CBCS SCHEME

USN

15BT44

Fourth Semester B.E. Degree Examination, June/July 2019
Bioprocess Principles and Calculation

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. A chemist is interested in preparing 500ml of 1 normal, 1 molar and 1 molal solution of H_2SO_4. Assuming the density of H_2SO_4 solution to be 1.075 g/cm^3, calculate the quantities of H_2SO_4 to be taken to prepare the solution. **(10 Marks)**

b. Define : (i) Amagat's law (ii) Daltons law (iii) Henry's law **(06 Marks)**

OR

2 a. An aqueous solution of K_2CO_3 is prepared by dissolving 43 kg of K_2CO_3 in 100 kg of water of 293 K (20°C). Calculate molarity, normality and molality in solution. **(08 Marks)**

b. A natural gas has the following composition by volume. CH_4 = 82%, C_2H_6 = 12% and N_2 = 6%. Calculate the density of gas at 288K (15°C) and 101.325 kPa and composition in weight %. **(08 Marks)**

Module-2

3 a. The feed containing 50% benzene and 50% toluene is fed to a distillation column at a rate of 5000 kg/hr. A top product contains 95% benzene and bottom product contains 92% toluene. All percentages are by weight calculate (i) The mass flow rates of top and bottom products (ii) percentage recovery of benzene. **(08 Marks)**

b. Calculate the net calorific value at 298K at a sample of fuel oil having C/H ratio 9.33 (by weight) and containing sulphur to the extent of 1.3% by weight. Data : The GCV of fuel oil at 298 K (25°C) = 41785 kJ/kg. Latent heat of water vapour at 298 K = 2442.5 kJ/kg. **(08 Marks)**

OR

4 a. Crude oil is analysed to contain 87% carbon, 12.5% hydrogen and 0.5% sulphur (by weight). Calculate the net calorific value of crude oil at 298 K(25°C).
Data : GCV of crude oil at 298 K is 45071 kJ/kg oil. Latent heat of water vapour at 298 K is 2442.5 kJ/kg. **(08 Marks)**

b. Soybean seeds are extracted with hexane in batch extractors. The flaked seeds are found to contain 18.6% oil, 69% soil and 12.4% moisture (by weight). At the end of the extraction process cake (meal) is separated from hexane oil mixture. The cake is analysed to contain 0.8% oil, 87.7% solids and 11.5% moisture by weight find the percentage recovery of oil. **(08 Marks)**

Module-3

5 a. In the production of sulphur trioxide, 100 kmol of SO_2 and 100 kmol of O_2 are fed to a reactor. If the percent conversion of SO_2 is 80. Calculate the composition of the product stream on mole basis. **(08 Marks)**

b. Oxidation of ethylene to produce ethylene oxide is given by reaction

$$C_2H_4 + \tfrac{1}{2}O_2 \rightarrow C_2H_4O$$

If air is used 20% in excess of that theoretically required, calculate the quantity of air supplied based on 100 kmol of ethylene fed to the reactor. **(08 Marks)**

OR

6 a. Define the following : (i) Limiting reactant (ii) Excess reactant (iii) % excess (iv) Yield (v) Selectivity. **(10 Marks)**

b. A combustion reactor is fed with 50 kmol/hr of butane and 2000 kmol/hr of air. Calculate the % excess air used and the composition of CO_2 and H_2O produced. The reaction is given as $C_4H_{10} + 13/2\ O_2 \rightarrow 4CO_2 + 5H_2O$. **(06 Marks)**

Module-4

7 a. A stream of nitrogen flowing at a rate of 100 kmol/h is heated from 303 K (30°C) to 373K (100°C). Calculate the heat that must be transferred for the following data:
$C_p^\circ = 29.509 - 5.141\times10^{-3}T + 11.1829\times10^{-6}T^2 - 4.968\times10^{-9}T^3$ **(08 Marks)**

b. Derive the empirical equation for heat capacity. **(08 Marks)**

OR

8 a. A natural gas has the following composition on mole basis. CH_4 = 84%, C_2H_6 = 13%, N_2 = 3%. Calculate the heat to be added to heat 10 kmol of natural gas from 298 K to 523 K, using the heat capacity data given below.
$C_P^\circ = a + bT + cT^2 + dT^3$ kJ/kmol K.

Gas	a	$b\times10^3$	$c\times10^6$	$d\times10^9$
CH_4	19.2494	52.1135	11.973	-11.3173
C_2H_6	5.4129	178.0872	-67.3749	8.7147
N_2	29.5909	-5.141	13.1829	-4.968

(08 Marks)

b. Calculate the heat of formation of liquid ethylacetate at 298K (25°C).
Data:
Standard heat of formation $CO_{2\,(g)}$ = –393.51 kJ/mol
Standard heat of formation $H_2O_{(l)}$ = –285.83 kJ/mol
Standard heat of combustion of liquid ethylacetate ($C_4H_8O_2$) = ΔH_C° = –2230.91 kJ/mol.
(08 Marks)

Module-5

9 a. Mention the various unit operations in a typical bioprocess and explain the steps in detail. **(12 Marks)**

b. Define : (i) Maintenance coefficient, (ii) Specific growth rate. **(04 Marks)**

OR

10 a. Assume that experimental measurement for a certain organism have shown that cells can convert 2/3 of substrate carbon to biomass.
(i) Calculate the stochiometric coefficients
(ii) Calculate the yield coefficients $Y_{(X/S)}$ and $Y_{(X/O_2)}$
$C_{16}H_{34} + aO_2 + bNH_3 \rightarrow c[C_{4.4}H_{7.3}N_{0.86}O_{1.2}] + dH_2O + eCO_2$ **(12 Marks)**

b. Write short notes on the historical developments of bioprocessing technology. **(04 Marks)**

* * * * *