B.E. CHEMICAL ENGINEERING FIRST YEAR FIRST SEMESTER EXAM 2019 (OLD)

FUNDAMENTALS OF CHEMICAL ENGINEERING

Use separate answer scripts for each part.

Time: Three hours *Full marks: 100*
(50 marks for each part)

PART I

Answer any five questions
Assume any missing data

1. Using Newton's backward difference formulae, fit a polynomial through the data points given in the following table [10]

x	-1	0	1	2	3
y	-5	8	19	40	83

2. Find the composition of vapour that is in equilibrium with a binary liquid solution containing 25% A and 75% B at 95 °C. Also determine the total pressure. [10]
The vapour pressure of A and B are given by

A: $$log_{10}P(mm\,Hg) = 6.906 - \frac{1211}{T(oC)+220.8}$$

B: $$log_{10}P(mm\,Hg) = 6.9533 - \frac{1343.9}{T(oC)+219.38}$$

3. (a) A gaseous fuel after combustion contains 10 wt% methane, 2 wt% carbon monoxide, 60 wt% carbon dioxide and the rest nitrogen. What is the average molecular weight of the mixture and the mole fraction of carbon dioxide in the mixture?
(b) Writer short notes on (i) Importance of Cox chart (ii) Duhring plot [6+4]

4. (a) The specific gravity of sulphuric acid is 1.8. 90g of water is added to 90 g of sulphuric acid. The specific gravity of the mixture is 1.5, Determine the percentage difference in volume between the mixture and the component water and sulphuric acid?
(b) Name three important dimensionless number in chemical engineering and their importance? [5+5]

5. Water is present in nitrogen at 30 °C and 1000 mm Hg. Determine the absolute humidity if the relative humidity is 70%. [10]
The vapour pressure of water is given by

$$log_{10}P(mm\,Hg) = 8.07131 - \frac{1730.63}{T(oC)+233.426}$$

6. Consider a liquid in a cylindrical container in which both the container and the liquid are rotating as a rigid body (solid-body rotation). The elevation difference *h* between the center of the liquid surface and the rim of the liquid surface is a function of angular velocity fluid density gravitational acceleration, and radius. Use Buckingham pi theorem to find a dimensionless relationship between the parameters. [10]

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Part-II

Use separate answer scripts for each part.

Time: Three hours *Full marks: 100*
(50 marks for each part)

*Answer any **five** questions. All questions carry equal marks. Assume any missing data.*

1. In a fan-assisted convection oven, the heat transfer rate to a roast, $\dot{Q}$(energy per unit time), is thought to depend on the heat capacity of air,c_p, temperature difference, Θ, a length scale,L_s , air density, ρ , air viscosity, μ , and air speed, V . Use Buckingham Pi theorem to
   (a) determine the number of dimensionless groups needed to characterize the oven.
   (b) obtain the Π parameters considering Θ, L_s, ρ, V as repeating parameters.

2+8

2. The Arrhenius equation which relates the rate of reaction with temperature is as follows

$$k = Ae^{-E/RT}$$

In investigating a certain chemical reaction, following data were obtained.

T(K)	k (sec^{-1})
375	1.06×10^{-16}
380	1.07×10^{-15}
392	9.30×10^{-15}
400	6.94×10^{-14}

Evaluate E and A using a semilogarithmic graph paper. $R = 8.314\ \text{JK}^{-1}\text{mol}^{-1}$

10

3. Consider the vapor-liquid equilibrium of a two component system (B and T which are similar in chemical nature) at 75°C. For equimolar mixture of B and T in the liquid phase what is the system pressure and the composition of the vapor ?

B: $\log_{10}(\text{bar}) = 5.0768 - \frac{1659.793}{T(\text{K}) - 45.854}$

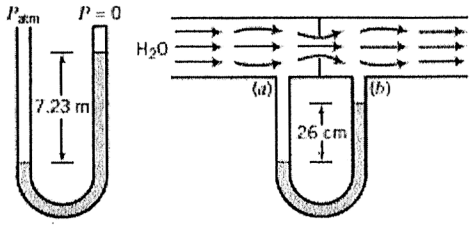
T: $\log_{10}(\text{mm Hg}) = 7.2316 - \frac{1277.03}{T(°\text{C}) + 273.23}$

10

4. (a) Write a short note on Henry's law.
(b) Discuss significance of dimensional analysis in Chemical Engineering.
(c) What is wet bulb temperature?

3+4+3

5. A fluid of unknown density is used in two manometers- one sealed end, the other across an orifice in a water pipeline. The readings shown here are obtained on a day when barometric pressure is 756 mm Hg. What is the pressure drop from point (a) to point (b) in N/m^2, mm Hg and psi?



10

6. (a) Write a short note on liquid-liquid extraction.
(b) How would you measure heat of vaporization of a substance using Clausius-Clapeyron equation.

5+5