Course code	Course Name	L-T-P - Credits	Year of Introduction
FS202	TRANSFER OPERATIONS IN CHEMICAL ENGINEERING	3-1-0-4	2016

Course Objectives

- To familiarize the concept of heat conduction ,convection and radiation
- To describe the application of different types of heat exchangers used in industries.
- To illustrate with examples the different types of evaporators used in chemical industries.
- To understand the principle of mass transfer, theories and application.
- To describe absorbers with the help of relevant examples.
- To compute number of stages in a distillation column with the help of McCabe Thiele method.
- To describe drying and extraction principles with their application.

Syllabus

Heat transfer -conduction, convection , radiation - Heat exchangers- evaporators. Mass transfer - Fick's law of molecular diffusion- theories of mass transfer - Absorption – Distillation- Drying, liquid –liquid extraction, solid-liquid extraction

Expected outcome.

The students will be able to

i. Understand the modes of heat transfer
ii. Analyse heat exchanger performance
iii. Understand gas- liquid ,liquid- liquid, gas-solid and solid –liquid operations

Text Books:

1. Binay K. Dutta, Heat Transfer Principles and Applications, PHI, New Delhi
2. Binay K. Dutta, MassTransfer and Separation Processes, PHI, New Delhi

References:

1. W.L. McCabe, J.C. Smith and P. Harriott - Unit Operations of Chemical Engineering, 7th Edition, McGraw Hill, 2005.
2. J.P. Holman - Heat Transfer, 8th Edition, McGraw Hill, NewYork, 1997.
3. Incropera, DeWitt, Bergmann, Lavine - Fundamentals of Heat and Mass Transfer, 6th Edition, Wiley Publications, 2010.
4. Necati Ozisik, Heat Transfer: A Basic Approach, Vol 1, McGraw Hill, 1985.
5. Donald Q. Kern, Process Heat Transfer, Tata McGraw Hill Education Pvt. Ltd., 2001.
6. Robert W. Serth, Process Heat Transfer: Principles and Applications, Academic Press, 2007.
7. K. V. Narayanan & B. Lakshmikutty, Mass Transfer Theory and Applications, CBS, New Delhi
8. R.E. Treybal, Mass Transfer Operations, McGraw Hill
9. Badger & Banchero, Introduction to Chemical Engineering, TMH
10. Geankoplis C.J., Transport processes and Separation Process Principles, 4th Ed., Prentice-Hall India, 2003
11.

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	**Heat Transfer by Conduction** Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer -Concept of heat conduction in solids - Fourier's law of heat conduction - Steady state heat conduction- Concept of heat transfer coefficient, Individual and overall heat transfer coefficient	6	10%
II	**Heat Transfer by Convection and Radiation** Convection: Concept of heat transfer by convection concept of boundary layers- Natural and forced convection - Heat transfer from condensing vapours, Heat transfer to boiling liquids Radiation: Concept of thermal radiation -Black body concept – Laws of radiation -concept of grey body, radiation between surfaces	8	15%
FIRST INTERNAL EXAMINATION			
III	**Evaporators and Heat Exchangers** Heat Exchangers: Parallel and counterflow heat exchangers Single pass and multipass heat exchangers;plate heat exchangers; - Log mean temperature difference - heat exchangers effectiveness; number of transfer unit Evaporators: Types of evaporation -single effect and multiple effect evaporator, natural and forced circulation evaporator	10	15%
IV	**Principles of Mass Transfer & Absorption** Principles of mass transfer-Fick's law of molecular diffusion ,diffusion in solids and liquids. Concept of mass transfer coefficients, theories of mass transfer and their applications, interphase mass transfer and overall mass transfer coefficients in binary systems Absorption: Types of absorbers- plate column packed column- Operating characteristics of stage wise and differential contactors.	10	15%
SECOND INTERNAL EXAMINATION			
V	**Distillation** Relative volatility-simple distillation, steam distillation, distillation with reflux, principle of azeotropic and extractive distillation. McCabe Thiele method of calculation of number of theoretical stages, total, minimum and optimum reflux	8	20%
VI	**Drying and Extraction** Drying: Equilibrium moisture and free moisture, critical moisture content, bound and unbound water, rate of drying curves, drying equipments-tray dryers, tower dryers, rotary dryers, fluid-bed dryers, spray dryers Extraction & Leaching: Liquid extraction liquid-liquid equilibrium, equipment for liquid extraction - mixer settlers, spray towers, **Solid- liquid extraction**- simple leaching, Bollmann extractor.	10	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Duration: 3 Hours

Part – A: 5 MARK QUESTIONS

There will be two questions from module 2 and module 3 and one question each from remaining modules (5x8 = 40)

PART B: 10 MARK QUESTIONS

5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions

(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS

4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions

(2 x15 = 30 marks)