Name: **Enrolment No:**	UPES

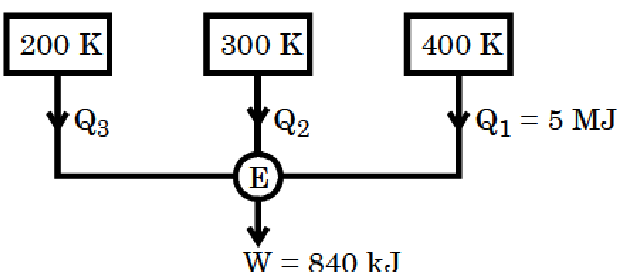
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2020

Course: Engineering Thermodynamics (MECH 2014) **Semester: III**
Program: B. Tech Mechatronics
Time: 3 Hours **Max. Marks: 100**

SECTION A

Note: For Q-1 to Q-6, Type the final answer only. Write precisely and to the point.

S. No.		Marks	CO
Q-1	Explain what you understand by thermodynamics equilibrium. Explain Mechanical, Chemical and Thermal equilibrium.	**5**	**CO1**
Q-2	Why does free expansion have zero work transfer?	**5**	**CO1**
Q-3	What do you understand by dissipative effect? When is the work said to be dissipated?	**5**	**CO1**
Q-4	What do you understand by the entropy principle? When the system is at equilibrium why would any conceivable change in entropy be zero?	**5**	**CO1**
Q-5	Classify internal combustion engine. What is air standard efficiency?	**5**	**CO1**
Q-6	What is PMM1, PMM2, and PMM3? What guidelines does it prescribe for energy conversion?	**5**	**CO1**
	SECTION B		
Q-7	A nozzle is a device for increasing the velocity of a steadily flowing stream. At the inlet to a certain nozzle, the enthalpy of the fluid passing is 3000 kJ/kg and the velocity is 60 m/s. At the discharge end, the enthalpy is 2762 kJ/kg. The nozzle is horizontal and there is negligible heat loss from it. (a) Find the velocity at exists from the nozzle. (b) If the inlet area is 0.1 m2 and the specific volume at inlet is 0.187m^3/kg, find the mass flow rate. (c) If the specific volume at the nozzle exit is 0.498m^3/kg, find the exit area of the nozzle.	**10**	**CO2**
Q-8	A household refrigerator is maintained at a temperature of 2°C. Every time the door is opened, warm material is placed inside, introducing an average of 420 kJ, but making only a small change in the temperature of the refrigerator. The door is opened 20 times a day, and the refrigerator operates at 15% of the ideal COP. The cost of work is Rs.	**10**	**CO2**

	2.50 per kWh. What is the monthly bill for this refrigerator? The atmosphere is at 30°C.		
Q-9	A system maintained at constant volume is initially at temperature $T1$, and a heat reservoir at the lower temperature T_0 is available. Show that the maximum work recoverable as the system is cooled to T_0 is $$W = C_V[(T_1 - T_0) - T_0 \ln \frac{T_1}{T_0}]$$	**10**	**CO2**
Q-10	Evaluate the entropy change of the universe as a result of the following processes: (a) A copper block of 600 g mass and with Cp of 150 J/K at 100°C is placed in a lake at 8°C. (b) The same block, at 8°C, is dropped from a height of 100 m into the lake. (c) Two such blocks, at 100 and 0°C, are joined together.	**10**	**CO3**
Q-11	What do you understand by Air standard cycle? Find the air standard efficiencies for Otto cycle with a compression ratio of 6 using ideal gases having specific heat ratios 1.3, 1.4, and 1.67. Plot the results for efficiency and heat ratios. **OR** A heat pump working on the Carnot cycle takes in heat from a reservoir at 5°C and delivers heat to a reservoir at 60°C. The heat pump is driven by a reversible heat engine, which takes in heat from a reservoir at 840°C and rejects heat to a reservoir at 60°C. The reversible heat engine also drives a machine that absorbs 30 kW. If the heat pump extracts 17 kJ/s from the 5°C reservoir, determine (a) The rate of heat supply from the 840°C source; (b) The rate of heat rejection to the 60°C sink.	**10**	**CO2**
	SECTION C		
Q 12	A reversible engine, as shown in Figure during a cycle of operations draws 5 MJ from the 400 K reservoir and does 840 kJ of work. Find the amount and direction of heat interaction with other reservoirs.  **OR** One kg of air initially at 0.7 MPa, 20°C changes to 0.35 MPa, 60°C by the three reversible non-flow processes, as shown in Figure. Process 1: a-2 consists of a constant pressure expansion followed by a constant volume cooling, process 1: b-2 an isothermal expansion followed by a constant pressure expansion, and process 1: c-2	**20**	**CO3**

	an adiabatic Expansion followed by a constant volume heating. Determine the change of internal energy, enthalpy, and entropy for each process, and find the work transfer and heat transfer for each process. Take *Cp* = 1.005 and Cv = 0.718 kJ/kg K and assume the specific heats to be constant. Also assume for air *pv* = 0.287 T, where *p* is the pressure in kPa, *v* the specific volume in m3/kg, and *T* the temperature in K.