

BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION MO2025)

CLASS: B.Tech, BSc.
BRANCH: Chemical Engg, Food Technology, and Chemistry

SEMESTER: III
SESSION: MO/2025

SUBJECT: CL24205 / CL217 CHEMICAL PROCESS CALCULATIONS
TIME: 02 Hours

FULL MARKS: 25

INSTRUCTIONS:

1. The question paper contains 5 questions each of 5 marks and total 25 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates: Graph paper

		CO	BL
Q.1(a)	Vapor pressure of benzene can be calculated using the following Antoine equation: $\log P = 6.9057 - 1211/(t+220.8)$, where p is the vapour pressure in mm-Hg and t is the temperature in °C. Convert the above equation in SI units, i.e. p in bar and T in K.	[2.5] CO1	3
Q.1(b)	(1) Convert the ideal gas constant: $R = 1.987 \text{ cal}/(\text{gmol})(\text{K})$ to $\text{Btu}/(\text{lbmol})(^\circ\text{R})$. (2) Overall heat transfer coefficient of given shell and tube heat exchanger is $100 \text{ Btu}/(\text{h ft}^2 \text{ }^\circ\text{F})$. Express the same in SI unit.	[1.5] CO1	3
Q.1(c)	A liquid mixture contains <i>n</i> -butane (50 mass%), <i>n</i> -pentane (30 mass%), and <i>n</i> -hexane (20 mass%). Convert the composition into mole fractions and determine the average molecular weight of the mixture.	[1] CO1	3
2	A vessel of volume 0.02 m^3 contains a binary mixture of hydrogen and helium gases at a pressure of 4.15 bar and a temperature of 320.15 K. The total mass of the mixture is 10 g. Using the ideal gas law, determine the individual amounts of hydrogen and helium in the mixture in grams.	[5] CO2	3
3	Ventilation air at 60°C and 1.0 bar is supplied at a rate of $900 \text{ m}^3/\text{h}$. The absolute humidity is $0.08 \text{ kg}/\text{kg}$ dry air. (1) Determine the molar flow rates of water vapor, dry air, and oxygen, (2) Calculate the mass fraction of water in the air, (3) Compute the partial pressure of water vapor. Data: Vapor pressure of water at 60°C is 20 kPa.	[5] CO2	3
4	Slabs of building boards containing 16% moisture by weight (wet basis) are dried to a final moisture content of 0.5% by weight (wet basis) by circulating hot air over them. Fresh air contains 0.02 kg water vapour per kg dry air, and the exhaust air contains 0.09 kg water vapour per kg dry air. If the feed rate of net dry board is $1000 \text{ kg}/\text{h}$, calculate (a) the mass of water removed from the boards (kg/h), (b) the required fresh air flow rate (kg dry air/ h), and (c) the volumetric flow rate of fresh air at 301 K and 101.325 kPa (m^3/h). Assume average molecular weight of fresh air (as whole) is $28.84 \text{ g}/\text{mol}$.	[5] CO3	3
5	In the azeotropic distillation of an ethanol-water solution, a feed mixture containing 95.6% alcohol is mixed with pure benzene and distilled. The benzene forms a ternary azeotrope with alcohol-water with a composition of 74.1% benzene, 7.4% water and 18.5% alcohol, which is distilled over as the overhead product. Absolute alcohol (100%) is obtained as the bottom product. Determine the quantity of benzene required for producing 100 kg of absolute alcohol. Also, calculate the percentage recovery of ethanol. All compositions are in mass%.	[5] CO3	3

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