Name:

Enrolment No:

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

Program Name: B. Tech (APE Gas) **Semester: III**
Course name: Engineering Thermodynamics **Time: 03hrs**
Course Code: MECH2001 **Max. Marks: 100**
Note: Assume suitable data wherever necessary.

Section – A
Attempt all the questions. All questions carry equal marks

S. No.		Marks	CO
Q1	A closed system consisting of 4 lb of a gas undergoes a process during which the relation between pressure and volume is pV^n = constant. The process begins with p_1 = 15 lbf/in.^{2}, v_1 = 1.25 ft^3 /lb and ends with p_2 = 53 lbf/in^2, v_2 = 0.5 ft^3 /lb. Determine (a) the volume, in ft^3, occupied by the gas at states 1 and 2 and (b) the value of n.	12	CO1
Q2	A large stationary diesel engine produces 15 MW with a thermal efficiency of 40%. The exhaust gas, which we assume is air, flows out at 800 K and the intake is 290 K. How large a mass flow rate is that if that accounts for half the Q_L? Can the exhaust flow energy be used?	12	CO2
Q3	Derive Maxwell equations from basic thermodynamic relations.	12	CO3
Q4	The enthalpy of a binary liquid system of species 1 and 2 at fixed T and P is represented by the equation: $$H = 400x_1 + 600x_2 + x_1x_2\,(40x_1 + 20x_2)$$ where H is in J·mol^{-1}. Determine expressions for $\bar{H}_1$ and $\bar{H}_2$as functions of x_1, numerical values for the pure-species enthalpies H_1 and H_2, and numerical values for the partial enthalpies at infinite dilution$\bar{H}_1^{\infty}$ and $\bar{H}_2^{\infty}$.	12	CO4
Q5	Explain Vapor-compression cycle.	12	CO5

Section – B
Answer all questions

Q6	Binary system acetonitrile(1)/nitromethane(2) confirms closely to Roult's law. Vapor pressures for the pure species are given by the following equations: $$\ln P_1^{sat}/kPa = 14.2724 - \frac{2945.47}{\frac{t}{^oC} + 224}$$ $$\frac{\ln P_2^{sat}}{kPa} = 14.2043 - \frac{2972.64}{\frac{t}{^oC} + 209}$$ (i) Prepare graph showing P vs. x_1 and P vs. y_1 for a temperature of 75^{o}C. (ii) Prepare graph showing t vs. x_1 and t vs. y_1 for a pressure of 75 kPa.	20	CO4

Q7	i. Explain the phase change of a pure substance with P-V, P-T and P-V-T diagram. ii. For liquid acetone at 20°C and 1 bar, $\beta = 1.487 \times 10^{-3}$ °C^{-1}, k = 62 × 10 −6 bar^{-1}, V = 1.287 cm^3·g^{-1} For acetone, find: a) The value of $(\partial P / \partial T)$ V at 20°C and 1 bar. (b) The pressure after heating at constant V from 20°C and 1 bar to 30°C. (c) The volume change when T and P go from 20°C and 1 bar to 0°C and 10 bar.	**10+10**	**CO3**