Ex/EE/ME/T/124/2019(old)

Bachelor of Electrical Engineering 1st Year 2nd Semester Examination, 2019(old)

THERMODYNAMICS & HEAT POWER ENGINEERING

Time: Three hours Full Marks:

Answer should be precise and 'to-the-point'. Use of Air, Steam and Refrigerant tables are permitted, if necessary. Data, if unfurnished, may be assumed consistent with the problem.

Answer any **FIVE** questions.

1.(a) Define: isolated system, extensive property, triple point, work, dryness fraction, saturated vapour. 12

(b) Show the following processes for water with proper labeling:

(i) Isothermal process from superheated vapor zone to compressed liquid zone on P-v diagram.
(ii) Isobaric process from saturated zone to superheated vapor zone on enthalpy-entropy diagram. 5

(c) Explain critical point. 3

2. (a) State the first law of Thermodynamics for a cycle. Show that energy is a property. What is PMM-I? 8

(b) 1 Kg of air in a piston cylinder at 50° C and 1000 KPa is expanded in a reversible isobaric process to 140°C. Find out the work done, heat transfer, and change in internal energy, enthalpy & entropy during the process. Also plot the above process on T-v plane. 12

3. (a) State the two statements of 2nd law of thermodynamics. Show that entropy is a property. 8

(b) Steam enters a turbine at 3 MPa, 450° C . It leaves the turbine at a pressure of 10 KPa. If the mass flow rate of steam is 2 Kg/s, what is the power output of the turbine. Plot the process on h-s diagram with proper labeling. 12

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4. (a) Why Carnot cycle is replaced by a Rankine cycle in power plants? What is reheating? 6

(b) In a steam power plant, the operating pressure of boiler is 4.5 MPa and the operating pressure of condenser is 15 KPa. Steam enters the Turbine at 450° C. Steam leaves the condenser as saturated liquid. Find out the heat and work transfer in all the components. Determine the efficiency of the cycle. Plot the cycle on T-s diagram and label properly. 14

5. (a) Define: mean effective pressure, compression ratio, cut off ratio, coefficient of performance of a refrigerator. 8

(b) 3 Kg of water in a piston cylinder at 150° C and 100 KPa is expanded in a reversible adiabatic process to 20 KPa. Find out the work done, heat transfer, and change in internal energy, enthalpy & entropy during the process. Also plot the above process on P-v plane. 12

6. (a) The maximum temperature in an air standard otto cycle is 1400°C. At the beginning of compression, the temperature, pressure and volume are 25°C, 125 KPa and 0.3 m^3 respectively. Compression ratio is 10. Calculate the heat added, heat rejected, the net work done, mean effective pressure and the air standard thermal efficiency of the above cycle. Plot the cycle on P-v and T-s planes with proper labeling. 10

(b) In a refrigerator, R-134a enters the condenser as saturated vapor and leaves as saturated liquid. Evaporator temperature is -25° C and the condenser temperature is 45° C. Find out the heat and work transfer in all the components. Evaluate COP of the refrigerator. Plot the process on T-s diagram with proper labeling. 10

7. (a) Mention the different causes for irreversibility. 4

(b) State and explain Fourier law of heat conduction. 3

(c) Derive an expression for air standard thermal efficiency of Brayton cycle in terms of pressure ratio and the ratio of specific heats. 6

(d) A cylindrical insulation for a steam pipe has an inside radius of 8 cm, an outside radius of 10 cm and a thermal conductivity of 0.5 w/(m-°C). The inside surface of the insulation is at a temperature of 500° C and the outside surface is at a temperature of 25° C. Determine the heat loss per meter of insulation. 7