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

CLASS: B.TECH **SEMESTER: III**
BRANCH: CHEMICAL **SESSION: MO/2022**

SUBJECT: CL217 CHEMICAL PROCESS CALCULATIONS

TIME: 2 HOURS **FULL MARKS: 25**

INSTRUCTIONS:
1. The total marks of the questions are 25.
2. Candidates attempt for all 25 marks.
3. Before attempting the question paper, be sure that you have got the correct question paper.
4. The missing data, if any, may be assumed suitably.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

				CO	BL
Q1	(a)	Convert the following units: i) 1000 BTU ft^{-1} $^oF^{-1}$ hr^{-1} to W m^{-1} K^{-1} ii) Convert 50 mm Hg gauge pressure in the psia. iii) Convert 600 ^oR (Rankine) to ^oC (Celsius) iv) Convert 10 gm cm^{-1} s^{-1} to lb ft^{-1} s^{-1} v) Convert 40 kg mol of NH_3 to lb mol vi) Convert 400 ppm CO_2 in air to gm-mol/L. Take density of air is 1.29 gm/L.	[3]	1	1,3
Q1	(b)	56 kg N_2 and 10 kg H_2 mixed to produce ammonia in the following reaction $N_2 + 3H_2 \rightarrow 2NH_3$. If conversion of the limiting reactant is 40%, determine the followings: i) compositions of the gas mixture after the reaction, and ii) extent of reaction.	[2]	1	3
Q2	(a)	Calculate the average molecular weight of air (i) from its approximate molar composition of 79% N_2 and 21% O_2 and (ii) from its approximate composition by mass of 77% N_2 and 23% O_2.	[2]	1	3
Q2	(b)	Methane and oxygen react in the presence of a catalyst to form formaldehyde. In a parallel reaction, methane is oxidized to carbon dioxide and water. $CH_4 + O_2 \rightarrow HCHO + H_2O$ $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ The fractional conversion of methane is 0.90 and the fractional yield of formaldehyde is 0.855. Calculate the molar composition of the reactor output stream and the selectivity of formaldehyde production relative to carbon dioxide production. Assume, feed only contains CH_4 & O_2 and molar flow rate of each component is 50 mol/s.	[3]	1	3
Q3	(a)	An equimolar liquid mixture of benzene (B) and Toluene (T) is in equilibrium with its vapour at 30 °C. What is the system pressure and the composition of the vapour? At 30 °C, the vapour pressures of benzene and toluene are 119 mmHg and 36.7 mmHg respectively.	[2]	2	3
Q3	(b)	An ideal-gas mixture contains 35% helium, 20% methane, and 45% nitrogen by volume at 2.00 atm absolute and 90 °C. Calculate (a) the partial pressure of each component, and (b) the density of the gas in kg/m^3.	[3]	2	3
Q4	(a)	Explain the followings: i) Wet bulb temperature, ii) Bubble point pressure of a liquid mixture	[2]	2	1
Q4	(b)	One kg mole of a mixture contains 0.400 kg mol of N_2 and 0.600 kg mol of C_2H_4 at 300 K and 200 kPa absolute pressure. Calculate the followings: i) volume of the gas mixture ii) density of the gas mixture (Treat it as an ideal gas)?	[3]	2	3
Q5	(a)	Define the following terms: (i) Absolute humidity, (ii) Relative humidity, and (iii) Raoult's law.	[3]	2	1
Q5	(b)	Determine the followings: i) Degree of freedom of liquid water with dissolved acetone in equilibrium with their vapours, ii) Calculate the humidity of air (kg water/kg dry air) at 1 atm pressure if the partial pressure of water in air is 4 kPa.	[2]	2	1,3

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