Course code	Course Name	L-T-P-Credits	Year of introduction
CH303	MASS TRANSFER OPERATIONS -I	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To impart the basic concepts of mass transport
- To develop understanding about gas absorption, humidification, crystallization, adsorption and drying.

Syllabus

Molecular diffusion- Theories of mass transfer – interphase mass transfer -Gas-Liquid contacting equipments for mass transfer operations- Gas absorption- Adsorption- Humidification and dehumidification- Drying-dryers- Crystallization-crystalizers

Expected Outcome

The students will be able to

i. Explain the fundamentals of mass transfer operations
ii. Design cooling tower, dryer, crystallizer and absorption systems
iii. Summarize the quantitative requirements of materials for the above unit operations.

References:

1. Coulson J.M. & Richardson J.F., Chemical Engineering, Vol. I & II, ELBS, Pergamon Press
2. Foust A.S. et. al., Principles of Unit Operations, John Wiley
3. K. V. Narayanan and B. Lakshmikutty, Mass Transfer Theories and Applications, CBS Publishers
4. McCabe W.L., Smith J.C. & Harriott P., Unit Operations in Chemical Engineering, McGraw Hill
5. Rousseau R.W., Handbook of Separation Process Technology, John Wiley
6. Seader J.D.& Henley E.J Separation Process Principles, John Wiley & Sons
7. Treybal R.E., Mass Transfer Operations, McGraw Hill
8. Welty J.R., Wilson R.E. & Wicks C.E., Fundamentals of Momentum Heat and Mass Transfer, John Wiley

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Molecular diffusion - mass fluxes J_A and N_A - Fick's law - diffusivity and estimation - steady state diffusion of A through stagnant B and equimolar counter diffusion in binary gases, liquids and multi component gas mixtures. Mass transfer coefficients, dimensionless groups and dimensional analysis - analogy between mass, heat and momentum transfer. Elementary treatment of theories of mass transfer: penetration and surface renewal theories - interphase mass transfer - equilibrium - diffusion between phases - two-film theory - local and overall k-type coefficients.	8	20%

II	Gas-Liquid contacting equipments for mass transfer operations - single stage and multistage contact , tray towers, wetted wall columns, tray types and general features of tray designs (qualitative treatment), continuous contact equipment, venturi scrubbers, packed columns, packing materials and characteristics, general constructional details of packed columns, Factors affecting column performance-flooding, priming, coning, weeping, loading etc, comparison between plate and packed columns.	8	20%
FIRST INTERNAL EXAMINATION			
III	Gas absorption - Solubility of gases in liquid, choice of solvent, Material balance in counter current and concurrent absorption and stripping, L/G ratio, multistage operation, number of plates by graphical construction, Kremser equation, tray efficiency, design of packed columns, transfer unit and general graphical method, dilute solutions and simplified design methods	8	15%
IV	Adsorption, types of adsorption, properties of adsorbents, adsorption isotherm for single gases, vapours and dilute liquid solutions, Adsorption isotherms (equations and derivations only), Adsorption equipments, adsorption wave, rate of adsorption and breakthrough curve. Humidification and dehumidification, Use of humidity chart to find properties of air, Lewis relation, water cooling with air, types of cooling towers, spray chambers for air humidification, principles of gas dehumidification.	8	15%
SECOND INTERNAL EXAMINATION			
V	Drying, equilibrium moisture content, batch drying, rate of drying, cross-circulation drying, mechanism of moisture movement, continuous drying, parallel and counter current, material and enthalpy balances, rough estimate of size of rotary dryer based on heat-transfer units for drying at high temperature, industrial dryers for batch and continuous drying.	**5**	15%
VI	Crystallization, principles of crystallization, purity, yield, energy requirements, super saturation, nucleation, rate of nucleation, growth of crystals, growth coefficients, crystallisation equipment, MSMPR crystallizer.	**5**	15%
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 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)

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 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)