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

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

Online End Semester Examination, December 2020

Course: Engineering Thermodynamics **Semester: III**

Program: B. Tech. ADE **Time 03 hrs.**

Course Code: MECH 2014 **Max. Marks: 100**

SECTION A

1. **Each Question will carry 5 Marks**
2. **Instruction: Write the statement / answer(s)**

S. No.	**Question** **5 × 6 M= 30 M**	**CO**
Q 1	Write down the Zeroth law of thermodynamics and state the practical application of the law in day to day life.	**CO1**
Q2	During one cycle the working fluid in an engine engages in two work interactions: 15 kJ to the fluid and 44 kJ from the fluid, and three heat interactions, two of which are known: 75 kJ to the fluid and 40 kJ from the fluid. Write down the magnitude and direction of the third heat transfer.	**CO2**
Q3	Discuss the conditions which must be fulfilled by a reversible process. Give some examples of ideal reversible processes.	**CO1**
Q4	A closed system of constant volume experiences a temperature rise of 25 °C when a certain process occurs. The heat transferred in the process is 30 kJ. The specific heat at constant volume for the pure substance comprising the system is 1.2 kJ/kg°C, and the system contains 2.5 kg of this substance. Determine : (i) The change in internal energy ; (ii) The work done.	**CO2**
Q5	Give the following statements of second law of thermodynamics. (i) Clausius statement (ii) Kelvin-Planck statement.	**CO1**
Q6	A heat cycle is claimed to develop 0.4 kW by heat addition of 32.5 kJ/min. The temperature of heat source is 1990 K and that of sink is 850 K. Is the statement true?	**CO1**

SECTION B

1. **Each Question will carry 10 Marks**
2. **Instruction: Write short / brief notes** **5 × 10 M= 50 M**

Q 7	1.2 m^3 of air is heated reversibly at constant pressure from 300 K to 600 K, and is then cooled reversibly at constant volume back to initial temperature. If the initial pressure is 1 bar, calculate the overall change in entropy. Take C_p = 1.005 kJ/kg K and R = 0.287 kJ/kg K	**CO2**

Q 8	Derive an expression for Exergy balance for a closed system in terms of availability function.	**CO2**
Q 9	A refrigerator having COP of 6 is driven by an engine of 35% thermal efficiency. Determine the heat input to the engine for each MJ removed from the cold body by the refrigerator? If this system is used as a heat pump, how many MJ of heat would be available for heating for each MJ of heat input to the engine?	**CO3**
Q 10	Steam is supplied to a turbine at 1470 KN/m^2 and internal energy of 2944.2 kJ/kg and specific volume of 0.16 m^3/kg and velocity of 110 m/s. Exhaust takes place at 4.9 kN/m^2 with internal energy of 1890 kJ/kg and specific volume equal to 26 m^3/kg and velocity of 300 m/s. Heat loss from steam turbine is 21 kJ/kg. Potential energy change is negligible. Determine the shaft work out put/kg.	**CO3**
Q 11	Draw the vapour compression cycle on a T-s diagram and explain the working principle with all the components. Discuss the expression of the COP in terms of enthalpy.	**CO3**

Section C

1. **Each Question will carry 20 Marks**
2. **Instruction: Write long answer.** **1 × 20 M= 20 M**

Q12	A steam turbine receives superheated steam at a pressure of 16 bar and having a degree of superheat of 109 ºC. The exhaust pressure is 0.07 bar and the expansion of steam takes place isentropically. Calculate (a) The heat rejected, (b) the heat supplied, (c) net work done, and (d) thermal efficiency. (Neglect pump work). OR 4 Kg of dry steam at 6.0 bar pressure and dryness fraction of 0.5 is heated, so that it become (a) 0.95 dry (b) Dry & saturated (c) Superheated to 300 ºC (d) Superheated to 250 ºC Determine the net heat supplied in each case. Take C_{sup} for superheated steam as 2.3 kJ/ kg K.	**CO4**

Saturated water and steam data for Q12

p MPa	T_{sat} °C	Volume, m^3/kg		Energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/(kg K)		
		v_f	v_g	u_f	u_g	h_f	h_g	h_{fg}	s_f	s_g	s_{fg}
0.0070	39.000	0.00100750	20.524	163.34	2428.0	163.35	2571.7	2408.4	0.55903	8.2745	7.7154
0.0075	40.290	0.00100800	19.233	168.74	2429.8	168.75	2574.0	2405.3	0.57627	8.2501	7.6738
0.58	157.506	0.00109905	0.32585	664.01	2565.7	664.65	2754.7	2090.0	1.9176	6.7707	4.8531
0.60	158.826	0.00110060	0.31558	669.72	2566.8	670.38	2756.1	2085.8	1.9308	6.7592	4.8284
1.65	202.856	0.00116103	0.12010	863.25	2595.5	865.17	2793.7	1928.5	2.3575	6.4089	4.0514
1.70	204.307	0.00116336	0.11667	869.76	2596.2	871.74	2794.5	1922.7	2.3711	6.3981	4.0270
1.75	205.725	0.00116565	0.11343	876.13	2596.7	878.17	2795.2	1917.0	2.3845	6.3877	4.0032

Water/Steam at p = 1.6 MPa (Tsat = 201.370.)

T	v	u	h	s
°C	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
300	0.15866	2781.5	3035.4	6.8863
310	0.16190	2798.8	3057.8	6.9250
320	0.16511	2815.8	3080.0	6.9628
330	0.16829	2832.8	3102.1	6.9997

Superheat steam data Water/Steam at p = 0.60 MPa (Tsat = 158.826 ºC)

T	v	u	h	s
°C	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
240	0.38568	2705.1	2936.5	7.1426
250	0.39390	2721.3	2957.6	7.1832
260	0.40208	2737.3	2978.5	7.2230

T	v	u	h	s
°C	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
290	0.42638	2785.4	3041.2	7.3373
300	0.43442	2801.3	3062.0	7.3740
310	0.44243	2817.3	3082.8	7.4100