

| B.Tech VI Semester <b>CHEMICAL ENGINEERING</b> |                            |          |          |          |          |                   |                   |
|------------------------------------------------|----------------------------|----------|----------|----------|----------|-------------------|-------------------|
| COURSE CONTENTS (UEC SCHEME)                   |                            |          |          |          |          |                   |                   |
| <b>CM6301</b>                                  | <b>Transport Phenomena</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> | <b>Max. Marks</b> | <b>Min. Marks</b> |
| Duration                                       | 3 Hours                    | 3        | 0        | 0        | 3        | 70                | 22                |

### Course Objective:

This course will provide the fundamentals to solve real life problems involving transports of momentum, energy and mass in biological, mechanical and chemical systems using a unified approach.

### Unit- I

#### Transport Properties:

Continuum fluids, Newton's law of viscosity, Introduction to non-Newtonian fluids, pressure and temperature dependency of viscosity, Viscosity of gases at low density, Laminar flow, shell momentum balance, boundary conditions, selected applications.

### Unit- II

#### Momentum Transport:

Equations of change for isothermal systems – Navier-Stokes equation, use of equations of change to set up steady state flow problems with Newtonian fluids, Microscopic mass, momentum and energy balance for isothermal systems, Bernoulli's equation, compressible flow, pipe flow. Introduction to Macroscopic momentum balances.

### Unit- III

#### Energy Transport:

Shell energy balances, Fourier's Law of heat conduction, boundary conditions. Application to steady and unsteady problems, convective heat transfer, heat transfer coefficients for forced convection around submerged objects, for free convection for condensation of pure vapors on solid surface. Introduction to Macroscopic energy balances.

### Unit- IV

#### Mass Transport:

Fick's Law of diffusion, analogy with heat transfer, shell mass balances, boundary conditions, applications, species continuity equation, conductive mass transfer, mass transfer coefficients, applications, correlations. Introduction to Macroscopic Mass Balances.

### Course Outcomes:

- Ability to analyze industrial problems along with appropriate boundary conditions.
- Ability to develop steady and time dependent solutions along with their limitations.
- Students will be capable to develop Model Equation for prototype system to scale up

### Suggested Readings:

1. Bird, R. B., Stewart, W. E. and Lightfoot, E. N., "Transport Phenomena," John Wiley, 1960.
2. Thomson, W. J., "Introduction to Transport Phenomena," Pearson Education Asia, 2000.
3. Brodkey, R. S. and Hershey, H. C., "Transport Phenomena Unified Approach, McGrawHill, NY, 1988.

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|------------------------------------------------|---------------------------------------|----------|----------|----------|----------|-------------------|-------------------|
| COURSE CONTENTS                                |                                       |          |          |          |          |                   |                   |
| LM 6302                                        | <b>Heat Transfer Equipment Design</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> | <b>Max. Marks</b> | <b>Min. Marks</b> |
| Duration                                       | 3 Hours                               | 3        | 1        | 0        | 4        | 70                | 22                |

### Course Objective:

This course will provide the ability to solve industrial design problems using a unified approach.

#### Unit I

**Double pipe heat exchanger:** Design calculation of double-pipe heat exchanger: thermal and hydraulic design- inner pipe, annulus, Hairpin heat exchanger- base inner tube- finned inner multi tubes- parallel and series arrangement, pressure drop, constructional features.

#### Unit II

**Shell and tube heat exchanger:** Basic components- shell-tube bundles, baffles- type and geometry, arrangement for increased heat recovery, calculation and design procedure for preliminary estimation of size, pressure drop and heat transfer calculations- shell and tube sides- Kern methods - Bell - Delaware method. Design of heat exchanger by TEMA and ASME standard

#### Unit III

**Condenser:** shell and tube condensers- horizontal & vertical types- design and operational consideration of condensers for single vapors, heat transfer coefficient correlation for condensation inside and outside of tubes of the vertical and horizontal condenser, pressure drop in condensers, plate condensers, air cooled and direct contact types, condensers.

#### Unit IV

**Evaporators:** Introduction, types of evaporators, methods of feeding of evaporators, general design consideration of a new system having one or more units in series: single effect evaporator, multiple effect evaporator with boiling point elevation.

**Reboilers and vaporizers:** types, selection, boiling heat transfer fundamentals, estimation of boiling heat transfer coefficients, pool boiling, convective boiling. Design of forced circulation reboilers, thermosyphon reboilers, and kettle reboilers.

#### Unit V

Basic design step calculations and performance evaluation of dryers – spray, rotary, tunnel, tray, fluid bed and thin film.

### Course Outcomes:

- After the completion of the course, students will be able to:
- Understand process design of double pipe heat exchanger and finned heat exchanger.
- Design of shell and tube exchanger.
- Process design of various type of condenser.
- Process design of various type of evaporator, reboiler and vaporizers.
- Process design and performance evaluation of dryers.

### Suggested Readings:

B.Tech VI Semester **CHEMICAL ENGINEERING**

**COURSE CONTENTS**

|               |                                 |          |          |          |          |                   |                   |
|---------------|---------------------------------|----------|----------|----------|----------|-------------------|-------------------|
| <b>CM6303</b> | <b>Chemical Process Control</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> | <b>Max. Marks</b> | <b>Min. Marks</b> |
| Duration      | 3 Hours                         | 3        | 1        | 2        | 5        | 70                | 22                |

**Course Objectives:**

- To understand system dynamics, block diagrams of a physical process using first principles,
- To convert the model to a form amenable to solution and analysis,
- To develop ability in the students to design various control schemes to meet desired needs in various processes.

**Unit I**

**Control Elements:** Construction and characteristics of final control elements such as Proportional, Integral, PD, PID controllers, pneumatic control valve, principles and construction of pneumatic and electronic controllers.

**Unit II**

**First Order System:** Laplace Transform, Linear open loop system, First order system and their transient response, Dynamic response of a pure capacitive process, Transportation lag, Dynamic response of a first order lag system.

**Unit III**

**Second Order System:** Second order system and their transient response. Interacting and non-interacting system, Linear closed loop system, block diagram of closed loop transfer function, controllers, Transient response of closed loop system.

**Unit IV**

**Stability Concept:** Stability concept, stability criterion, relative stability, Routh-Hurwitz stability criterion, Root locus technique, Feedback controllers tuning

**Unit V**

**Frequency Response:** Introduction to frequency response, Bode diagram, Bode stability criterion, gain and phase margins, Ziegler Nichols controller setting, Nyquist's stability criterion.

**List of Experiments:**

1. To study the characteristics of control valves (linear, quick opening, etc)
2. To study the dynamics of liquid level systems of non-interacting and interacting types.
3. To study the response of mercury in glass thermometer with and without a thermowell.
4. To study the characteristics of an electronic PID controller.
5. To study the characteristics of a current to pneumatic converter.
6. To study the effectiveness of computer control of a distillation column.
7. To study the effectiveness of a computer control of a heat exchanger.
8. To study to effectiveness of a computer control of a chemical reactor

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|------------------------------------------------|---------------------------|----------|----------|----------|----------|-------------------|-------------------|
| COURSE CONTENTS                                |                           |          |          |          |          |                   |                   |
| <b>CE6304</b>                                  | <b>Mass Transfer - II</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> | <b>Max. Marks</b> | <b>Min. Marks</b> |
| Duration                                       | 3 Hours                   | 3        | 1        | 2        | 5        | 70                | 22                |

### Course Objectives:

To teach the students different separation techniques. At the end of the study students will come to know the design of a distillation column, as well as design of a adsorber and calculations involved in liquid liquid extraction and solid liquid extraction .

#### Unit I

**Adsorption:** Adsorption theories, types of adsorbent; activated carbon, silica and molecular sieves. Batch and column, adsorption; Break through curves, Liquid percolation and gas adsorption, BDST models for adsorption, calculation.

#### Unit II

**Humidification and Dehumidification:** Humidification: General Theory, psychometric chart, fundamental concepts in humidification & dehumidification, wet bulb temperature, adiabatic saturation temperature, measurement of humidification calculation of humidification operation, cooling towers and related equipments.

#### Unit III

**Drying:** Drying Theory Equilibrium mechanism, drying rate curve, Estimation of Drying time, drying rate curve, Classification of Driers, drying Characteristics Batch and continuous drying for tray driers, Drum dryers, spray and tunnel dryers. Through circulation driers design, Description and application of Drier Analysis of continuous driers.

#### Unit IV

**Leaching and Crystallization:** Leaching: solid liquid equilibrium, Equipment, principles of leaching, concurrent and counter current systems and calculation of number of stage required. Crystallization: Factors governing nucleation and crystal growth rates, controlled – growth of crystals, super saturation curve, principle and design of batch and continuous type equipment.

#### Unit V

**Liquid –Liquid Extraction:** Liquid equilibrium & Ponchon – Savarit method, Mc-Cabe- Thiele method, packed & spray column, conjugate curve and tie line data, plait point, ternary liquid – liquid extraction, operation and design of extraction towers analytical & graphical solution of single and multistage operation in extraction, Co-current, counter current and parallel current system.

### List of Experiment

1. To determine to diffusion coefficient of liquid vapour in air by Stefan's tube.
2. To study the rate dissolution of a rotating cylinder and then to calculate the mass transfer coefficient.
3. To investigate the mass transfer characteristic of a wetted surface column unit.

4. To investigate the characteristics of cooling tower.
5. To study the drying characteristics of a wet granular material using natural and forced circulation in tray dryer.
6. To prepare the drying rate curve for fluidized bed dryer.
7. To study the characteristics of spray dryer.
8. To study the characteristics of drum and Tunnel dryer.
9. Studies on solid-liquid extraction column.
10. To find out the crystal yields with and without seeds.
11. To draw the tie lines and plot equilibrium curve for given ternary system.
12. Liquid- Liquid extraction in a packed column for co-current and counter current flow of binary systems.

**Note: Each student should perform at least eight experiments from the above list.**

#### **Course Outcomes:**

- Design calculation of distillation column.
- Separation by adsorption and design of adsorber, chromatographic separation.
- Separation by liquid Liquid Extraction.
- Separation by leaching.

#### **Suggested Readings:**

1. Mc-Cabe, W.L. Smith J.M. – UNIT OPERATION IN CHEMICAL ENGG. – 5th edition Tata McGraw Hill – Hogakusha, Tokyo, New Delhi.
2. Coulson J.M. Richardson J.F. - CHEMICAL ENGG. – Vol – 2 Edition-2, Butserworth Heinmann, Oxford, New Delhi.
3. Treybal R.E. – MASS TRANSFER OPERATION – 3rd edition, Mc. Graw Hill Book Co. New York.

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|------------------------------------------------|---------------------------------------|----------|----------|----------|----------|-------------------|-------------------|
| COURSE CONTENTS                                |                                       |          |          |          |          |                   |                   |
| LE6351                                         | <b>Industrial Pollution Abatement</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> | <b>Max. Marks</b> | <b>Min. Marks</b> |
| Duration                                       | 3 Hours                               | 3        | 1        | 2        | 5        | 70                | 22                |

**Course Objectives:** Learning the nature and characteristics of various industrial pollutants (water, air and solid waste) so that these can be minimized and / or appropriate technology could be utilized for treatment of pollutants before discarding these into environment.

#### Unit- I

##### Introduction:

Characteristics and classification of water, air, solid waste pollutants in the environment. Types and classification of Industrial pollutants. Effects of pollutants on living and non- living things. Environmental regulatory legislations and standards. Importance of industrial pollution abatement. Green house gases, Global warming and Climate change .

#### Unit - II

##### Water Pollution and Wastewater Treatment:

Identification, quantification and analysis of wastewater. Classification of different treatment methods into physico-chemical and biochemical techniques. Design of Settling Tank, Neutralization and Flocculation, Disinfection, Biological methods, concept of aerobic digestion, anaerobic digestion, design of activated sludge process. Different unit operations and unit processes involved in conversion of polluted water to potable standards.

#### Unit -III

##### Air Pollution and Control Strategies:

Sources and classification of air pollutants, nature and characteristics of gaseous and particulate pollutants, analysis of different air pollutants. Air pollution meteorology, plume and its behaviour, atmospheric dispersion of air pollutants. Operating principles and simple design calculations of particulate control devices, concepts of control of gaseous emissions by absorption, adsorption, chemical transformation and combustion.

#### Unit- IV

##### Solid Waste Management:

Analysis and quantification of hazardous and non-hazardous wastes. Methods of solid waste collection, transportation, treatment and disposal, land filling, composting, incineration, leachate treatment, land fill site reclamation.

#### Unit- V

##### Environmental Management System (EMS):

Environmental impact assessment (EIA), its concept and constituents, Environmental audit, ISO - 14000 system, EMS benefits, EMS resources. Concepts of zero waste and green technology. Sustainable development. Real life case study of Environmental Management System.

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