A/L/TY

Reg. No: 24BBT0183

VIT
Vellore Institute of Technology

Final Assessment Test – November 2025

Course: BBIT201L - Principles of Chemical Engineering

Class NBR(s): 0978

Slot: F1+TF1

Time: Three Hours

Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

COs	CO Statements
CO1	Explain the basics of engineering calculations pertaining to dimensions and system of units.
CO2	Summarize the material balances of biochemical processes and equipment.
CO3	Develop the energy balance calculations for various processes in chemical engineering.
CO4	Solve problems involving recycle, purge and bypass in a process or unit.
CO5	Assess different non-dimensional numbers and relating the variables using theorems.
CO6	Apply equations related to fluid flow and different types of flow measuring devices.

BL – *Blooms Taxonomy* Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – *Evaluate, 6 – Create)*

Answer ALL Questions
(10 X 10 = 100 Marks)

1. Feed 10000 kg/h containing 7% (w/w) solids is to be concentrated to a product having 90 % (w/w) solids using a four effect evaporator. Assume equimolar vaporisation is taking place in the system. Calculate **CO2 BL3**

   a) Mass of product (kg/h), b) total water evaporated (kg/h), c) Product in each effect (kg/h), and d) Solid composition in the second and third evaporator.

2. Use Buckingham's theorem and show that the discharge of a centrifugal pump is given by **CO5 BL3**

   $$Q = ND^2 f\left(\frac{gH}{N^2C}, \frac{\mu}{N\rho D^2 \rho}\right)$$

   Where (N) is the speed of the pump in r.p.m., (D) the diameter of impeller, (g) gravitational acceleration, (H) manometric head, (μ), (ρ) are the dynamic viscosity and the density of fluid.

3. Explain about the classification of pumps in detail with neat labelled sketches. **CO6 BL1**

4. Carbon dioxide gas at 300 K and 100 kPa is saturated with water vapour. The vapour pressure of water at 300 K is 3.56 kPa. Calculate **CO5 BL3**

   a) The mole percent of water vapour in mixture.
   b) The percent composition of weight.
   c) The mole ratio of water vapour in the mixture.
   d) The weight ratio of water vapour in the mixture.
   e) The amount of vapour in kg/m^3 of the mixture.

5. An aqueous solution of K_2CO_3 is prepared by dissolving 33 kg of K_2CO_3 in 100 kg of water at 293 K. Calculate M, m and N of solution. Density of the solution is 1.3 g L^{-1}. CO1 BL3

6. In the production of ethanol by the hydrolysis of ethylene, diethyl ether is produced as a byproduct. A typical feed stream composition is 55% ethylene, 5% inerts, 40% water; and product stream: 52.26% ethylene, 5.49% ethanol, 0.16% ether, 36.81% water, and 5.28% inerts. Calculate the following, CO2 BL3

a) Selectivity of ethylene for ethanol and selectivity of ethylene for ether
b) Conversion of ethylene and
c) Yield of ethanol and ether based on ethylene.

Reactions are as follows,

$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

$$2C_2H_5OH \rightarrow (C_2H_5)_2O + H_2O$$

7. Prove that for an ideal gas, pressure fraction = mole fraction = volume fraction. CO1 BL2

8. Give a detailed explanation on the application of continuity equation and Bernoulli's theorem with a neat labelled sketch. CO6 BL3

9.a) Calculate the heat added to 100 g of water to heat it from -10°C to 120°C at 1 atm pressure. CO3 BL3

Specific heat of ice = 0.485 cal / (g.°C).

Specific heat of water = 18.03 cal / (g.°C).

Specific heat of steam = $7.256 + 2.298 * 10^{-3} T + 0.283 * 10^{-6} T^2$ (cal / (mol. °C))

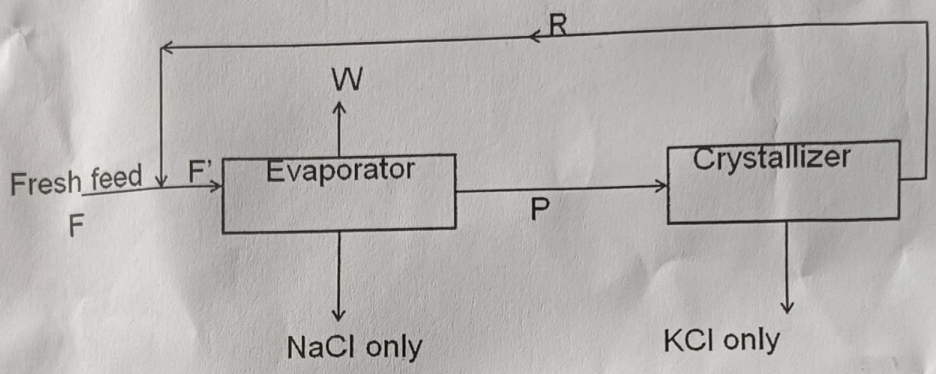
Latent heat of fusion of ice = 1436 cal/mol

Latent heat of vaporisation of water = 9717 cal/mol.

OR

9.b) The specific latent heat of vaporisation of water is 2200 KJ/kg, and the specific heat capacity of water is 4200 J/Kg.K. A heating element is immersed in an insulated cup of water. It takes five minutes to boil the water completely from an initial temperature of 30°C. Assuming no heat is lost to the surroundings, determine the mass of the water if the heating element is operating at 1000 W. CO3 BL3

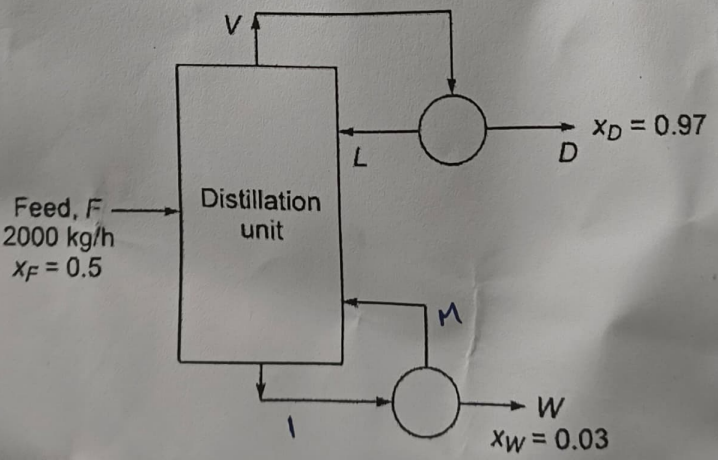
10.a) A solution containing 15% NaCl, 5% KCl and water is fed to the process shown in figure at the rate of 25,500 kg/h. The compositions of the stream are as follows: Evaporator product P: NaCl =20%, KCl=25% and water. Recycle product R: NaCl =26.67 % and water. Calculate the flow rates in kg/h and compute the composition of feed to the evaporator(F') **CO4 BL4**



OR

10.b) A continuous fractionating column separates 2000 kg/h of a solution of benzene and toluene containing 0.5 mass fraction benzene into an overhead product containing 0.97 mass fraction benzene and bottom product containing 0.03 mass fraction of benzene. A reflux ratio of 2.5 kg of reflux per kg of product is to be used. Calculate the quantity of top and bottom product in kg/h. **CO4 BL4**

wtf is this



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