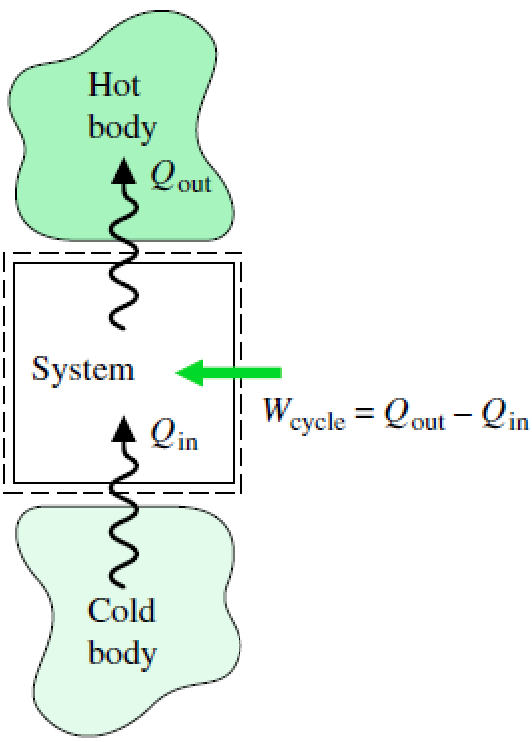
Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2019

Course: B.Tech ADE ,MECHATRONICS **Semester: III**
Program: Engineering Thermodynamics **Time 03 hrs.**
Course Code: MECH2014 **Max. Marks: 100**
Instructions: All the questions are compulsory.
Steam table is allowed

SECTION A (Attempt all the questions)

S. No.		Marks	CO
Q 1	A refrigeration cycle operating as shown in Fig has heat transfer Qout = 2530 kJ and net work of Wcycle is 844 kJ. Determine the coefficient of performance for the cycle.  .	5	CO1
Q 2	Simplify the general forms of the mass and energy rate balances to describe the process of blowing up a balloon. List all of your modeling assumptions.	5	CO1

Q 3	Explain why do frozen water pipes tend to burst?	5	CO3
Q 4	A heat pump receives energy by heat transfer from the outside air at 0°C and discharges energy by heat transfer to a dwelling at 20°C. Is this in violation of the Clausius statement of the second law of thermodynamics? Explain.	5	CO1
SECTION B (Attempt all of the following questions)			
Q 5	Steam enters a converging–diverging nozzle operating at steady state with p_1=40 bar, T_1= 400°C, and a velocity of 10 m/s. The steam flows through the nozzle with negligible heat transfer and no significant change in potential energy. At the exit, p2 = 15 bar, and the velocity is 665 m/s. The mass flow rate is 2 kg/s. Determine the exit area of the nozzle, in m^2.	10	CO2
Q 6	At the beginning of the compression process of an air-standard Diesel cycle operating with a compression ratio of 18, the temperature is 300 K and the pressure is 0.1 MPa. The cutoff ratio for the cycle is 2. Determine (a) the temperature and pressure at the end of each process of the cycle, (b) the thermal efficiency, (c) the mean effective pressure, in MPa.	10	CO3
Q 7	Water initially a saturated liquid at 100°C is contained within a piston–cylinder assembly. The water undergoes a process to the corresponding saturated vapor state, during which the piston moves freely in the cylinder. There is no heat transfer with the surroundings. If the change of state is brought about by the action of a paddle wheel, determine the net work per unit mass, in kJ/kg, and the amount of entropy produced per unit mass, in kJ/kg K. OR At the beginning of the compression process in an airstandard Otto cycle, p1= 1 bar and T1=300 K. The maximum cycle temperature is 2000 K. Plot the net work per unit of mass,in kJ/kg, the thermal efficiency, and the mean effective pressure, in bar, versus the compression ratio ranging from 2 to 14.	10	CO4
Q 8	The absolute pressure inside a tank is 0.4 bar, and the surrounding atmospheric pressure is 98 kPa. What reading would a Bourdon gage mounted in the tank wall give, in kPa? Is this a *guage* or *vacuum* reading?	10	CO1
SECTION-C(Attempt all of the following)			
Q 9	A vertical piston–cylinder assembly containing 0.05 kg of ammonia, initially a saturated vapor, is placed on a hot plate. Due to the weight of the piston and the surrounding atmospheric pressure, the pressure of the ammonia is 1.5 bars. Heating occurs slowly, and the ammonia expands at constant pressure until the final temperature is 25°C. Show the initial and final states on T–v and p–v diagrams, and determine (a) The volume occupied by the ammonia at each state, in m3. (b) The work for the process, in kJ.	20	CO4

Q 10	A power plant based on the Rankine cycle is under development to provide a net power output of 10 MW. Solar collectors are to be used to generate Refrigerant 22 vapor at 1.6 MPa, 50°C, for expansion through the turbine. Cooling water is available at 20°C. Specify the preliminary design of the cycle and estimate the thermal efficiency and the refrigerant and cooling water flow rates, in kg/h. OR Steam enters a turbine with a pressure of 30 bar, a temperature of 400°C, a velocity of 160 m/s. Steam exits as saturated vapor at 100°C with a velocity of 100 m/s. At steady state, the turbine develops work at a rate of 540 kJ per kg of steam flowing through the turbine. Heat transfer between the turbine and its surroundings occurs at an average outer surface temperature of 350 K. Develop a full accounting of the net exergy carried in by the steam, per unit mass of steam flowing. Neglect the change in potential energy between inlet and exit. Let T_0 = 25°C, P_0 = 1 atm.	20	CO3