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|-----------------------|------------------------|
| <b>COURSE TITLE</b>   | <b>MASS TRANSFER-I</b> |
| <b>COURSE CODE</b>    | <b>01CH1406</b>        |
| <b>COURSE CREDITS</b> | <b>4</b>               |

**Objective:**

- 1 The objective of this course is to impart knowledge about basic principles of mass transfer and its application in solving engineering problems involving different mass transfer operations.

**Course Outcomes:** After completion of this course, student will be able to:

- 1 Understand basic principles of mass transfer in various operations
- 2 Apply the concept of mass transfer theories to the concept of species movement between two phases due to diffusion
- 3 Evaluate diffusivity of gases by using empirical equation
- 4 Analyze the basic parameter to improve the working of crystallizer and dryer.

**Pre-requisite of course:**None

**Teaching and Examination Scheme**

| <b>Theory Hours</b> | <b>Tutorial Hours</b> | <b>Practical Hours</b> | <b>ESE</b> | <b>IA</b> | <b>CSE</b> | <b>Viva</b> | <b>Term Work</b> |
|---------------------|-----------------------|------------------------|------------|-----------|------------|-------------|------------------|
| 3                   | 0                     | 2                      | 50         | 30        | 20         | 25          | 25               |

| <b>Contents : Unit</b> | <b>Topics</b>   | <b>Contact Hours</b> |
|------------------------|---|----------------------|
| 1                      | <b>Diffusion</b><br>Introduction to Mass transfer operation, Concentration, Mass & Molar Average, Velocity,, Mass & Molar Flux, N & J flux, Fick's law of diffusion, Steady state molecular diffusion in fluids under stagnant and laminar flow conditions, steady state diffusion: of A through non-diffusing B, equimolar counter diffusion, Effect of Temperature and Pressure on diffusivity, Diffusion coefficient measurement and prediction. | 8                    |
| 2                      | <b>Interphase Mass Transfer</b><br>Concept of Equilibrium, Diffusion between two phases, Modes of Convective Mass transfers, Introduction to Mass transfer coefficients, Gas Phase & Liquid Phase Mass Transfer coefficients, Local & Overall Mass Transfer coefficients, Dimensionless Numbers in Mass transfer, Simultaneous Heat & Mass Transfer,, Steady state co-current & counter-current processes. Theories of Mass Transfer                | 10                   |

| Contents :<br>Unit | Topics   | Contact<br>Hours |
|--------------------|--|------------------|
| 3                  | <b>Crystallization and Humidification</b><br>Principles of Crystallization, Super saturation, Nucleation,, Crystal growth, Material & Energy Balance applied to Crystallizers, Types of Crystallizers used in practice., Principles of Humidification, Wet Bulb Temperature & Adiabatic Saturation Temperatures, Air/Water System psychrometric, Dehumidification, Cooling Towers, Types of cooling tower, Design calculations of cooling tower  | 10               |
| 4                  | <b>Drying</b><br>Importance of drying in processes, principles of drying, equilibrium and free moisture, bound and unbound water, constant drying conditions, constant-rate period, critical moisture content and falling-rate period, calculation of drying under constant drying conditions, Classification of dryers, solids handling in dryers, , equipments for batch and continuous drying processes: working principle of tray driers, tower driers, rotary driers, spray driers. | 10               |
| <b>Total Hours</b> |  | <b>38</b>        |

#### Suggested List of Experiments:

| Contents :<br>Unit | Topics  | Contact<br>Hours |
|--------------------|---|------------------|
| 1                  | <b>Experiments</b><br>To determine the rate of diffusion and diffusivity coefficient of vapors of organic liquid in atmosphere., To determine mass transfer coefficient of liquid (water) evaporation to atmospheric air at elevated temperature., To determine the rate of drying of wet sand and saw dust in the natural draft tray dryer., To determine the rate of drying of filter cake in the natural draft tray dryer., To determine the yield and percentage recovery of MgSO <sub>4</sub> .7H <sub>2</sub> O crystal in the batch crystallizer. , To determine the wet bulb and dry bulb temperature., To study the cooling tower characteristics of water at different air flow rate. | 14               |
| <b>Total Hours</b> |   | <b>14</b>        |

#### Textbook :

- 1 Mass transfer operation, R. E. Treybal, Mc-Graw Hill international, 1980
- 2 Principles of Mass transfer & Separation Processes, Binary K. Dutta, PHI Publication, 2007

#### References:

- 1 Unit Operations in Chemical Engineering, Unit Operations in Chemical Engineering, Warren L. McCabe Smith, McGraw Hill , 2005
- 2 Chemical Engineering” Vol. 1 & 2 – Fluid flow, Heat Transfer and Mass Transfer, Chemical Engineering” Vol. 1 & 2 – Fluid flow, Heat Transfer and Mass Transfer, Coulson & Richardson’s, Butterworth -Heinemann Publication, 1999

#### Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

| Distribution of Theory for course delivery |                   |              |                |                 |   |
|--|-------------------|--------------|----------------|-----------------|---|
| <b>Remember / Knowledge</b>                | <b>Understand</b> | <b>Apply</b> | <b>Analyze</b> | <b>Evaluate</b> | <b>Higher order Thinking / Creative</b> |
| 20.00                                      | 30.00             | 25.00        | 15.00          | 10.00           | 0.00                                    |

**Instructional Method:**

- 1 The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.
- 2 The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room
- 3 Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory
- 4 Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory

**Supplementary Resources:**

- 1 <https://nptel.ac.in/courses/103103145>
- 2 <https://nptel.ac.in/courses/103103035>