U.S.N.										

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

Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main Examinations

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

Branch: Chemical Engineering **Duration: 3 hrs.**

Course Code: 23CH3PCPPC / 22CH3PCPPC **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.

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 the following i. Normality ii. Molarity iii. Molality iv. ppm	*CO1*	*PO1*	**08**
	b)	Prove that Pressure % = Volume % = Mole %.	*CO2*	*PO1*	**06**
	c)	A gas mixture contains 0.274 kmol of HCl, 0.337 kmol of N_2 and 0.089 kmol of O_2. Calculate: i. Average molecular weight of gas ii. Volume occupied by this mixture ar 405.3 kPa and 303K.	*CO1*	*PO1*	**06**
		OR			
2	a)	A mixture of two gases, A and B, is kept in a 10 L container at 1 atm and 300 K. Gas A has a molar mass of 32 g/mol, and gas B has a molar mass of 28 g/mol. The mixture contains 1.5 moles of gas A and 2.5 moles of gas B. Calculate the average molar mass of the gas mixture and its density.	*CO1*	*PO1*	**06**
	b)	Define Amagats and Daltons Law.Write its equations.	*CO2*	*PO1*	**06**
	c)	A 10 L container is filled with a mixture of two gases, A and B, at 300 K and 1 atm. The partial pressure of gas A is 0.6 atm and that of gas B is 0.4 atm. The molar volume of an ideal gas at these conditions is 22.4 L/mol. Calculate: i. The number of moles of each gas in the mixture. ii. The mole fraction of each gas.	*CO1*	*PO1*	**08**
		UNIT - II			
3	a)	Define and write the basic material balance and component balance for the unit operations i. Distillation	*CO3*	*PO1*	**08**

			ii. Evaporation iii. Extraction iv. Absorption			
		b)	A single effect evaporator is fed with 10000 kg / h of weak liquor containing 15 % caustic by weight and is concentrated to get thick liquor containing 40 % by weight caustic. Calculate: i. kg/h of water evaporated and ii. kg/h of thick liquor	*CO4*	*PO1*	**12**
			OR			
	4	a)	The waste acid from a nitrating process contains 30 % H_2SO_4, 35 %HNO_3 and 35 % H_2O w/w. the acid is to be concentrated to contain 39 % H_2SO_4 and 42% HNO_3 by addition of concentrated sulfuric acid containing 98% H_2SO_4 and concentrated Nitric acid containing 72 % HNO_3. Calculate the quantities of three acids to be mixed to get 1000 kg of desired mixed acid.	*CO3*	*PO1*	**10**
		b)	The ground nut seeds containing 45% oil and 45% solids are fed to expeller. The cake coming out of expeller is found to contain 80% solids and 5% oil, find the percentage recovery of oil.	*CO4*	*PO1*	**10**
			UNIT - III			
	5	a)	The carbon monoxide is reacted with hydrogen to produce methanol. Calculate: 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 reactor in stoichiometric ratio of CO to H_2 if both are fed to reactor in stoichiometric proportions iv. The quantity of CO required to produce 1000 kg CH_3OH	*CO4*	*PO2*	**14**
		b)	Define the following (i) limiting reactant (ii) excess reactant	*CO4*	*PO2*	**06**
			OR			
	6	a)	The producer gas made from the coke has the following composition by volume: CO - 28%, CO_2 - 3.5%, O2 - 0.5% and N_2 - 68%. The gas is burnt with such a quantity of air that the oxygen from air is 20% in excess of the net oxygen required for complete combustion. If the combustion is 98% complete, calculate the weight of the gaseous product formed per 100 kg of the gas burned.	*CO4*	*PO2*	**14**
		b)	Define the following (i) fractional yield (ii) Percentage yield (iii) selectivity	*CO4*	*PO2*	**06**
			UNIT - IV			
	7	a)	Classify the types of fuel. Explain with examples.	*CO4*	*PO2*	**06**
		c)	Coal containing C - 68.2%, H – 4.5%, S – 0.7%, N – 1.7%, O - 7.8%, Ash – 4.4%, and water - 12.7%, is burnt in a furnace. The product of combustion dry gas, analyses CO_2 – 14.4%, O_2 – 4.6% and rest N_2. Calculate:	*CO4*	*PO2*	**16**

<table>
<tr><td></td><td></td><td></td><td>i. The theoretical volume of air used for the complete combustion of 100 kg of coal
ii. The percentage of excess air used.</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td>OR</td><td></td><td></td><td></td></tr>
<tr><td></td><td>8</td><td>a)</td><td>Write a note on calorific value of fuels.</td><td>CO1</td><td>PO1</td><td>06</td></tr>
<tr><td></td><td></td><td>b)</td><td>Hydrogen (H_2) is combusted with 25% excess air. The balanced equation for the combustion of hydrogen is:
$2H_2+O_2 \rightarrow 2H_2$
Calculate the actual air required for the combustion of 2 moles of hydrogen.</td><td>CO4</td><td>PO2</td><td>08</td></tr>
<tr><td></td><td></td><td>c)</td><td>Explain ultimate and proximate analysis of coal.</td><td>CO1</td><td>PO1</td><td>06</td></tr>
<tr><td></td><td></td><td></td><td>UNIT - V</td><td></td><td></td><td></td></tr>
<tr><td></td><td>9</td><td>a)</td><td>Explain adiabatic flame temperature and theoretical flame temperature.</td><td>CO1</td><td>PO1</td><td>06</td></tr>
<tr><td></td><td></td><td>b)</td><td>Obtain an empherical equation for calculating the heat of reaction at any temperature T (in K) for the reaction:
CO (g) + $2H_2$ (g) → CH_3OH (g)
Data : ΔH_R^o = -90.41KJ/mol
Cpo = a + bT + cT^2 + dT^3, kJ/(kmol.K)
<table>
<tr><td>Component</td><td>a</td><td>b X 10^3</td><td>c X 10^6</td><td>d X 10^9</td></tr>
<tr><td>CO (g)</td><td>29.0277</td><td>-2.8165</td><td>11.6437</td><td>-4.7063</td></tr>
<tr><td>H_2 (g)</td><td>28.6105</td><td>1.0194</td><td>-0.1476</td><td>0.769</td></tr>
<tr><td>CH_3OH(g)</td><td>21.137</td><td>70.843</td><td>25.86</td><td>-28.479</td></tr>
</table></td><td>CO6</td><td>PO2</td><td>14</td></tr>
<tr><td></td><td></td><td></td><td>OR</td><td></td><td></td><td></td></tr>
<tr><td></td><td>10</td><td>a)</td><td>Explain the Hess’s law of heat summation.</td><td>CO1</td><td>PO1</td><td>04</td></tr>
<tr><td></td><td></td><td>b)</td><td>Define the following
(i) Heat of reaction
(ii) Heat of formation
(iii) Heat of combustion</td><td>CO1</td><td>PO1</td><td>06</td></tr>
<tr><td></td><td></td><td>c)</td><td>Calculate the heat of formation of phenol crystals at 298.15K From its elements using following data.
Standard heat of formation CO_2 (g) = -393.51 kJ/mol
Standard heat of formation H_2O (l) = -285.83 kJ/mol
Heat of combustion of phenol crystals at 298.15 K =-3053.25 kJ/mol</td><td>CO6</td><td>PO2</td><td>10</td></tr>
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