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Manipal Institute of Technology, Manipal

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III SEMESTER B.TECH (BIOTECHNOLOGY)

END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: PROCESS & BIOPROCESS CALCULATIONS [BIO 207]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** questions.
- Missing data may be suitable assumed.

1A.	The heat capacity of carbon dioxide gas is given by $C_P = 0.1978 + 1.059 * 10^{-4} T - 2.395 * 10^{-8} T^2$ Where C_P is in Btu/(lb ^oF) and T is in ^oF. Change the equation into the form in which C_P is given in kJ/(kmol K) and temperature is in K.	**5**
1B.	A liquid mixture contains three components A (MW=72), B (MW=58) and C (MW=56) in which A and B are present in the mole ratio 1.5:1 and the weight percent of B is 25%. A sample of the mixture is found to contain 10 kg of C. Calculate the total number of moles of the mixture.	**5**
2A.	In the production of a drug having a molecular weight of 192, the exit stream from the reactor flows at the rate of 10.3 L/min. The drug concentration is 41.2% (in water), and the specific gravity of the solution is 1.025. Calculate the concentration of the drug (in kg/L) in the exit stream, and the flow rate of the drug in k mol /min	**4**
2B.	Sodium chloride (Mol. Wt 58.5) weighing 600 kg is mixed with 200 kg potassium chloride (Mol. Wt 74.5). Find the composition of the mixture in (a) mass % (b) mole%	**3**
2C.	In a gas mixture consisting of hydrogen, nitrogen and carbon dioxide, the partial pressures are 25 kPa for hydrogen, 35 kPa for nitrogen and 140 kPa for CO_2. For 50 m^3 of the gas mixture at 400 K, determine the following: (a) The number of moles and mole fraction of hydrogen (b) The pure-component volume of hydrogen (c) The average molecular weight of the mixture	**3**
3A	At 300 K, the vapour pressure of two pure liquids A and B are respectively 80 kPa and 50 kPa. The concentration of A in the vapour in equilibrium with a	**4**

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	solution of A and B is found to be 35 Mole%. Determine (a) The composition of the liquid and (b) The total pressure of the vapour	
3B	One kmol CO_2 occupies a volume of 0.381 m^3 at 313 K. compare the pressures given by the (a) Ideal gas equation (b) Van der waals equation Take the van der waals constants to be a=0.365 (N m^4/mol^2) and b=4.28*10^{-5} m^3/mol	**4**
3C	Calculate the vapour pressure of water at 363 K if the vapour pressure at 373 K is 101.3 kPa. The mean heat of vaporization in this temperature range is 2275 kJ/kg.	**2**
4A.	A triple effect evaporator is used to concentrate 1500 kg of aqueous solution from a concentration of 25 % solute to 75 % solute. Assuming equal amount vaporization in each effect, calculate the composition and weight of the solution entering the second and third evaporator	**7**
4B.	A cellulose solution containing 5% cellulose by weight in water. It is to be diluted to 4% using 1% solution of cellulose in water. Determine the kilograms of 1% solution required to dilute 100 kg of the 5% solution.	**3**
5A.	Chlorine is produced by the oxidation of hydrogen chloride gas with air $4\ HCl + O_2$ ----- > $2\ Cl_2 + 2\ H_2O$ The reaction is carried out at 1.2*10^5 N/m^2 and 400 k. 50% excess oxygen is used and the reaction is only 80% complete. Calculate the following (a) The volume of air admitted per 100 m^3 of HCl if both air and HCl enter the reactor at 1 bar and 290 K. (b) The volume of gases leaving the reactor per 100 m^3 of HCl entering (c) The percentage composition by volume of the exit gas on a dry basis.	**6**
5B.	A distillation column is charged with aqueous solution of ethanol containing 35% ethanol by weight. The concentrated alcohol is withdrawn as the distillate containing 85% ethanol. The bottom product contains 5% ethanol. Determine the following: (a) The mass of distillate per 100 kg of feed. (b) The ratio of the mass of the distillate to mass of the residue.	**4**
6A	Heat capacity data for gaseous SO_2 is given by the following equation: $C_P = 43.458 + 10.634*10^{-3}\ T - 5.945*\frac{10^5}{T^2}$ Calculate the heat needed to raise the temperature of 1 kmol pure Sulphur dioxide from 300 K to 1000 K	**4**
6B.	In a process producing KNO_3 salt, 1000 kg/h of a feed solution containing 10% KNO_3 is fed to an evaporator which evaporates some water to produce a 50%	**6**

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KNO_3 solution. This is then fed to a crystallizer, where crystals containing 95% KNO_3 are removed. The saturated solution containing 35% KNO_3 is recycled to the evaporator. Calculate the following:

(a) The amount of recycle stream, kg/h

(b) The amount of crystals, kg/h

(c) The quantity of water evaporated, kg/h