

Maulana Abul Kalam Azad University of Technology, West Bengal
(Formerly West Bengal University of Technology)
Syllabus for B. Tech in Chemical Engineering
(Applicable from the academic session 2018-2019)

Semester V

Transport Phenomena

CHE-PC501

3L: 1T: 0P

4 credits

Objectives:

- This course will highlight coupling between three transport phenomena with applications in various disciplines in engineering and science, and will demonstrate to the students the common mathematical structure of transport problems.
- The course will deal with flow problems involving Newtonian and non-Newtonian fluids, solid-state heat conduction, forced and free convection, binary diffusion with or without chemical reaction.

Contents:

1. Introduction to Transport Phenomena, Formulation of transport problems from nature. **(3L+1T)**
2. Vector and Tensor Analysis: Basic concepts. **(6L+2T)**
3. Basics of momentum transport: Euler/Lagrangian viewpoint, laminar and turbulent flows, boundary layers, stress tensor. **(3L+1T)**
4. Shell momentum balances, equations of change, dimensional analysis, applications to isothermal flow of Newtonian & non-Newtonian fluids. **(9L+3T)**
5. Basics of energy transport, conductive, convective and viscous dissipation energy fluxes. **(3L+1T)**
6. Equations of change for non-isothermal systems, dimensional analysis, and applications to steady- state conduction and convection. **(9L+3T)**
7. Basics of mass transport, mechanisms, and mass and molar fluxes. **(3L+1T)**
8. Derivation of equation of continuity for a binary mixture and its application to convection-diffusion problems. **(6L+2T)**
9. Unsteady-state momentum, heat and mass transport, formulation of basic equations and similarity transform method. **(3L+1T)**

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Total 60 (L+T)

List of Text Books:

1. R. B. Bird, W. E. Stewart, and E. S. Lightfoot. Transport Phenomena, 2nd ed., Wiley India Pvt. Ltd., 2002.
2. Welty, C. E. Wicks, R. E. Wilson, and G. L. Rorrer. Fundamentals of Momentum, Heat, and Mass Transfer. 5th ed., Wiley India Pvt. Ltd., 2007.

List of Reference Books:

1. W. M. Deen, Analysis of Transport Phenomena, Oxford University Press, 1998.
2. W. J. Thompson, Introduction to Transport Phenomena, Prentice Hall, 2000.

Course outcomes:

On completion of the course, students would be familiar with

- Basics of vector and tensor analysis
- Be able to solve transport problems using shell balances
- Formulate and solve one-dimensional transport problems by using the conservation equations
- Formulate simple multi-dimensional transport problems

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Mass Transfer-II

CHE-PC502

3L: 0T: 0P

3 credits

Pre-requisites: Mass Transfer – I

Objectives:

Unit Operations based on Mass Transfer

Contents:

1. Perspective on unified approach to operations. (2L)
2. Liquid-liquid Extraction. (6L)
3. Leaching & Washing. (3L)
4. Adsorption, Ion-Exchange; Fixed bed absorbers, breakthrough. (10L)
5. Simultaneous Heat & Mass Transfer: Humidification and Dehumidification. (3L)
6. Simultaneous Heat and Mass Transfer: Drying. (3L)
7. Design of Cooling Towers. (6L)
8. Membrane processes. (6L)
9. Ultrafiltration and Osmosis, Reverse Osmosis. (6L)

Total 45L

List of Text Books:

1. Binay K. Dutta, Principles of Mass Transfer and Separation Processes, 2nd edition, Prentice Hall of India, 2007.
2. R. E. Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, New Delhi, 1983.
3. A. S. Foust, Principles of Unit Operations, 2nd Edition, Wiley, New York, 1980.
4. W. L. McCabe, J. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, Tata McGraw Hill, India, 2014.

List of Reference Books:

1. C. J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition, Prentice Hall, India, 1993.

Course outcomes:

Students will be able to

- List situations where liquid–liquid extraction might be preferred to distillation
- Explain the concept of breakthrough in fixed-bed adsorption
- Design cooling towers
- Distinguish among micro-filtration, ultra-filtration, nano-filtration, and reverse osmosis

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Chemical Reaction Engineering – II

CHE-PC503

3L:0T:0P

3 credits

Pre-requisites: Chemical Reaction Engineering – I

Objectives

Basic Concepts of Catalysis

Kinetics and Mechanistic aspects of Catalysts

Design and Rating of Catalytic Reactors

Design Aspects of Gas-Liquid Reactors

Contents:

1. Introduction to Catalysis, homogeneous and heterogeneous catalysis. Preparation and characterization of catalysts (3 lectures)
2. Physical and chemical adsorption, Adsorption isotherms, Determination of BET surface area and pore volume of the Catalyst (3 lectures)
3. Kinetics of solid catalyzed gas phase reaction (6 lectures)
4. Laboratory reactors for catalytic gas solid reactions. Design concepts (3 lectures)
5. Mass transfer, Diffusion and Chemical reactions in catalysts. Effects of external mass transfer and heat transfer, Effectiveness factor. Design aspects of catalytic reactors. (12 lectures)
6. Non-catalytic gas-solid reactions, different model for gas-solid reactions (6 lectures)
7. Gas liquid reactions, film and penetration theories, enhancement factor in gas-liquid reactions, gas-liquid reactors (12 lectures)

Total 45 lectures

Suggested Text Books

1. Elements of Chemical Reaction Engineering, Foggler H. S., Prentice Hall, 2001

Suggested References Books

2. Chemical and Catalytic Reaction Engineering, Carberry, J. J., Dover Books on Chemistry, 2001.
3. Chemical Reactor Analysis and Design Gilbert F. Froment, Kenneth B. Bischoff, Juray De Wilde, John Wiley & Sons, Incorporated, 2010

Course Outcomes

Students will be able to

Design catalytic reactors

Identify regions of mass transfer control and reaction rate control and calculate conversion

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Renewable Energy

CHE-PEC504

3L: 0T: 0P

3 credits

Contents:

Introduction (world energy status, current energy scenario in India, environmental aspects of energy utilization, energy and sustainable development; Solar energy (basic concepts, flat plate and concentrating collectors, solar desalination, solar pumping, solar photo voltaic conversion, solar cells); Wind energy (availability, wind power plants, wind energy conversion systems, site characteristics, types of wind turbines); energy from biomass (biomass resources, biomass conversion technologies - direct combustion, pyrolysis, gasification, anaerobic digestion, bioethanol and biodiesel production); Other Renewable Sources (Tidal energy; geothermal energy; hydroelectric).

Total 45L

Books:

1. Elements of Fuels & Combustion Technology, Gupta, Khanna Publishing House
2. Energy Audit and Management, Teri Press
3. Energy Conservation, Diwan & Dwivedi, Pentagon Press
4. Non-Conventional Energy Resources, Chandra, Khanna Publishing House
5. Energy Technology, O.P. Gupta, Khanna Publishing House

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Industrial Safety and Hazard Analysis

CHE-OE505A

3L: 0T: 0P

3 credits

Content:

Module I: 10L

Definition of safety, Hazard and Risk, Safety program, Engineering ethics, Inherent safety, Safety regulations, OSHA, Process

safety management, Windroses, Hazards due to fire, explosions and toxic chemicals, Distinction between fire and explosion,

Upper

Flammability limit and Lower Flammability Limit, Fire Triangle, BLEVE, Runaway reaction.

Module II: 10L

Tools for hazards identification: HAZOP, Fault Tree, Event Tree, FMEA, Dow Fire and Explosion Index, Mond Index, Safety

Audits..

Module III: 10L

Risk analysis concept and methodology: Risk concept and measure of risk, Risk acceptance criteria, Quantitative risk analysis,

Probit number.

Module IV: 15L

Engineering control of chemical plant hazards, Intensification and attenuation of hazardous materials, Industrial plant layout, Ventilation, Fire prevention, Personnel protection devices, Laboratory safety, Emergency safety, Safety systems and disaster management. Case studies, Flixborough (England), Bhopal (India), Seveso (Italy), Pasadona (Texas).

Total Lectures: 45

Text Books :

1. Chemical Process Safety: Fundamentals with Applications: D. A. Crowl and J.F.Louvar, Prentice Hall, 1990
2. Elements of Hazardous Waste Management, O.P. Gupta, Khanna Publishing House, 2018.
3. Industrial Safety, S.C. Sharma, Khanna Publishing House, 2018.

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References:

1. Safety in Chemical Process Industries: O. P. Kharbanda, E. A. Stallworthy, Heinmann Professional Publishing LTD.,1988
- 2.. Hazardous Waste management: C. A. Wentz, MGH.
3. Environmental Risks & Hazards, S.L. Cutter, Prentice Hall,1994
4. Chemical Process Technology, O.P. Gupta, Khanna Publishing House, 2019. (AICTE Recommended)

Petrochemical Technology

CHE-OE505B

3L: 0T: 0P

3 credits

Content:

Module I: 15 L

Petrochemical Industries & their feed stocks: Brief History and Survey of Petrochemical Industries in India. Different feed stocks used for Petrochemical Industries and their sources. Feed stocks used by Petrochemical Industries in India and their sources. Impurities in feed stocks and processes for their removal. Natural Gas processing. General idea of LNG, CNG, NGL, LPG and their generation.

Production and Utilization of Synthesis gas: Process of Synthesis gas production by steam reforming of Natural Gas and Naphtha and partial oxidation of Fuel Oil. Production of Methanol from Synthesis gas. Chemicals from Synthesis gas by Oxosynthesis. Production of liquid fuels from Synthesis gas by Fischer – Tropsch process.

Module II: 10 L

Name of Major Petrochemical products and their applications. First, Second and Third generation petrochemical products. Production of Ethylene, Propylene, and Butadiene by Naphtha/Gas cracking.

Petrochemicals based on Ethylene, Propylene and Butadiene : Like VCM, VAM, Ethylene Oxide, Ethylene Glycol, Ethanol Amines from Ethylene. Acrylonitrile, Isopropanol, Propylene oxide, Glycerine, Acrylic acid, Acrolein from Propylene. Production of Butadiene.

Module III: 10 L

Production, Separation and Utilization of Aromatics :- Catalytic Reformation of Naphtha and production of Xylenes. Separation of Xylenes. Isomerization of Meta xylene. Pyrolysis Gasoline hydrogenation and separation of BTX aromatics. Production of Benzene, Toluene, Xylenes from BTX aromatics by distillation. Production of Benzene from Toluene. Uses of xylenes. Alkylation of Benzene. Production of Styrene, Cumene and Phenol. Production of Phthalic Anhydride etc.

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Synthetic Detergents: Classification of detergents. Production of Linear Alkyl Benzene (LAB) from Superior Kerosene and Benzene. Sulphonation of LAB for production of Synthetic Detergents. Additives for synthetic detergents. Hard and soft detergents.

Module IV: 10 L

Plastomers, Elastomers and Synthetic fibres. : Various methods of polymerization and their mechanisms. Production processes of LDPE, LLDPE and HDPE. Basic difference among the three and their applications. Production of PVC and Polystyrene. Production of Polypropylene. Production of SBR, PBR and Butyl rubber. Production of ABS plastics. Production of Polyamide (Nylon 6 and Nylon 6,6) , Polyester and Acrylic fibres. Production of Phenol Formaldehyde resins.

Text Books :

1. Petrochemical processes: Chauvel , Gulf Publishing
2. Elements of Petrochemical Engineering, O.P. Gupta, Khanna Publishing House
3. Bulk Chemicals from Petrochemicals: B.K.B. Rao, Khanna Publishing House

References:

1. The Petroleum chemicals Industry: R. F. Goldstein and A. L. Waddams.
2. Advanced Petrochemicals: Dr. G. N. Sarkar, Khanna Publishers
3. Introduction to Petrochemicals, Sukumar Maity. Oxford and IBH Publishing Co.

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Chemical Engineering Lab - I

CHE-PC591

0L:0T: 4P

2 credits

Pre-requisites: Fluid Mechanics, Heat Transfer, Mass Transfer - I

Objectives:

Chemical Engineering lab provides students the first hand experience of verifying various theoretical concepts learnt in theory courses. It also serves as a bridge between theory and practice. This particular lab focuses on fluid dynamics, heat and mass transfer

Contents :

1. 4 – 5 experiments on fluid flow such as: flow through pipes and fittings, flow through coil, flow through fittings, packed and fluidized beds, orifice and venturimeter, non-Newtonian flow in pipes, characteristics of pumps, sedimentation and filtration (16 lab. Hours)
2. 4 – 5 experiments on heat transfer such as: double pipe, shell and tube exchangers, natural convection, fin efficiency, thermal conductivity and specific heat (16 lab. Hours)
3. 2 – 3 experiments on mass transfer such as: diffusivity in gases and liquids, absorption in packed column, (8 lab. Hours)
4. 2 – 3 experiments on Thermodynamics such as: Refrigeration cycle, vapor – liquid and liquid – liquid equilibria, partial molar properties (8 lab. Hours)

Total 48 lab. Hours

Lab. Outcomes

Students will be able to

- Learn how to experimentally verify various theoretical principles
- Visualize practical implementation of chemical engineering equipment
- Develop experimental skills

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HASS-III

Course code: CHE-HS506

3L:0T: 0P

3 credits

OBJECTIVE: This is one of the foundation courses in Humanities (in Foundation Area 1). It is envisaged that this course will provide a natural link between engineering and humanities with an emphasis that Development is not just materialistic, larger view of all round human development should also be considered. The importance of sustainable development, interdependence and co-existence with nature should be realised through this course. It is to gain an understanding of alternative models of development.

COURSE TOPICS:

Unit I: Social Development (5 hours)

1. Concepts behind the origin of Family, Clan and Society
2. Different Social Systems
3. Relation between Human being and Society
4. Comparative studies on different models of Social Structures and their evolution

Unit II: Political Development (4 hours)

1. Ideas of Political Systems as learnt from History
2. Different models of Governing system and their comparative study

Unit III: Economic Development (18 hours)

1. Birth of Capitalism, Socialism, Marxism
2. Concept of development in pre-British, British and post British period- Barter, Jajmani
3. Idea of development in current context.
4. E. F. Schumacher's idea of development, Buddhist economics. Gandhian idea of development. Swaraj and Decentralization.

READINGS TEXTBOOK:

- a) Introduction to the Sociology of Developing Societies by Hamza Alavi (Editor), Teodor Shanin (Editor)
- b) The Process of Development of Societies by K C Alexander

***REFERENCE BOOKS::**

- a) Social Change and Development: Modernization, Dependency and World-System Theories - Vol. 178 by Alvin Y. So
- b) Social Development and Societies in Transition by Stewart MacPherson, Hoi-Kwok Wong

ASSESSMENT (indicative only)

5.1 HA:: [5% GRADE]

5.2 QUIZZES-HA:: [5% GRADE]

5.3 PERIODICAL EXAMS:: [10% GRADE]

5.4 *PROJECT:: [10% GRADE]

(18 hours)

5.5 FINAL EXAM:: [70% GRADE]

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CHE-MC 501B

Essence of Indian Knowledge Tradition

Course Contents

Module No.	Description of Topic	Contact Hrs.
1	Indian Ethos- An Overview: Introduction, Indian Ethos, Requisites for Indian Ethos, Indian Ethos for Management, Work Ethos and values for Indian managers, Indian heritage in business, Impact of values on stakeholders, Value system in work culture, Trans-cultural human values, Importance of Karma to managers, Nishkama Karma and its impact on employees today, Teaching Ethics, Gurukul system of learning.	3
2	Understanding Ethics: Ethics- Meaning & Concept, Types of Ethics, Ethics in Work life, Some unethical issues in society, Ethical Theories: Moral Development Theories(Piagets Theory, Kohlberg's Theory, Gilligan's Theory); Basic Theories(Deontology, Utilitarianism, Virtue Theory, Rights Theory), Role of Scriptures in Understanding Ethics.	3
3	Business Ethics: Engineering as a profession, Engineering Ethics, Code of Ethics, Business Ethics – concept, meaning, importance, Factors influencing business ethics, Ethical principles in business, Conflict between business deal and professional ideal, Ethical issues and challenges in business, Ethical governance in business, Good corporate Governance.	3
4	Ethical Dilemma and Ethical Decision Making: Ethical Dilemma, Ethical dilemma in different business areas, Managing ethical dilemmas, Business Decision Making and difficulties, Moral Development and Moral Reasoning, Role of moral philosophies in decision making, Using Ethical Reasoning, Ethical Leadership.	3
5	Understanding Human Values: Human Values – Meaning and concept, value system, importance, classification, role of socialization in formation of values; Types of Values – <i>Societal values</i> : The modern search for a good society, justice, democracy, secularism, rule of law, values in Indian Constitution; <i>Moral and ethical values</i> : Nature of moral judgments; canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; <i>Psychological values</i> : Integrated personality; Maslow's Need Hierarchy theory, mental health, <i>Aesthetic values</i> : Perception and enjoyment of beauty, simplicity, clarity; Meaning of a good life, Value spectrum of a good life, Values Crisis in contemporary society – Individual crisis, Social crisis, Cultural crisis, Intellectual crisis	4