UNIVERSITY COLLEGE TATI

UNIVERSITY COLLEGE TATI (UCTATI)

FINAL EXAMINATION QUESTION BOOKLET	
COURSE CODE	: DTC 2093
COURSE	: UNIT OPERATION 1
SEMESTER/SESSION	: SEM 1- 2024/2025
DURATION	: 3 HOURS

Instructions:

1. This booklet contains **4** questions. Answer **ALL**.
2. All answers should be written in answer booklet.
3. If in doubt, raise your hands and ask the invigilator.
4. You are allowed to bring one A4 paper to write needed equations.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 4 PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1

a) There are many types of evaporators,

i. Mention 3 of them, (5 marks)

ii. Talk about one in details (clarify your answers with appropriate sketches if needed). (5 marks)

b) A feed of 4535 kg/h of a 2.0 wt % salt solution at 311 K enters continuously a single-effect evaporator and is being concentrated to 3.0 wt %. The evaporation is at atmospheric pressure and the area of the evaporator is 69.7 m^2. Saturated steam at 383.2 K is supplied for heating. Since the solution is dilute, it can be assumed to have the same boiling point as water. The heat capacity of the feed can be taken as C_p = 4.10 kJ/kg. K. calculate the followings:

i. Draw simplified diagram to show the main components of single effect evaporator. (5 marks)

ii. Amount of vapor in kg/hr (5 marks)

iii. Amount of liquid in kg/hr (5 marks)

QUESTION 2

In certain processes it is desired to absorb 90% of the acetone in a gas containing 1.0 mol % acetone in air in a countercurrent stage tower. The total inlet gas flow to the tower is 30.0 kg mol/h, and the total inlet pure water flow to be used to absorb the acetone is 108 kg mol H_2O/h. The process is to operate isothermally at 300 K and a total pressure of 101.3 kPa. The equilibrium relation for the acetone (A) in the gas–liquid is $y_A = 2.53x_A$. Do the followings:

a. Draw a countercurrent stage tower and show V1, L0, Vn+1 and Ln (5 marks)

b. Draw the graph and show where the values of V1, L0, Vn+1 and Ln (5 marks)

c. Draw the equilibrium and operating lines (5 marks)

d. Determine the number of theoretical stages required for this separation. (10 marks)

QUESTION 3

a) In Mc Cabe-Thiele diagram for distillation column, draw the enriching, stripping, q lines and show the feed tray location? (5 marks)

b) A saturated liquid feed of 200 kgmol/h at the boiling point containing 42 kgmol % heptane and 58 kgmol % ethyl benzene is to be fractionated at 101.32 kPa abs to give a distillate containing 97 kgmol % heptane and a bottom of 1.1 kgmol % heptane. Do the followings;

i. Draw simple distillation column, show the boiler, condenser, and stages. (5 marks)

ii. In the same sketch show the feed (F) , distillate (D) and waste (W). (5 marks)

(5 marks)

iii. Calculate the amount of F in kgmole/h. (5 marks)

iv. Calculate the amount of D in kgmole/h.

QUESTION 4

a) Interpret how to use rectangular coordinates to calculate the compositions of extract and raffinate layers in liquid-liquid extraction. (5 marks)

b) A mixture weighing 1000 kg containing 250 kg of Isopropyl Ether, 100 kg of acetic acid, 650 kg of water is equilibrated in a mixer settler and the phases are separated Use equilibrium data from Appendix A to do the followings;

Appendix A. Acetic Acid - Water - Isopropyl Ether System, Liquid - Liquid Equilibrium at 293 K or 20 °C					
Water Layer (wt %)			Isopropyl Ether Layer (wt %)		
Acetic acid	**water**	**Isopropyl Ether**	**Acetic acid**	**water**	**Isopropyl Ether**
0	98.8	1.2	0	0.6	99.4
0.69	98.1	1.2	0.18	0.5	99.3
1.41	97.1	1.5	0.37	0.7	98.9
2.89	95.5	1.6	0.79	0.8	98.4
6.42	91.7	1.9	1.93	1	97.1
13.3	84.4	2.3	4.82	1.9	93.3
25.5	71.1	3.4	11.4	3.9	84.7
36.7	58.9	4.4	21.6	6.9	71.5
44.3	45.1	10.6	31.1	10.8	58.1
46.4	37.1	16.5	36.2	15.1	48.7

i. Use data in Appendix A to draw the phase diagram for the three components. (10 marks)

ii. Show the solvent, solute and Carrier (5 marks)

iii. Fix M point in the diagram. (5 marks)

----------END OF QUESTIONS----------