SCHOOL OF ENGINEERING

DEPARTMENT OF FOOD PROCESS ENGINEERING

BSc. ENGINEERING FIRST SEMESTER 2020/2021 SUPPLEMENTARY EXAMINATIONS

FPEN 302: SEPARATION PROCESSES (2 CREDITS)

INSTRUCTIONS:

ANSWER ANY **THREE** (3) QUESTIONS OF YOUR CHOICE
GRAPH SHEETS ARE PROVIDED
EQUILIBRIUM CURVE FOR METHANOL/WATER SYSTEM IS PROVIDED

TIME ALLOWED: TWO (2) HOURS

1.

a. Discuss three factors that influence solvent extraction.

b. With the aid of a diagram, describe the operating principles of;
   i. a mixer-settler extraction equipment
   ii. a centrifugal extracting equipment.

c. State the name of the graphical method and construct the diagram used in the determination of ideal stages of a cascade.

2. A system uses a plate column, where acetone is absorbed from its mixture with air in a nonvolatile absorption oil. The entering gas contains 25 mole percent acetone, and the entering oil contains 1.5 mole percent acetone. Of the acetone in the air 96 percent is to be absorbed, and the concentrated liquor at the bottom of the tower is to contain 8 mole percent acetone. The equilibrium relationship is $y_e = 1.9x_e$.

   a. Draw the plate column indicating the inlet and exit streams.

b. Plot the operating line.

c. Calculate the number of ideal stages.

d. What would be your explanation at a particular point where the equilibrium line and the operational line meet?

3. In the removal of a component from a liquid feed, the Kremser equation is used to relate the N (number of stages), A (absorption factor), x and y components. This equation is expressed as;

$$N = \frac{\ln[(x_a - x_a*)/(x_b - x_b*)]}{\ln[(x_a - x_b)/(x_a* - x_b*)]}$$

a. From the above expression, in terms of x-terms, plot the y-x diagram indicating all the quantities involved including the operating and equilibrium lines.

b. Briefly explain an equilibrium stage operation and state two conditions needed to achieve this type of operation.

4. It is required to separate a mixture containing 60% methanol and 40% water by distillation. The overhead product is to contain 96% methanol and the bottom product 97% water. All compositions are in terms of moles. The reflux ratio at the top of the column is 1.4 and the reflux is at its bubble point. If the feed enters as saturated vapour, calculate:

i. The molar ratio of the overhead product to feed

ii. The minimum number of plates

iii. The actual number of plates required for the separation assuming a plate efficiency of 72%

iv. Where should the feed plate be located?

v. What will be the composition of methanol in both the vapour and liquid phases at minimum reflux?

Equilibrium curve for Methanol/Water system is provided.