Name: Enrolment No:	UPES UNIVERSITY OF TOMORROW

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination December, 2024

Course: Chemical Engg. Thermodynamics — **Semester: III**

Program: B. Tech Chemical Engg. — **Time: 3 hours**

Course Code: CHCE 2002 — **Max. Marks: 100**

Instructions: (1) This is an **Open Books and Open notes examination**. Students can carry ***ANY ONE*** text book of their choice and class notes/photocopy in the examination hall. Answer **ALL** questions

(2) Assume the appropriate value of missing data, if any.

(3) The thermodynamic terms have their usual meanings as described in the class

Q1	A deodorant spray is stored in a can at an initial temperature of 20 °C and a pressure of 5bar. When the spray is released, it expands to atmospheric pressure (1bar) through a nozzle. When the deodorant spray hits the skin, it evaporates by absorbing heat from the skin. The latent heat of vaporization of the deodorant is 200 J/g. The mass of the deodorant sprayed in one shot is 5g. The skin is exposed to the spray with an area of 25cm^2, and the initial temperature of the skin is 35°C. Assume the followings: • The cooling of the spray due to throttling follows the Joule-Thomson effect. • All the latent heat required for the evaporation of the deodorant is taken from the skin. • Neglect external heat losses other than from the skin. • The temperature drop of the skin is solely due to the heat transfer from the skin to the deodorant. Consider the following data for the deodorant, Heat Capacity, C_P=400 J/mol-K, Molar volume V=0.01m^3/mol, Volume expansivity, $\beta=4.56\times10^{-3}$ K^{-1} Find: (a) The Joule Thomson coefficient of the deodorant. (b) The temperature of the deodorant immediately after throttling. (c) The final temperature of the skin just after the deodorant spray hits the skin.	**15+ 15+ 10**	**CO1+ CO4+ CO4**

Q2

In the month of summer, you turn on the ceiling fan in your hostel room in the morning before heading to the university, hoping that the room will be cooler when you return in the evening. Your hostel room measures 5m×5m×7m, and the ceiling fan has a power rating of 30W. Additionally, there is a fridge in your room with a power consumption of 100W, and you leave the fridge door open and keep it on, thinking it will help cool the room. The room's temperature before you leave in the morning is 290 K, and the atmospheric pressure is 1atm. Assume your hostel room is a closed system with closed doors and windows. Will the room be cooler in the evening? What will be the room's temperature if you leave at 8 AM and return at 6 PM?

Now, assume the room is not a perfectly closed system and can exchange heat with the surrounding air (outside the room) through its walls at a constant rate of 20W. Considering this heat exchange, what will be the final temperature of the room in the evening? Use the following data:

Heat capacity of air: Cp=1.005 kJ/kg (independent of temperature and pressure).

Air density in the room as 1.2 kg/m^3.

15+ 15 | **CO2+ CO3**

Q3

An LPG (mixture of propane and butane) cylinder in your kitchen is at 288 K and 550 kPa. Assume that the cylinder contains a large amount of liquid and small amount of gas at the given conditions. Also assume that both liquid phase and vapor phase behave non-ideally. The Antoine constants for propane and butane are given in the Table below. The Antoine equation for the components is $\ln P_i^{sat} = A - \frac{B}{T - C}$. Where P^{sat} is in Torr and temperature, T, is in ^{o}C. Determine the composition of the LPG stored in the cylinder. The LPG is connected to the stove and after 15 days the pressure inside the cylinder is reduced to 300 kPa and temperature also reduced to 290 K. Will the compositions of liquid and gas phases change inside the cylinder. If ***NO,*** why***?*** If **YES**, find compositions. The Antoine constants, activity coefficients, γ and fugacity coefficients, ϕ are given below

Component	A	B	C	γ	ϕ
propane	6.82972	813.2	248	1.23	1.1
butane	6.83029	945.9	240	1.40	1.25

15+ 15 | **CO3+ CO4**