Course Type	Course Code	Name of Course	L	T	P	Credit
DC	NCHC508	Advanced Mass Transfer	3	1	0	4

Course Objective
• To extend the fundamental concepts of mass transfer in cases of multi-component systems (with and without chemical reactions) and the application of those concepts in solving real engineering problems.
Learning Outcomes
• Students shall have adequate knowledge in tackling engineering problems with complex mass transfer operations.

Unit No.	Description of Lectures	Class Hours	Learning Outcomes
1.	**Review:** VLE and VLLE of binary system, Introduction to Multi-phase equilibrium, ternary diagram, residual curve, ideal solution of multi-components	3 L + 1 T	Student will learn the basics of vapor-liquid equilibrium.
2.	**Thermodynamic correlation:** Multi-phase equilibrium, K-value and activity coefficient	3 L + 1 T	Student will learn the basic of thermodynamic relations.
3.	**Multi-component diffusion and convection:** Multi-component diffusion, convective mass transfer, correlations for mass transfer coefficients, review of the models for mass transfer at fluid–fluid interface.	6 L + 2 T	Student will learn fundamental concepts of diffusion and convection especially for multi-component system.
4.	**MESH equations:** Formulation of Material and Energy balance equation (MESH) for single stage operation, batch distillation, flash vaporization, degrees of freedom (DOF)	6 L + 2 T	Student will learn mathematical concept of single stage mass transfer operation.
5.	**Short-cut methods:** Short-cut methods for designing multi-component multi-stage fractionation: Kremser equation, Fenske–Underwood–Gilliland, Wang–Henke, Naphtali–Sandholm, Thiele–Geddes	3 L + 1 T	Student will learn the different easy mathematical method for designing of distillation unit.
6.	**Rigorous methods:** Rigorous method of multi-component multi-stage fractionation: MESH Equations for multi-stage fractionation, DOF, Solution technique	6 L + 2 T	Student will learn the rigorous method for designing of distillation unit.
7.	**Multicomponent distillation:** Multi-component distillation and cascading of columns, divided-wall distillation columns	6 L + 2 T	Student will learn operation techniques of distillation unit for multi-component system.

8.	**Reactive mass transfer:** Introduction to reactive distillation (RD) process, advantages and disadvantages of RD, design of RD columns. Mass transfer: Gas liquid reactions: solutions for slow, fast and instantaneous reactions with adsorption for single and two gases.	6 L + 2 T	Student will learn the reactive distillation process.
9.	**Supercritical Fluid Extraction:** Supercritical fluid extraction	3 L + 1 T	Student will learn the supercritical fluid extract phenomena.
	Total	**56**	

Textbooks:

1. Treybal, R.E. (1981). Mass Transfer operations, 3rd Ed. McGraw Hill Publication.

2. Seader, J. D., Henley, E. J., & Roper, D. K. (1998). Separation Process Principles. John Wiley & Sons.

Reference Books:

1. Taylor, R., & Krishna, R. (1993). Multicomponent mass transfer. John Wiley & Sons.
2. Doraiswamy, L.K. & Sharma, M.M (1984) Heterogeneous reaction: analysis, examples and reactor design vol2 , Fluid-fluid Solid reaction, Wiley.
3. Kulprathipanja, S. (2002). Reactive separation processes. Taylor & Francis: New York.