B.E. CIVIL ENGINEERING SECOND YEAR FIRST SEMESTER - 2019

THERMODYNAMICS & HEAT POWER

Time: Three hours Full Marks: 100

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: control volume, intensive property, triple point, heat, dryness fraction, saturated liquid. 12

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

(i) Isothermal process from compressed liquid zone to superheated vapor zone on P-v diagram.

(ii) Isobaric process from saturated zone to superheated vapor zone on temperature-volume diagram. 6

(c) State zeroth law of Thermodynamics. 2

2. (a) State the first law of Thermodynamics for a cycle and hence, derive the first law of Thermodynamics for a system undergoing a non-cyclic process. 8

(b) 1 Kg of air in a piston cylinder at 100° C and 800 KPa is expanded in a reversible adiabatic process to 100 KPa. 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 of a system. 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) What is superheating? What is reheating? Define nozzle efficiency. 6

(b) A steam power plant operates between 4 MPa and 20 KPa, the Turbine inlet temperature being 500° C. State clearly the assumptions. 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, turbine efficiency, compression ratio, coefficient of performance. 8

(b) At the beginning of compression in an air standard Otto cycle, the temperature, pressure and volume are 25°C, 110 KPa and 0.4 m3 respectively. If the compression ratio is 10 and the amount of heat added in the cycle is 900 KJ/Kg, calculate the maximum temperature, heat rejected, the net work done, mean effective pressure and the air standard thermal efficiency of the above cycle. Plot the cycle on T-s planes with proper labeling. 12

6. (a) Derive an expression for air standard thermal efficiency of Diesel cycle in terms of compression ratio, cut-off ratio and the ratio of specific heats. 8

(b) Superheated steam enters a nozzle at 400 °C, 4000 KPa with a low velocity and at a steady rate of 0.01 Kg/sec. The steam comes out of the nozzle at 100 Kpa, with a velocity of 450 m/sec. Determine the temperature (and quality, if saturated) and the exit area of the nozzle. 12

7. (a) State the assumptions for a flow system with steady and non-uniform conditions 4

(b) An inventor claims to have developed a refrigerator that maintains the refrigerated space at -10°C, while operating in a room where the temperature is 25°C, and which has a COP of 8.5. How do you evaluate his claim? How would you evaluate his claim of a COP of 7.5? 6

(c) 2 Kg of water in a piston cylinder at 120° C and 100 KPa is expanded in a reversible isothermal process to 50 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. 10

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