Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III (NEW) EXAMINATION – WINTER 2021

Subject Code:3133606 Date:17-02-2022

Subject Name:Fundamentals of Material & Energy Balance Calculations

Time:10:30 AM TO 01:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	Define the following quantities with MKS units: i) Density ii) Force iii) Heat.	**03**
	(b)	Write in brief about gram mole and gram atom.	**04**
	(c)	Write short notes on vapour pressure and partial pressure.	**07**
Q.2	**(a)**	Explain the following unit operations with their block diagram and material balances: i) Distillation ii) Evaporation.	**03**
	(b)	Differentiate between: (i) Sensible heat and latent heat (ii) Endothermic and exothermic reactions	**04**
	(c)	Write short note on recycling, bypassing and purging operations.	**07**
		OR	
	(c)	The average molecular weight of the flue gas sample is calculated by two different engineers. One engineer used the correct molecular weight of N2 as 28, while the other used an incorrect value of 14. They got the average molecular weight as 30 and the incorrect one as 18.74. Calculate the % volume of N2 in the flue gases. If the remaining gases are CO2 and O2, calculated their compositions also.	**07**
Q.3	**(a)**	Define (1) conversion (2) yield (3) selectivity	**03**
	(b)	Explain: Dalton's law , Raoult's law, Henry's law and Ideal gas law	**04**
	(c)	A soap plant produced raw soap containing 50 % moisture. This is to be dried 20 % moisture before it is pressed into cakes for sale. How many 100 g soap piece can be obtained from 1000 kg of original raw soap?	**07**
		OR	
Q.3	**(a)**	Define: (1) Dry-bulb temperature (2) Wet-bulb temperature.	**03**
	(b)	Explain adiabatic reaction with a suitable example.	**04**
	(c)	The gaseous reaction A = 2B + C takes place isothermally in a constant- pressure reactor. Starting with a mixture of 75 % A and 25 % inerts (by volume), in a specified time the volume double. Calculate the conversion achieved.	**07**
Q.4	**(a)**	Write down the general energy balance procedure steps.	**03**
	(b)	Discuss Proximate and Ultimate analysis of coal.	**04**
	(c)	Air being compressed from 100 kPa and 255 K (enthalpy 489 kJ/kg) to 1000 kPa and 278 K (enthalpy 509 kJ/kg). The exit velocity of air is 60 m/s. what is the power required (in kW) for the compressor if the load is 100 kg/hr of air?	**07**
		OR	
Q.4	**(a)**	Explain standard heat of reaction and standard heat of combustion.	**03**
	(b)	A force of 15 kgf is applied on a piston of diameter 3 cm. Find the pressure exerted on a piston in KPa.	**04**

	(c)	For the following reaction , estimate the heat of reaction at 298 K $A + B \rightarrow C + D$ Data: ΔH^0_f, A = -269.8 kcal/gmol , ΔH^0_f, B = -195.2 kcal/gmol, ΔH^0_f, C = -337.3 kcal/gmol , ΔH^0_f, D = -29.05 kcal/gmol	**07**
Q.5	**(a)**	Explain in brief about law of conservation of mass and energy.	**03**
	(b)	Derive the following: $\rho mix = (PMavg) / RT$	**04**
	(c)	A petroleum gas has the following composition by volume expressed as: CH_4 =78%, C_2H_6 = 12% and C_3H_8 =10%. Calculate the gas density in kg/m3 under 585 psig and 310 K.	**07**

OR

Q.5	**(a)**	Write in short about NCV and GCV.	**03**
	(b)	Discuss methods of solving material balance problems without chemical reaction.	**04**
	(c)	An aqueous solution of K_2CO_3 is prepared by dissolving 44 g K_2CO_3 in 100 g water at 293 K. Find, Molarity, Normality and Molality of the solution. Take density of solution as 1.3 kg/L.	**07**

****