LOK JAGRUTI UNIVERSITY (LJU)

INSTITUTE OF ENGINEERING AND TECHNOLOGY

Department of Chemical Engineering

Bachelor of Engineering (B.E.) - Semester - V

Course Code:	**017083503**
Course Name:	**Mass Transfer II**
Category of Course:	Professional Core Course (PCC)
Prerequisite Course:	Thermodynamics II and Mass Transfer I

Teaching Scheme				
Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Credit**	**Total Hours**
4	**0**	**2**	**5**	**40**

Syllabus

Unit No.	Topic	Prerequisite Topic	Successive Topic	Teaching Hours
01	**Introduction of Distillation**			**4 (10%)**
	1.1 Definition of Distillation			
	1.2 Flash Distillation			
	1.3 Steam Distillation			
	1.4 Simple Distillation	Tray Tower Internals (017083402- Unit 6.4)		
	1.5 Batch and Continuous Rectification			
	1.6 Azeotropic Distillation			
	1.7 Extractive Distillation			
02	**Vapor-Liquid Equilibria in Distillation**			**4 (10%)**
	2.1 Concept of Vapor-Liquid Equilibria	Concept of Equilibria (017083402- Unit 4.1) Criteria of Equilibrium, Introduction (017083301- Unit 2.1)		
	2.2 P-X-Y & T-X-Y Diagrams	Phase Diagram for Single Component (017083301- Unit 4.1)		
	2.3 Concept of Relative Volatility			
	2.4 Effect of P and T on Equilibrium Data			
03	**Concept Of Distillation for Ideal Solutions**			**4 (10%)**
	3.1 Ideal Solutions	Ideal and Non-Ideal Solution (017083402- Unit 5.2)		
	3.2 Raoult's Law as Applied to Distillation Operations			
	3.3 Deviation from Ideality	Deviations from Raoult’s Law (017083301- Unit 3.1)		
	3.4 Minimum and Maximum Boiling Azeotropic Mixtures	Minimum Boiling Azeotrope (017083301- Unit 3.4)		
	3.5 Enthalpy-Concentration Diagrams			
04	**Design of Distillation Columns**			**4 (10%)**
	4.1 Determination of Number of Stages by McCabe-Thiele Method			
	4.2 Determination of Number of Stages by Ponchon and Severit Method			
	4.3 Reboilers and Condensers			
05	**Concept of Reflux Ratio in Distillation Columns**			**5 (12%)**
	5.1 Definition of Reflux Ratio			
	5.2 Minimum Reflux Ratio			
	5.3 Total Reflux Ratio			
	5.4 Optimum Reflux Ratio			
	5.5 Concept of Multicomponent Distillation			
06	**Humidification Operations**			**6 (14%)**
	6.1 Humidification			
	6.2 Dehumidification			
	6.3 VLE and Enthalpy for Pure Substances			
	6.4 Saturated and Unsaturated Vapor-Gas Mixtures			
	6.5 Terminologies such as Dry Bulb Temperature, Dew Point, Wet Bulb Temperature			
	6.6 Percentage and Relative Saturation			
	6.7 Adiabatic Saturation Temperature, Humid Heat, Humid Volume			
	6.8 Psychometric Chart and Psychometric Relation for Air-Water System			
	6.9 Adiabatic Saturation Curves			
	6.10 Wet Bulb Temperature Theory, Lewis Relation, Adiabatic Operation			

	6.11 Cooling Towers			
07	**Drying**			**4 (10%)**
	7.1 Equilibrium Relationship And Hysteresis			
	7.2 Various Types of Moisture in Drying			
	7.3 Batch and Continuous Drying			
	7.4 Rate and Time of Drying			
	7.5 Concept of Nt_{og} and Ht_{og}			
	7.6 Type of Dryers			
	7.7 Drying at Low Temperature			
08	**Adsorption**			**5 (12%)**
	8.1 Definition and Industrial Application			
	8.2 Types of Adsorptions			
	8.3 Nature of Commonly Used Adsorbents			
	8.4 Adsorption Equilibria			
	8.5 Single Stage and Multistage Adsorption			
	8.6 Single Gases and Vapors			
	8.7 Adsorption Hysterises			
	8.8 Single Stage and Multistage Equipments			
	8.9 Effect of Temperature on Adsorption			
	8.10 Heat of Adsorption			
	8.11 Material Balance and Freundlich's Equation in Adsorption			
	8.12 Equipments for Adsorption			
09	**Ion Exchange**			**2 (6%)**
	9.1 Ion-Exchange Principles			
	9.2 Applications of Ion Exchange			
	9.3 Equilibrium in Ion Exchange			
	9.4 Rate of Ion Exchange			
10	**Applications of Mass Transfer Operations**			**2 (6%)**
	10.1 Applications of Distillation			
	10.2 Applications of Humidification			
	10.3 Applications of Adsorption and Ion Exchange			
	10.4 Applications of Drying			

Sr No.	Practical Title	Link to Theory Syllabus
1	To Measure the Vapor Pressure of Acetone and Calculate Latent Heat of Vaporization	Unit 1
2	To Verify Henry's Law for Steam Distillation.	Unit 1,2
3	To Verify the Equilibrium Relationship for N-Butanol Water System	Unit 2,3
4	To Study the Distillation at Different Reflux Ratio in Distillation Column	Unit 5
5	To Determine Pressure, Drop Data and Values of KG for Various Air and Liquid Velocities in a Counter Current Cooling Tower	Unit 6
6	To Study the Humidification Operation and Calculate all Psychometric Parameters for Air – Water System.	Unit 6
7	To Study the Mechanism of Drying	Unit 6,7
8	To Study the Characteristics of Adsorption for Silica Gel	Unit 8
9	To Study and Verify the Freundlich's Adsorption Isotherm for Adsorbing Oxalic Acid and Charcoal	Unit 8,9

Major Components/ Equipment	
Sr. No.	**Component/Equipment**
1	Simple Distillation unit
2	Packed Bed Distillation column
3	Falling-film column (or wetted-wall column)
4	Dryer
5	Adsorptive Materials
6	Three neck flasks
7	Magnetic Stirrer with heating plate
8	Heating bath Oil and Water
9	Weight Balance machine

Proposed Theory + Practical Evaluation Scheme by Academicians (% Weightage Category Wise and it's Marks Distribution)					
L:	**4**	**T:**	**0**	**P:**	**2**
Note: In Theory Group, Total 4 Test (T1+T2+T3+T4) will be conducted for each subject. Each Test will be of 25 Marks. Each Test Syllabus Weightage: Range should be 20% - 30%					
Group (Theory or Practical)	**Group (Theory or Practical) Credit**	**Total Subject Credit**	**Category**	**% Weightage**	**Marks Weightage**
Theory	**4**	**5**	MCQ	42%	50
Theory			Theory Descriptive	17%	20
Theory			Formulas and Derivation	5%	6
Theory			Numerical	20%	24
Expected Theory %	**83%**		**Calculated Theory %**	**83%**	**100**
Practical	**1**		Individual Project	0%	0
Practical			Group Project	10%	60
Practical			Internal Practical Evaluation (IPE)	0%	0
Practical			Viva	7%	40
Practical			Seminar	0%	0
Expected Practical %	**17%**		**Calculated Practical %**	**17%**	**100**
Overall %	**100%**			**100%**	**200**

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Course Outcome	
	Upon completion of the course students will be able to
1	Understand the concept of distillation for ideal solutions, including ideal behavior assumptions and deviations from ideal behavior, and apply this knowledge to design and troubleshoot distillation processes effectively.
2	Understand the concept of reflux ratio and its importance in distillation column operation, so that they may optimise reflux ratios to achieve desired separation efficiency and product purity.
3	Learn about humidification and drying processes, including moisture transport concepts, psychrometric analysis, and industrial and environmental equipment.
4	Learn about the fundamentals of mass transfer, equilibrium behaviour, and factors that influence adsorption and ion exchange capabilities.
Suggested Reference Books	
1	Mass transfer operation by R.E. Treybal, McGraw-Hill international, 3rd edition
2	Mass Transfer by Sherwood, Pigford and Wilke, McGraw-Hill international
3	Chemical Engineering, Volume-2, by Coulson and Richardson, 4thedition
4	Unit Operations of Chemical Engg. By W.L. McCabe, J.C. Smith and Harriott, McGraw-Hill international, 6th edition
5	MASS TRANSFER: Theory and Practice, N. Anantharaman and K.M. Meera Sheriffa Begum by PHI Learning Private Limited
6	UNIT OPERATIONS – II BY K. A. GAVHANE, NIRALI PRAKASHAN
7	PRINCIPLES OF MASS TRANSFER OPERATIONS – I, BY KIRAN D PATIL Volume I, NIRALI PRAKASHAN
8	PRINCIPLES OF MASS TRANSFER OPERATIONS BY B K DUTTA PHI PUBLICATION
9	MASS TRANSFER II BY K A GAVHANE, NIRALI PRAKASHAN
List of Open-Source Software/Learning Website	
1	https://nptel.ac.in/courses/103/103/103103154/
2	https://nptel.ac.in/courses/103/103/103103145/
3	https://nptel.ac.in/courses/103/103/103103035/

Hands On Project		
Sr. No.	**Hands On Project**	**Linked with Unit**
1	Derivation of equation for flash distillation and simple distillation	Unit 1
2	Study of Raoult's law for ideal solution and comparison with non-ideal solution	Unit 3
3	Comparison of minimum boiling and maximum boiling azeotrope system with example	Unit 3
4	Comparison between McCabe Thiele and Ponchon Savarit method for determining number of theoretical stages	Unit 3
5	Cost analysis in terms of reboiler and condenser duty for different reflux ratios	Unit 4
6	With reference of a cooler explain evaporative cooling	Unit 6
7	Prove that characteristics of material affects the rate of drying by carrying out simple experiment	Unit 7
8	Experimentally show that increase in surface area reduces the time required for drying	Unit 7
9	Study various adsorbents available in the market	Unit 8
10	Compare different isotherms available for adsorption	Unit 8