U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

Programme: B.E. **Semester: III**

Branch: Biotechnology **Duration: 3 hrs.**

Course Code: 23BT3ESPPC / 22BT3PCPPC **Max Marks: 100**

Course: Process Principles and Calculations

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.
3. Use of psychrometric (humidity) chart and periodic table is allowed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	*CO*	*PO*	Marks
1	a)	Define normality, molarity and molality.	*CO1*	*PO 1*	**06**
	b)	It is required to prepare 500mL of following sulphuric acid concentration solutions i. 1 normal ii. 1 molar and iii. 1 molal solution Assuming the density of sulphuric acid acid solution to be 1.075 g/cm^3, calculate the quantities of sulphuric acid to be taken to prepare the above solutions.	*CO1*	*PO1*	**08**
	c)	An aqueous solution of sodium chloride is prepared by dissolving 25 kg of sodium chloride in 100 kg of water. Determine (a) weight % and (b) mole % composition of solution.	*CO1*	*PO1*	**06**
		OR			
2	a)	A solution of caustic soda contains 20% NaOH by weight. Taking density of the solution as 1.196 kg/L, find normality, molarity and molality of solution.	*CO1*	*PO1*	**08**
	b)	Define pH and pKa. Write the equations.	*CO1*	*PO1*	**04**
	c)	A saturated solution of salicylic acid (HOC_6H_4COOH) in methanol (CH_3OH) contains 64 kg salicylic acid per 100 kg of methanol at 298 K. Determine the composition of solution in (a) weight % (b) mol %.	*CO1*	*PO1*	**08**
		UNIT - II			
3	a)	Explain Raoult's law and Henry's law. Give two differences.	*CO1*	*PO1*	**06**

		b)	The dry bulb temperature and dew point of ambient air were found to be 302 K and 291 K respectively. Calculate a) absolute humidity b) molal humidity c) %RH d)% Saturation e) Humid heat Vapour pressure of water 291K = 2.0624 kPa Vapour pressure of water 302K = 4.004 kPa	*CO3*	*PO3*	**10**
		c)	Prove that mole% is equal to volume % for ideal gas mixtures. Why this is violated in solids?	*CO1*	*PO1*	**04**
			OR			
	4	a)	How to calculate the average molecular weight of mixture of gases? A mixture of A and B has the average molecular weight of 22.4. Find the mole percent of A and B in the mixture. Molecular weight of A and B are 16 and 30 respectively.	*CO1*	*PO1*	**08**
		b)	Mixture of n-heptane and n-octane are expected to behave ideally. The total pressure over the system is 101.3 kPa. Using the vapour pressure data given below: T (K) 371.4 378 383 388 393 P_A^s (kPa) 101.3 125.3 140.0 160.0 179. P_B^s (kPa) 44.4 55.6 64.5 74.8 86.6 Construct boiling point diagram (T-x-y).	*CO1*	*PO1*	**12**
			UNIT - III			
	5	a)	The feed to a continuous fractionating column analyses by weight 28% benzene and 72% toluene. The analysis of the distillate shows 52% weight % benzene and 5 weight % benzene was found in bottom product. Calculate the amount of distillate and bottom product per 1000 kg of feed per hour. Find the percent recovery of benzene	*CO2*	*PO2*	**10**
		b)	Draw a neat flowchart showing recycle and purge stream in bioprocess and discuss the importance of recycle and purge with suitable example.	*CO2*	*PO2*	**10**
			OR			
	6	a)	Draw neat block diagram of absorption, drying and extraction.	*CO2*	*PO2*	**06**
		b)	It is desired to have a mixed acid containing 40% HNO_3, 43% H_2SO_4, and 17% H_2O by weight. Sulphuric acid of 98% by weight is readily available. Calculate (a) the strength of nitric acid and (b) the weight ratio of sulphuric acid to nitric acid.	*CO2*	*PO2*	**06**

		c)	A tannery extracts contains wood barks which contains 37% tannin, 4% moisture, 23% soluble non-tannin materials and rest insoluble lignin. The residue removed from the extraction tanks contain 62% of water, 2.8% tannin, and 0.9% soluble tannin non tannin materials. Determine the composition of extracted product.	*CO2*	*PO2*	**08**
			UNIT - IV			
	7	a)	Define the limiting reactant, excess reactant. Give suitable examples.	*CO2*	*PO2*	**06**
		b)	In production of sulphur trioxide, 100 kmol of SO_2 and 100 kmol of O_2 are fed to the reactor. If the % conversion of SO_2 is 80, calculate the composition of the product stream on mole basis.	*CO2*	*PO2*	**06**
		c)	A feed containing 60 mole % A, 30 mole % B and 10 mole % inerts enters the reactor. 80 % of original A reacts according to the following reaction: $2A + B \rightarrow C$ Determine the composition of product stream.	*CO2*	*PO2*	**08**
			OR			
	8	a)	Differentiate between yield and conversion. Explain with examples.	*CO2*	*PO2*	**06**
		b)	Explain proximate and ultimate analysis of coal in the process of combustion.	*CO2*	*PO2*	**06**
		c)	The carbon monoxide is reacted with hydrogen to produce methanol. Calculate the following from the reaction stoichiometry: (i) The stoichiometric ratio of H_2 to CO (ii) kmol of CH_3OH produced per kmol CO reacted (iii) The weight ratio of CO to H_2, if both are fed to the reactor in stoichiometric properties (iv) The quantity of CO required to produce 1000 kg of CH_3OH	*CO2*	*PO2*	**08**
			UNIT - V			
	9	a)	Derive the equation relating temperature and heat of reaction with suitable assumptions.	*CO4*	*PO2*	**10**
		b)	Production of single cell proteins from hexadecane is given by the following equation. If the respiratory quotient (RQ) is 0.4, determine the stoichiometric coefficients: $C_{16}H_{34} + aO_2 + bNH_3 \rightarrow cCH_{1.66}O_{0.27}N_{0.2}$ (Biomass) $+ dCO_2 + eH_2O$	*CO4*	*PO2*	**06**
		c)	Discuss the application of Hess's law in determination of heat of reaction.	*CO4*	*PO2*	**04**
			OR			

<table>
<tr><td></td><td>10</td><td>a)</td><td>Define heat of combustion, heat of formation and heat of reaction.</td><td>CO4</td><td>PO2</td><td>04</td></tr>
<tr><td></td><td></td><td>b)</td><td>Explain the stoichiometry of microbial growth with one example</td><td>CO4</td><td>PO2</td><td>06</td></tr>
<tr><td></td><td></td><td>c)</td><td>A natural gas has the composition on mole basis:
CH_4 = 84%, C_2H_6 = 13%, and N_2 = 3%
Calculate the heat to be added to heat 10 kmol of natural gas from 298 K to 523 K using heat capacity data given below:
$Cp^o = aT+bT+cT^2 + dT^3$
<table>
<tr><th>Gas</th><th>a</th><th>b x 10^3</th><th>c x 10^6</th><th>d x 10^9</th></tr>
<tr><td>CH_4</td><td>19.2494</td><td>52.1135</td><td>11.973</td><td>-11.3173</td></tr>
<tr><td>C_2H_6</td><td>5.4129</td><td>178.0872</td><td>-67.3749</td><td>8.7147</td></tr>
<tr><td>N_2</td><td>29.5909</td><td>-5.141</td><td>13.1829</td><td>-4.968</td></tr>
</table></td><td>CO4</td><td>PO2</td><td>10</td></tr>
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