(6)

Reg.No.: | | | | | | | | | | | | |

VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN
[AUTONOMOUS INSTITUTION AFFILIATED TO ANNA UNIVERSITY, CHENNAI]
Elayampalayam – 637 205, Tiruchengode, Namakkal Dt., Tamil Nadu.

Question Paper Code: 90009

B.E. / B.Tech. DEGREE END-SEMESTER EXAMINATIONS – NOV. / DEC. 2025
Fifth Semester
Biotechnology
U23BT516 – HEAT AND MASS TRANSFER OPERATIONS
(Regulation 2023)

Time: Three Hours | Maximum: 100 Marks

Answer ALL the questions

Knowledge Levels (KL)	K1 – Remembering	K3 – Applying	K5 - Evaluating
	K2 – Understanding	K4 – Analyzing	K6 - Creating

PART – A

(10 x 2 = 20 Marks)

Q.No.	Questions	Marks	KL	CO
1.	Compare and contrast thermal conductivity and thermal diffusivity.	2	K1	CO1
2.	Differentiate convective heat transfer by forced and natural convection.	2	K1	CO1
3.	Distinguish between boiling and condensation process.	2	K1	CO2
4.	Quote the salient features of multiple effect evaporator.	2	K1	CO2
5.	Uni-molal and bi-molal diffusion – Differentiate	2	K2	CO3
6.	Suggest the resistance factors involved in laminar and turbulent flow diffusion.	2	K1	CO3
7.	Mention the significance of relative volatility.	2	K2	CO4
8.	Write a short note on the performance of bubble cap and sieve plate tray.	2	K1	CO4
9.	List any five important requirements of solvent used for Gas absorption.	2	K1	CO5
10.	Indicate the purpose of using - Mixer settlers in extraction equipments.	.2	K2	CO5

PART – B

(5 x 13 = 65 Marks)

Q.No.		Questions	Marks	KL	CO
11.	a)	Develop steady state conduction equation for two-layer composite wall for i. Rectangular block ii. Cylindrical block	13	K2	CO1

(OR)

b)	i.	A steam pipe with 0.28 m outside diameter is insulated with a layer of calcium silicate. If the insulation is 30 mm thick and its inner and outer surfaces are maintained at 800 K and 490 K respectively. What is the heat loss per unit length of the pipe. Thermal conductivity of insulation is 0.055 W/m.K.	9	K2	CO1
	ii.	What are Black and grey bodies?	4		
12. a)		Describe constructional operation of i. Short tube and ii. Long tube evaporator	13	K2	CO2
		(OR)			
b)	i.	The ethyl alcohol is flowing in an inner tube of double pipe heat exchanger at the rate of 1200 Kg/hr and cooled from 45 to 23 °C, using water as cooling available at a temperature of 17 °C, with the flow rate of 1000 kg/hr. Find out outlet temperature of water. Calculate LMTD for both counter and parallel flow arrangement	8	K3	CO2
	ii.	Explain the significance of Fouling factors.	5		
13. a)		Portray the different ways of predicting diffusion coefficients in a multi component system.	13	K2	CO3
		(OR)			
b)		Categorize the different theories of mass transfer and brief each.	13	K2	CO3
14. a)		Draw Vapour liquid equilibrium diagram and Boiling point diagram. Explain its significance with respect to distillation.	13	K2	CO4
		(OR)			
b)		Ammonia-air mixture containing 5.0% ammonia by volume is admitted to a concurrent absorber at a rate of 52 m^3/h at 292 K and 101.3 kPa in order to reduce the ammonia content to 1.2% using pure water as the solvent. i. Determine the minimum (L_s/G_s) value ii. If the water used is 1.5 times the minimum, determine the actual water rate iii. Determine the exit liquid composition for the conditions in part (b). The equilibrium data are	13	K3	CO4

X, (kmol NH_3/kmol water)	0.01	0.02	0.03	0.04	0.05	0.06	0.07
Y, (kmol NH_3/kmol air)	0.013	0.025	0.037	0.047	0.057	0.068	0.078

15. a)		Explain various geometrical configuration of tower packings material and its make up material in gas absorption.	13	K2	CO5
		(OR)			

b) Acetic acid is extracted from an aqueous feed containing 25 weight% acetic acid using pure isopropyl ether in a multistage counter current unit so that the acid concentration in the exit aqueous phase is reduced to 6.0 weight%. If 1100 kg/h of the feed is treated with 3100 kg/h of the solvent, calculate: 13 K3 CO5

i. The composition of the final raffinate and extract products
ii. The flow rates of final raffinate and extract products
iii. The number of theoretical stages. Equilibrium data are given below:

Water-rich phase, weight%			Ether-rich phase, weight%		
Acetic acid	Water	Isopropyl ether	Acetic acid	Water	Isopropyl ether
1.41	97.1	1.49	0.37	0.73	98.9
2.89	95.5	1.61	0.79	0.81	98.4
6.42	91.7	1.88	1.93	0.97	97.1
13.3	84.4	2.3	4.82	1.88	93.3
25.5	71.1	3.4	11.4	3.9	84.7
36.7	58.9	4.4	21.3	6.9	71.5
45.3	45.1	9.6	31.1	10.8	58.1
46.4	37.1	16.5	36.2	15.1	48.7

PART – C

(1 x 15 = 15 Marks)

Q.No.		Questions	Marks	KL	CO
16.	a)	Elaborate the structural configuration of shell and tube heat exchanger with clear illustrations.	15	K3	CO2
		(OR)			
	b)	Exemplify the different types of agitators used for different applications in mass transfer, with neat diagrams.	15	K2	CO5