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

CLASS: BTECH **SEMESTER : III/ADD**
BRANCH: BIOTECHNOLOGY **SESSION : MO/2025**

SUBJECT: BE24245 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)	The overall reaction for microbial conversion of glucose to L-glutamic acid is: $C_6H_{12}O_6 + NH_3 + 1.5O_2 \rightarrow C_5H_9NO_4 + CO_2 + 3H_2O$ What mass of oxygen is required to produce 15 g glutamic acid?	[5]	CO1	Understanding
Q.1(b)	A liquefied mixture has the following composition: n-C_4H_{10} =50% (MW=58), n-C_5H_{12} =30% (MW=72), and n-C_6H_{14} =20% (MW=86). For this mixture, calculate: (a) mole fraction of each component. (b) Average molecular weight of the mixture. (Hint: Basis 100 kg)	[5]	CO1	Applying
Q.2(a)	10,000 kg/h of solution containing 20% methanol is continuously fed to a distillation column. Distillate is found to contain 98% methanol and waste solution from the column carries 1% methanol. All percentage are by weight. Calculate: (i) The mass flow rates of distillate and bottom product (ii) The percentage loss of methyl alcohol.	[5]	CO2	Remembering
Q.2(b)	An aqueous solution of pyridine containing 27% (by weight) pyridine and 73% (by weight) water is to be extracted with chlorobenzene. The feed and solvent are mixed well in batch extractor and the mixture is then allowed to stand for phase separation. The extract phase contains 11% pyridine, 88% chlorobenzene and 1% water by weight. The raffinate phase contains 6% pyridine and 94% water by weight. Calculate: (i) The quantities of two phases (layers) (ii) The weight ratio of solvent to feed based on 100 kg of feed.	[5]	CO2	Creating
Q.3(a)	Two reactions take place in a continuous reactor operating at steady state, $C_2H_6 \rightarrow C_2H_4 + H_2$ $C_2H_6 + H_2 \rightarrow 2CH_4$ The feed stream contains 85.0 mole % ethane (C_2H_6) and 15 mole % inert (i.e. unreactive) components. The fractional conversion of ethane is 0.501, and the fractional yield of ethylene (C_2H_4) is 0.471. What is the molar composition of the product gas?	[5]	CO2	Evaluating
Q.3(b)	Ammonia is produced by the following reaction. $N_2 + 3H_2 \rightarrow 2NH_3$ Calculate: (i) The molal flow rate of hydrogen corresponding to nitrogen feed rate of 50 kgmol/h if they are fed in stoichiometric proportion. (ii) The amount of ammonia produced per hour if percentage conversion is 30 and nitrogen feed rate is 50 kgmol/h.	[5]	CO2	Evaluating

PTO

Q.4(a)	Since blood is refrigerated for storage, it is warmed before contact with a patient to prevent hypothermia. Calculate the rate of heat required to continuously warm 10 L/min of blood from 30 ° C to 37 ° C using an electric heater. A stirrer adds work to the system at a rate of 0.50 kW. Assume the heat capacity of blood is constant at 4.185 J/g. ° C and the density of blood is 1 g/mL. Working volume of the tank is 1 L.	[5]	CO3	Analyzing
Q.4(b)	A stream of nitrogen flowing at a rate of 150 kgmol/h is heated from 298 K to 373 K. Calculate the heat that must be transferred. $C_P = 29.49 - 5.14 \times 10^{-3}T + 13.18 \times 10^{-6}T^2 - 4.95 \times 10^{-9}T^3$, kJ/kgmol.K	[5]	CO3	Evaluating
Q.5(a)	Calculate the standard heat of reaction of the following reaction from the combustion data. $C_2H_6(g) \rightarrow C_2H_4(g) + H_2(g)$ Data: Component | $\Delta H^\circ C$ (kJ/mol) $C_2H_6(g)$ | -1561 $C_2H_4(g)$ | -1411 $H_2(g)$ | -286	[5]	CO3	Understanding
Q.5(b)	Calculate the heat of formation of benzoic acid crystals $C_7H_6O_2$ at 298 K using the following data. The heat of formation of CO_2 and H_2O are –93.98 kcal/mol and –68.26 kcal/mol. Heat of combustion of benzoic acid crystals $C_7H_6O_2$ is –770.71 kcal/mol.	[5]	CO3	Evaluating

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