Name: **Enrolment No:**	UPES UNIVERSITY OF THE FUTURE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End semester Examination, December 2022

Programme Name: B. Tech. (APE-Gas) **Semester : III**
Course Name : Material and Energy Balance Computations **Time : 3 hrs**
Course Code : CHCE 2025 **Max. Marks : 100**
Nos. of page(s) : 02
Instructions : Assume any missing data. Draw the diagrams, wherever necessary.

SECTION A
(5X4=20 marks)

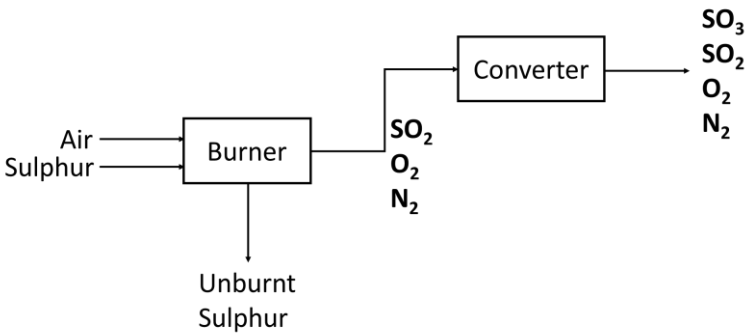
S. No.		Marks	CO
1	***Identify*** the different methods of non-dimensionalization.	**4**	**CO1**
2	***Summarize*** material balance equation for a reactive system.	**4**	**CO1**
3	***Illustrate*** the use of excess air in the combustion of fuel and write down the formulae.	**4**	**CO1**
4	***Dramatize*** the use of Bypass in process industry.	**4**	**CO3**
5	***Classify*** sensible heat and latent heat and the methods necessary for calculating total heat balances during the energy balances.	**4**	**CO4**

SECTION B
(4 X 10=40 marks)

6	A liquefied mixture of methane, butane and propane has the compositions of 30,30 and 40 percent respectively by volume. ***Identify*** mol%, weight %, and average molecular weight of the mixture.	**10**	**CO1**
7	Humid air at 75^{O}C, 1.1 bar and 30% relative humidity is fed into a process unit at a rate of 1000 m^3/h. **Explore** the molal humidity, absolute humidity and the percentage humidity of air. Vapor pressure of water at the given conditions is 0.3854 bar.	**10**	**CO2**
8	To a combustion chamber, if 10 kg of methane (CH4) and 700 kg of air are admitted, ***Solve*** a. Write the chemical reaction and balance. b. Moles of methane entering. c. Moles of air entering. d. Exhaust composition.	**10**	**CO3**
9	1000 kg /h of thermic fluid to be used as a heat transfer medium is being heated using a heater from 380 to 550 K. ***Appraise*** the heat load on the heater in KW. The heat capacity of the fluid is given by the equation $Cp=1.436+2.18x10^{-3}T$ where T in K and Cp in kJ/kg K.	**10**	**CO4**

SECTION C
(2 X 20=40 marks)

10	A simplified process for SO_2 to SO_3 is as shown in the figure below.	**20**	**CO3**



Sulfur is burned with 100% excess air in the burner though the conversion of SO_2 is only 90%. In the converter, the conversion from SO_2 to SO_3 is only 95%. ***Calculate*** the lbs of air needed to burn 100 lbs of Sulfur and the composition of exiting stream from the converter.

OR

(a) A distillation column is designed to separate Benzene, Toluene and Xylene. The system is designed such that the bottoms will contain 2% Xylene and no Benzene in it. The composition of feed stream is 30% Benzene, 35% Toluene and 35% Xylene. These percentages are on mole percent). If 100 moles per hour of feed is fed to the distillation column to have 30 mol/h of bottoms, ***evaluate*** the composition of bottoms and distillate by using material balances.

(b) For carrying out nitration reaction it is desired to have a mixed acid containing 39% HNO_3 and 42%H_2SO_4. Nitric acid of 68.3% is already available. ***Calculate*** the required strength of sulfuric acid to obtain the given concentration**.**

11

A natural gas stream has the following composition on mole basis:
CH_4 – 84%, C_2H_6 – 13% and N_2 – 3%.
Analyze 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.

$C_p = a + bT + cT^2 + dT^3$, kJ/ (kmol-K).

Gas	a	b x 10^3	c x 10^6	d x 10^9
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

20 **CO4**