Seat No: _____   Enrollment No: _____

PARUL UNIVERSITY
FACULTY OF ENGINEERING & TECHNOLOGY
B.Tech. Winter 2022 - 23 Examination

Semester: 3   Date: 8/10/2022
Subject Code: 203103205   Time: 2:00pm to 4:30pm
Subject Name: Material & Energy Balance Computations   Total Marks: 60

Instructions:
1. All questions are compulsory.
2. Figures to the right indicate full marks.
3. Make suitable assumptions wherever necessary.
4. Start new question on new page.

Q.1   Objective Type Questions: **(15)**
1.   Define unit operations with two examples.
2.   100 nm = _____
       a. 100^{-5} cm
       b. 100^{-9} cm
       c. 100^{-6} cm
       d.   none
3.   SI Unit of Luminous intensity is
       a.   Ampere
       b.   Candela
       c.   Mole
       d.   Coulomb
4.   500 ppm = _____ g/L
5.   For distillation operation, material balance equation at steady state condition will be
       a)   input = output
       b)   input – output + generation = accumulation
       c)   input – output = accumulation
       d)   input – output + generation – consumption = 0
6.   For producing vehicular fuels like petrol and diesel, _____ operation is preferred. (batch, continuous, semi-batch, semi-continuous)
7.   What is the unit of saturated molal absolute humidity in air-water vapor mixtures?
8.   Define degree of freedom (DoF).
9.   What is the importance of purge stream in industries?
10.   Define humidification operation.
11.   What is meant by reflux ratio in distillation?
12.   What are the dimensions of gravitational acceleration (g)?
       (M = mass, L = length, T = time, θ = temperature)
       a) M^3T^{-1} b) $L^3T\theta^{-1}$ c) LT^{-2} d) $M^3\theta T^{-1}$
13.   Prove that potential energy is dimensionally homogenous.
14.   What is full form of SI and how many base units are there in SI?
15.   How will you find mole fraction of "A" if a gas mixture contains three components A, B and C?

Q.2   Answer the following questions. (*Attempt any three*)   **(15)**
A)   500 mL of an aqueous sodium chloride solution contains 5g NaCl. Calculate the concentration in
       a.   ppm
       b.   Normality
       c.   Molarity
            Given atomic weight Na =23, Cl =35.5

B) In a textile industry, a double-effect evaporation system is used to concentrate weak liquor containing 25% (by mass) caustic soda to produce a lye containing 70% solids (by mass). Calculate the water evaporated per 1000 kg feed in the evaporator.

C) The weight (mg = F) of an object is 350 N at a location where acceleration due to gravity is 9.81 m/s^2.
    a) Determine the mass of object in kilograms.
    b) Express the mass in FPS system. (1 kilogram (kg) = 2.2046 pounds (lb))
    c) Is force a primary or secondary quantity? Give reason for your answer.

D) Using neat block diagrams, explain the following operations (streams) with applications in industry:
    a. Recycle
    b. Bypass

Q.3 A) Solve the following system to estimate: **(07)**
    i.   Weight of product leaving the drier (S_1), kg/h
    ii. Weight of product leaving the oven (S_2), kg/h
    iii. Vapor produced, V_1 and V_2, kg/h
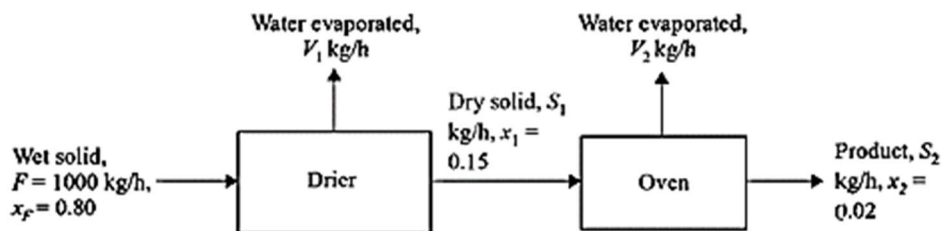
B) Draw a triple effect evaporation system. Use symbols to define streams appropriately. **(08)** Also, write down following material balance equations for this system:
    i.   Total material balance over the entire system
    ii. Material balance over each effect: total and species balances

<div align="center">OR</div>

B) Explain the following laws mathematically that govern the Pressure-Volume- **(08)** Temperature behavior of ideal gases:
a) Boyle's Law   b) Charle's Law   c) Gay-Lussac's Law   d) Avagadro's Hypothesis
Also, calculate the following:
An automobile tyre is inflated to a pressure of 295 kPa at 293 K. Assume that the volume of air inside the tyre remains constant.
    i.   If the pressure inside the tyre is not to exceed 550 kPa, what is the maximum temperature to which the tyre may be heated?
    ii. Which law applies in this case?

Q.4 A) Estimate the following properties of water vapor – air mixture using the psychrometric **(07)** chart given below. Data given: DBT = 50ºC, $Y' = 0.04$ kg water vapor/kg dry air, P = 1 atm, $M_A = 18$, $M_B = 29$.

i) Ys′   (ii) Y   (iii) Ys   (iv) $\overline{P_A}$ (v) P_A (vi) Dew Point   (vii) WBT
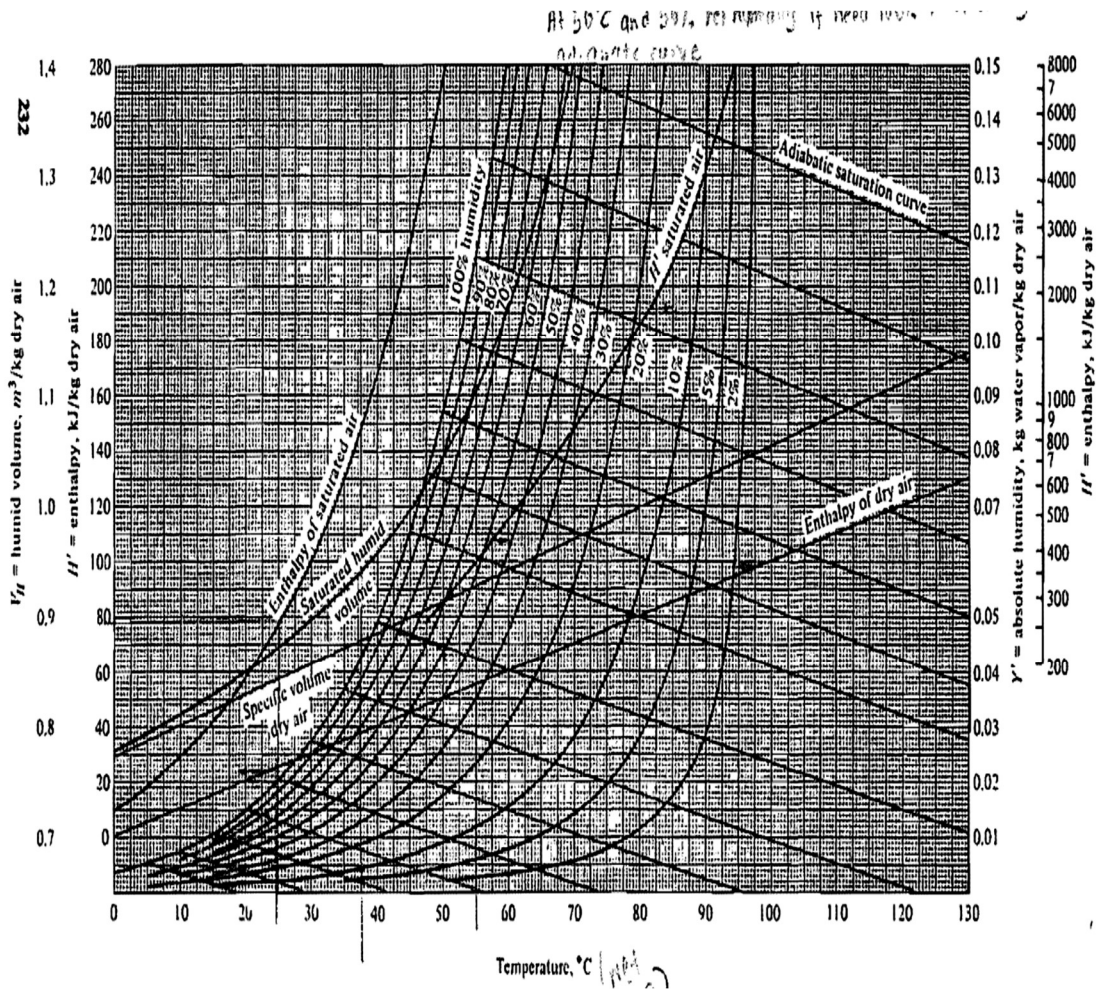
OR

A)   Explain the following terms related to humidification: **(07)**
    a) Dry bulb temperature
    b) Wet Bulb Temperature
    c) Dew Point
    d) Saturated molal absolute humidity

B)   Differentiate between Batch and Continuous systems. Also, provide their applications.   **(08)**