Ref. No. : Ex/EE/ME/T/124/2018

B.E. ELECTRICAL ENGINEERING FIRST YEAR SECOND SEMESTER – 2018

THERMODYNAMICS AND HEAT POWER ENGINEERING.

Full Marks: 100 Time: 3 hours

Answer should be precise and 'to-the-point'.
Use of Air, Steam and Refrigerant tables and charts is permitted, if necessary.
Data, if unfurnished, may be assumed consistent with the problem.
Answer **Question Number 1** and any **four** from the rest

1. Answer as directed:
   a) Define (i) System, (ii) Energy, (iii) Reversible process, (iv) Mean Effective Pressure, (v) Conduction (2×5=10)
   b) Draw an isothermal process for water on P-v plane from the compressed liquid zone to the superheated vapour zone. (3)
   c) State the two propositions (Carnot theorems) related to Carnot engines. (2+2=4)
   d) Discuss Cut-off ratio. (3)

2. a) Find out the change in specific entropy during any process executed by an ideal gas in terms of the temperature and pressure ratios of the end states. State the relevant assumptions. (10)

   b) Find the heat transfer in the process 1-2 as shown in Figure Q2b, executed by 1 kg air (to be taken as an ideal gas with C_p, C_v constant) in a system. (10)

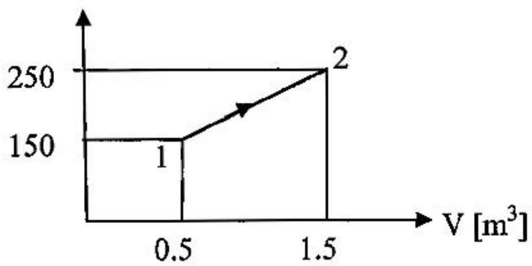

Figure Q2b

3. a) State the First Law of Thermodynamics for a cycle executed by a system. Hence derive the First Law of Thermodynamics for a non-cyclic process executed by a system. (2+6=8)

   b) A piston/cylinder arrangement contains 5 kg of water that has the piston exposed to atmospheric pressure. The piston mass is such that the pressure inside is 200 kPa. The initial volume of water is 0.5 m^3. This water is heated until it becomes saturated vapour. Find all the thermodynamics properties at the final state. Also find the heat and work transfer for the process. Plot the process on T-s plane and label properly. (12)

4. a) Write down the two statements of the second law of thermodynamics. Prove that the violation of the Kelvin-Planck Statement leads to the violation of the Clausius statement. (4+4=8)

   b) Steam enters a turbine at 2 MPa, 300°C. It leaves at a pressure of 10 KPa. Isentropic efficiency of the turbine is 0.85. Determine the condition of steam at turbine outlet and work done by the turbine. Plot the process on h-s plane with proper labelling. (12)

5. a) Why Carnot Cycle is not used in steam power plants? (6)

   b) In a steam power plant, steam enters the turbine at 400°C. Boiler pressure is 4 MPa and condenser pressure is 20 KPa. Steam comes out of 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 plane and label properly. (14)

6. a) Write down the assumptions behind Air Standard Cycle Analysis. (8)

   b) State the Fourier's law of heat conduction. (2)

   c) An insulating powder fills up the space between two concentric hollow spheres of radii 5 cm and 10 cm. The inside sphere is heated electrically by passing 0.256 Ampere current at a potential difference of 100 Volts across a resistor. At steady state the average temperature of inside and outside spheres are 95°C and 45°C respectively. Estimate the thermal conductivity of the insulating powder. (10)

7. a) At the beginning of compression in an air standard Otto cycle, t_1 = 50°C, P_1 = 100 kPa and V_1 = 0.2 m^3. If the compression ratio is 6 and the maximum cycle temperature is 1400°C, calculate (i) the heat added, (ii) the heat rejected, (iii) the net work done, (iv) the efficiency, and (v) the Mean Effective Pressure. Plot the cycle on P-V and T-S planes. (10)

   b) Consider an ideal refrigeration cycle that has a condenser temperature of 45°C and an evaporator temperature of -15°C. Determine the coefficient of performance of this refrigerator for the working fluid R-134a. Plot the cycle on P-h plane and label properly. (10)

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