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

CLASS: B.Tech **SEMESTER : III**
BRANCH: Biotechnology **SESSION : MO/2023**

SUBJECT: BE206 CHEMICAL PROCESS CALCULATIONS

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	A solution of common salt in water is prepared by adding 20 kg of salt to 100 kg of water, to make a liquid of density 1323 kg/m^3 . Calculate the concentration of salt in this solution as a (a) weight fraction, (b) weight/volume fraction, (c) mole fraction, (d) molal concentration	[5]	CO1	Understanding
Q.1(b)	One type of anaerobic respiration converts glucose to ethanol and carbon dioxide. If the molecular weight of glucose is180 grams/mol and the molar mass of ethanol is 46 g/mol, how many grams of carbon dioxide are produced when 1 mol of glucose is digested via respiration?	[5]	CO1	Applying
Q.2(a)	It is required to prepare 1250 kg of a solution composed of 12 wt.% ethanol and 88 wt.% water. Two solutions are available, the first contains 5 wt.% ethanol, and the second contains 25 wt.% ethanol. How much of each solution are mixed to prepare the desired solution?	[5]	CO2	Remembering
Q.2(b)	A solution of ethyl alcohol containing 8.6% alcohol by weight is fed at the rate of 5000 kg/hr to a continuous fractionating column operating at atmospheric pressure. The distillate which is the desired product contains 95.4% alcohol by weight and the residue from the bottom of the column contains 0.1% alcohol by weight. Calculate the following: i. the mass flow rates of the distillate and residue in kg/hr, and ii .the percentage loss of alcohol.	[5]	CO2	Creating
Q.3(a)	In the Deacon process for the manufacture of chlorine, HCl and O_2 react to form Cl_2 and H_2O. Sufficient air (21 mole% O_2,79% N_2) is fed to provide 35% excess oxygen and the fractional conversion of HCl is 85%. Determine the amount of air required per mole of HCl fed into the process. Calculate the mole fractions of the product stream components using (i) molecular species balances (ii) atomic species balances (iii) extent of reaction	[5]	CO2	Evaluating
Q.3(b)	The oxidation of ethylene to produce ethylene oxide proceeds according to the equation 2 C_2H_4 + O_2 $\rightarrow$2C_2H_4O The feed to a reactor contains 100 kmol C_2H_4 and 100 kmol O_2 . i) Which reactant is limiting? ii) What is the percentage excess of the other reactant? iii) If the reaction proceeds to completion, how much of the excess reactant will be left; how much C_2H_4O will be formed; and what is the extent of reaction? iv) If the reaction proceeds to a point where the fractional conversion of the limiting reactant is 50%, how much of each reactant and product is present at the end, and what is the extent of reaction? v) If the reaction proceeds to a point where 60 kmol of O_2 is left, what is the fractional conversion of C_2H_4?The fractional conversion of O_2 ? The extent of reaction?	[5]	CO2	Evaluating
Q.4(a)	Toluene is to be heated from 290 K to 350 K at the rate of 250 g/s. Calculate the heat to be supplied to toluene using the heat capacity data given below. C = $a+bT+cT^2+dT^3$, kJ/ (kmol K)	[5]	CO3	Analyzing

Component	a	b	c	d
Toluene	1.80	812.2x 10^{-3}	1512.6x10^{-6}	1630.0x10^{-9}

PTO

Q.4(b)	To sterilize a fermenter, two streams of water are fed. Feed 1 is 120 kg/min at 30° C and Feed 2 is 175 g/min at 65° C. The pressure inside the fermenter is 17 bar (absolute) and 295 kg of water vapour leaving as saturated steam. The exiting steam leaves the fermenter through a 10-cm ID pipe. Calculate the required heat input to the fermenter in kJ/min if the steam leaving is saturated at the fermenter pressure. Neglect kinetic energies of the liquid inlet streams. Given Data: Specific enthalphy for H_20 (l) at 30 ° C = 125.7 kJ/kg Specific enthalphy for H_20 (l) at 65 ° C = 271.9 kJ/kg Specific enthalphy for saturated vapour H_20 (v) at 17 bar = 2793.4 kJ/kg at 204° C	[5]	CO3	Evaluating
Q.5(a)	Fumaric acid is produced from malic acid using enzyme fumarase. Calculate the standard heat of reaction for the reaction. The standard heat of combustion for malic acid and fumaric acids are -1328.8 kJ $gmol^{-1}$ and -1334.0 kJ $gmol^{-1}$.	[5]	CO3	Understanding
Q.5(b)	Calculate the heat of formation of liquid 1-3 butadiene at 298.15 K using the following data. Standard heat of formation of CO_2 = -393.51 kJ/mol Standard heat of formation of H_2O = -285.83 kJ/mol Heat of combustion of C_4H_6 (l) at 298 K = -2520.11 kJ/mol	[5]	CO4	Evaluating

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