Name: **Enrolment No:**	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
Supplementary Examination, Dec 2023

Course: Thermodynamics-1 **Semester: III**
Program: B. Tech Chemical (Spl R&P) **Time: 3 hrs**
Course Code: CHCE 2012 **Max. Marks: 100**

Instructions: (1). 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

S. No.		Marks	CO
Q1	Air goes through a polytropic process from 130 kPa, 315 K to 280 kPa and 450 K. Find the polytropic constant 'n' and the specific work in the process. Assume air to be an ideal gas.	**10**	**CO1**
Q2	Determine the volume expansion ratios for both the isothermal and adiabatic stages of a Carnot cycle operating between thermal reservoirs at temperatures of 575 K and 278 K. The given overall volume expansion ratio is 20, and the specific heat ratio (C_P/C_v) is assumed to be 1.4.	**10**	**CO3**
Q3	In the P-T phase diagram, water exhibits an unusual characteristic: the fusion curve possesses a negative slope, unlike other substances where the fusion curve typically has a positive slope. Provide two examples where this distinctive behavior of water on the P-T diagram proves to be beneficial.	**10**	**CO3**
Q4	A balloon that was originally empty is being filled with hydrogen from a cylinder at a constant temperature of 300 K. The atmospheric pressure is 1.01325 bar. What is the work done by the balloon–cylinder system when the balloon attains a spherical shape 6 m in diameter?	**10**	**CO2**
Q5	Consider a pure substance in its solid-state in a closed system. Energy is supplied continuously in the isobaric process (constant pressure P1) till the solid is completely converted to superheated vapor. Trace the path of the process for the variation of volume of the substance with temperature. The same processes are carried out at different pressure P2, P3, P4, etc., such that P1 < P2 < P3 < P4. Show the variation of volume with temperature on the two -dimensional plot for different isobars on the same plot. Indicate various regions and discuss the process.	**10**	**CO2**
Q6	One mole of an ideal gas is at an initial state of (P_1, T_1) in a closed system. The gas undergoes a reversible adiabatic compression to the pressure P_2 followed by the reversible isochoric cooling to the final pressure to P_1. Finally, some energy is transferred as heat at constant pressure till the system is restored at final temperature	**10**	**CO2**

	T_1. Derive the equation for total work transferred in terms of the pressures, temperature T_1 and the adiabatic exponent, γ ($\gamma = C_p/C_v$).		
Q7	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 4m x 4m x 6m, and the ceiling fan has a rating of 150 W. The room's temperature before you leave in the morning is 288 K, and the pressure is atmospheric. Assuming your hostel room is a closed system with closed doors and windows, and no heat exchange occurs between the room and the surrounding environment, will the room be cooler in the evening? What would be the room's temperature if you left at 8 AM and returned at 6 PM? Consider the constant heat capacity of air as Cp = 1.005 kJ/kg·K, independent of temperature and pressure.	**20**	**CO4**
Q8	An Insulated electrically heated tank for hot water contains 190 kg of liquid water at 60^o C when a power outage occurs. If water is withdrawn from the tank at a steady rate of 0.2 kg/s, how long will it take for the temperature of the water in the tank to drop from 60 to 35^o C ? Assume that the cold water enters the tank at 10^oC, and that the heat losses from the tank are negligible. KE and PE changes are negligible and $C_P = C_V = C$	**20**	**CO4**