroleum Refining Technology and Economics", Fourth Edition,
2. W. L. Nelson, *Petroleum Refinery Engineering*, 4th Ed. (McGraw-Hill Book Company, New York, 1958), p. 114.
3. David S. J. Jones, Peter R. Pujado, "Handbook of Petroleum Processing", Springer Publication, 2008.
4. Rao B.K.B., "Modern Petroleum Refining Processes", Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 2002, (4th Ed).

B. Tech. III (CH), Semester-VI

L	T	P	C
3	0	0	3

CH 314: CLEANER TECHNOLOGIES IN CHEMICAL PROCESS INDUSTRIES (EIS-II)

- **INRODUCTION TO CLEANER TECHNOLOGY (03 Hours)**
  Industrial impacts on the environment, Concept of sustainable development, Cleaner technology and cleaner production, Basis, necessity and scope of cleaner production/cleaner technologies in survival of chemical process industries.
- **CLEANER PRODUCTION TOOLS (05 Hours)**
  C.P. tools, techniques, methodology, Assessment of cleaner production.
- **GREEN CHEMISTRY AND GREEN ENGINEERING (10 Hours)**
  Principles and concepts of green chemistry and green engineering, green chemistry metrics, Environmentally benign solvents, design of cleaner production/green processes.
- **INHERENTLY SAFER DESIGN (06 Hours)**
  Industrial process safety strategies, Hazard Prevention by CT Alternatives, HAZOP, HAZAN, Inherent safety concepts and strategies.
- **LIFE CYCLE ASSESSMENT (06 Hours)**
  ISO 14000, Life cycle analysis of products and processes, LCA methodologies
- **ENERGY AND ENVIRONMENTAL AUDIT (05 Hours)**
  Energy conservation, Energy audit and its methodology, Environmental auditing
- **WASTE MINIMIZATION CIRCLES (04 Hours)**
  Concept, Need and benefits, Methodology, Techniques and barriers
- **INDUSTRIAL CASE STUDIES (06 Hours)**
  Typical case studies from industrial sectors viz. Petrochemicals, Polymers, Chloralkali, Dyes, Pharmaceuticals, Pesticides, Food processing, Textile and Specialty Chemicals.

(Total contact time: 45 hours)

BOOKS RECOMMENDED:

1. Gujarat Cleaner Production Centre, "Cleaner Production and its Application to Industries", GCPC, Gandhinagar, Gujarat, 2010.
2. Lennart Nilsson, Per Olof Persson, Lars Ryden, Siarhei Darozhka, Audrone Zaliauskiene "Cleaner Production: Technologies and Tools for Resource Efficient Production", Baltic University Press, 2007.
3. United Nations Environment Programme "Cleaner Production - A Training Resource Package", UNEP/Earthprint, 1996.
4. David T. Allen, David R. Shonnard, "Green Engineering: Environmentally Conscious Design of Chemical Processes", Pearson Education, 2001.
5. Concepción Jiménez-González, David J.C. Constable, "Green Chemistry and Engineering: A Practical Design Approach", John Wiley & Sons, 2011.
6. Kenneth L. Mulholland "Identification of Cleaner Production Improvement Opportunities", John Wiley & Sons, 2006.

7. Center for Chemical Process Safety (CCPS) “Inherently Safer Chemical Processes: A Life Cycle Approach”, John Wiley & Sons, 2010.
8. Asian Productivity Organization, “Working Manual on Energy Auditing in Industries”, APO, Japan, 2008.