Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

V SEMESTER B.TECH. ONLINE PROCTORED END SEMESTER EXAMINATIONS JAN 2021

SUBJECT: MASS TRANSFER II [CHE 3152]

REVISED CREDIT SYSTEM
(30/01/2021)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A. A dilute aqueous solution of ethanol is to be concentrated from 30 mass% to 85 mass% alcohol in a tray tower at 1 atm pressure. The feed rate is 6500 kg/h at its bubble point. The bottom product must not contain more than 3.5 mass% ethanol. The reflux is at the bubble point. Using Ponchon-Savarit method determine (i) the minimum reflux ratio, (ii) number of ideal trays if the reflux ratio is 1.5 and (iii) the reboiler and condenser heat duties. The enthalpy-concentration (kJ/kmol) and the equilibrium data at 1 atm are given as: **10**

x, y	0	0.0417	0.0891	0.1436	0.207	0.281	0.37	0.477	0.61	0.779	1.0
H_L	7540	7125	6880	6915	7097	7397	7750	8105	8471	8945	9523
H_V	48150	48250	48300	48328	48436	48450	48450	48631	48694	48950	

x	0	0.00792	0.016	0.0202	0.0417	0.0891	0.1436	0.281	0.37	0.477
y	0	0.0850	0.1585	0.191	0.304	0.427	0.493	0.568	0.603	0.644
x	0.61	0.641	0.706	0.779	0.86	0.904	0.95	1.0		
y	0.703	0.72	0.756	0.802	0.864	0.902	0.9456	1.0		

2A. A solution of carbon tetrachloride and carbon disulfide containing 50 wt% each is to be continuously fractionated at standard atmospheric pressure at the rate of 5500kg/h. The distillate product is to contain 92 wt % carbon disulfide, the residue 0.8 wt %. The feed will be 40 mol% vaporized before it enters the tower. A total condenser will be used, and the reflux will be returned at the bubble point. The equilibrium data (x,y* = mole fraction CS_2) is as follows: **10**

T (°C)	x	y*
76.7	0	0
74.9	0.0296	0.0823
73.1	0.0615	0.1555
70.3	0.1106	0.2660
68.6	0.1435	0.3325
63.8	0.2585	0.4950

59.3	0.3908	0.6340
55.3	0.5318	0.7470
52.3	0.6630	0.8290
50.4	0.7574	0.8780
48.5	0.8604	0.9320
46.3	1	1

Determine (i) the product rates (ii) the minimum reflux ratio (iii) the number of theoretical trays required at the minimum reflux ratio (iii) the number of theoretical trays required at a reflux ratio equal to the twice the minimum and the position of the feed tray.

3A. A feed of 1200 kg aqueous solution of pyridine per hour (50% by mass) is to be extracted with pure benzene to reduce the solute content in the raffinate to 3%. Determine the minimum solvent rate and the number of ideal stages required if the solvent rate is 1.2 times the minimum. **10**

Water layer		Benzene layer	
Pyridine (mass %)	Benzene (mass %)	Pyridine (mass %)	Benzene (mass %)
1.17	0	3.28	94.54
3.55	0	9.75	87.46
7.39	0	18.35	79.49
13.46	0.15	26.99	71.31
22.78	0.25	31.42	66.46
32.15	0.44	34.32	64.48
42.47	2.38	36.85	59.35
48.87	3.99	39.45	56.43
49.82	4.28	39.27	55.72
56.05	19.56	48.39	40.05

4A. 900 kg of crushed oil seeds (22% oil, 78% meal) is extracted in a three-stage cross-current unit using 600 kg of pure hexane in each stage. The equilibrium data are as follows: **08**

Overflow (100 kg) solution			**Underflow (100 kg) slurry**		
W_A (kg)	**W_B (kg)**	**W_C (kg)**	**W'_A (kg)**	**W'_B (kg)**	**W'_C (kg)**
0.3	99.7	0	67.2	32.8	0
0.45	90.6	8.95	67.1	29.94	2.96
0.54	84.54	14.92	66.93	28.11	4.96
0.70	74.47	24.83	66.58	25.06	8.36
0.77	69.46	29.77	66.26	23.62	10.12
0.91	60.44	38.65	65.75	20.9	13.35
0.99	54.45	44.56	65.33	19.07	15.6
1.19	44.46	54.35	64.39	16.02	19.59
1.28	38.50	60.22	63.77	14.13	22.10
1.28	34.55	64.17	63.23	12.87	23.90
1.48	24.63	73.89	61.54	9.61	28.85

(i) Calculate the fraction of oil extracted in a three-stage cross-current unit using PS method.

(ii) Also, calculate the fraction of oil extracted in a single stage contactor for the same volume (1800kg) of the solvent and comment on the result.

4B. Dilute ethanol-water solutions can be continuously rectified to give at best the mixtures containing 89.4 mole % ethanol at atmospheric pressure, since this is the composition of minimum boiling azeotrope in the binary system. Ethanol can be further purified either by using n-pentane as entrainer or ethylene glycol as solvent. Write short notes on the methods **02**

	which uses the above-mentioned compounds in the purification of ethanol and comment on the most desirable method.	
5A.	Write a short note on any two solid-liquid contacting equipment which does not result in the clogging by fines with neat schematic diagram.	**4**
5B.	Discuss about any two types of membranes used in food industries with their exact application. Also comment on the modules used for such membranes in food industries.	**4**
5C.	Comment on any one membrane separation technique other than reverse osmosis for the desalination of water.	**2**

****