Course code	Course Name	L-T-P-Credits	Year of Introduction
CH306	MASS TRANSFER OPERATIONS II	3-0-0-3	2016

Prerequisite: CH303 Mass transfer operations - I

Course Objectives

- To impart the fundamental concepts of mass transfer operations such as distillation, liquid extraction, leaching and membrane separation processes.
- To develop understanding about design and analysis of distillation, extraction, leaching and membrane operation units.

Syllabus

Distillation – vapour-liquid equilibrium- enthalpy-composition diagrams -Distillation methods-flash distillation - differential distillation - steam distillation – fractionation-principles of rectification – material and energy balance - Design of fractionation columns - McCabe-Thiele method – number of plates- total reflux -minimum reflux - optimum reflux-cold reflux - open steam. Ponchon-Savarit method - feed plate location - minimum reflux conditions. Rectification in packed columns - azeotropic and extractive distillation. Liquid extraction - applications - distribution curve - single-stage and multistage operations – continuous contact extraction-Extraction equipments. Leaching- leaching equilibrium - working principles of leaching equipment. Constant underflow - variable underflow- single stage and multistage leaching - Membrane separation processes – classification of membranes - concentration polarization – ultrafiltration. Reverse osmosis – pervaporation – dialysis.

Expected Outcome

The students will be able to

i. Analyse chemical engineering operations involving mass transfer
ii. Design differential and stage wise separation processes

References:

1. Coulson J.M. & Richardson J.F., Chemical Engineering, Vol. II, ELBS, Pergamon
2. Foust A.S. et al, Principles of Unit Operations, John Wiley.
3. Geankoplis C.J., Transport Processes and Unit Operations, Prentice Hall India
4. K.V.Narayanan and B.Lakshmikutty.,Mass Transfer,Theory and Applications,CBS Publishers.
5. McCabe W.L., Smith J.C. & Harriott P., Unit Operations in Chemical Engineering, McGraw Hill.
6. Seader J.D.& Henley E.J Separation Process Principles Wiley India
7. Treybal R.E., Mass Transfer Operations, McGraw Hill.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Distillation- boiling-point diagram and equilibrium curves - application of Raoult's law -relative volatility - enthalpy composition diagrams-Distillation methods- flash distillation - differential distillation - steam distillation - fractionation- plate columns for distillation - condensers – reboilers.	7	15%

II	Principles of rectification - material and energy balance -Design of fractionation columns by McCabe-Thiele method - basic assumptions - feed quality and feed line - number of plates -feed plate location –- total reflux -minimum reflux -optimum reflux- plate efficiency -cold reflux – open steam.	7	15%
FIRST INTERNAL EXAMINATION			
III	Ponchon-Savarit method– difference points and reflux ratio- number of plates- feed plate location- minimum reflux conditions Rectification in packed columns - height of packed towers - azeotropic and extractive distillation (qualitative treatment only).	7	15%
IV	Extraction - applications - ternary equilibria on triangular coordinate system - mixer rule -distribution curve - selectivity - choice of solvent - Single-stage and multistage extraction operations. calculations for immiscible systems and partially miscible systems.	7	15%
SECOND INTERNAL EXAMINATION			
V	Construction and working of mixer - settler cascades, sieve-tray columns, agitated towers, pulse columns and centrifugal extractors. Continuous contact extraction - design for insoluble liquids - simplification for dilute solutions. Leaching - factors affecting rate of leaching. Working principles of leaching equipment - Shank's system- thickeners, classifiers and moving bed leaching equipment.	7	20%
VI	Leaching equilibrium -constant underflow - variable underflow Single stage and multistage leaching. Membrane separation processes – classification – types of membranes: flat, spiral wound, hollow fibre - concentration polarization – ultrafiltration. reverse osmosis- – pervaporation -– dialysis effects of operating variables.	7	20%
END SEMESTEREXAMINATION			

Question Paper Pattern:

Maximum Marks: 100 Exam Duration: 3 Hours

Part A: There shall be **Three questions** uniformly covering Modules 1 and 2, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in each main question with a total of 15 marks for all the subdivisions put together. (2 x15= 30 Marks)

Part B: There shall be **Three questions** uniformly covering Modules 3 and 4, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in each main question with a total of 15 marks for all the subdivisions put together. (2 x15= 30 Marks)

Part C: There shall be **Three questions** uniformly covering Module 5 and 6, each carrying 20 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in each main question with a total of 20 marks for all the subdivisions put together. (2 x20= 40 Marks)