B.E. Civil Engineering - Second Year - Second Semester Exam - 2024

Thermodynamics & Heat Power (Old)

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 mass, Heat, Mean effective pressure, Reversible process, Boundary, Compression ratio, Dryness fraction.

   (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 on enthalpy-entropy diagram from saturated zone to superheated vapor zone.

   © What is PMM-I? (7X2)+4+2=20

2. (a) State the first law of Thermodynamics for a system undergoing a cyclic process and hence, derive the first law of Thermodynamics for a system undergoing a non-cyclic process.
   (b) Find out an expression for work done in an isothermal process for an ideal gas.
   © 1 Kg of air in a piston cylinder at 50° C and 1000 KPa is expanded in a reversible isothermal process to 100 KPa. Find out the work done, heat transfer and change of entropy during the process. Also plot the above process on p-v, p-T, and T-v planes. (2+4)+2+12

3. (a) State the statements of the 2nd law of Thermodynamics. Prove that entropy is the property of a system.
   (b) Define: dryness fraction, degree of superheat, saturated vapour
   (c) An inventor claims to have developed a heat engine that is capable of developing 9 Kw while working between the temperature limits of 20° C and 40° C. It receives 1047 KJ/min of heat. Discuss the possibility of the claim. (4+4)+6+4=20

4. (a) Derive an expression for air standard thermal efficiency of Otto cycle in terms of compression ratio and the ratio of specific heats.
   (b) At the beginning of compression in an air standard otto cycle, the temperature, pressure and volume are 50°C, 100 KPa and 0.2 m^3 respectively. If the compression ratio is 6 and the maximum cycle temperature is 1400°C, calculate the heat added, heat rejected, the net work done and the air standard thermal efficiency of the above cycle. Plot the cycle on P-v and T-s planes. 8+12=20

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5. (a) Define: sub-cooled liquid, critical point, triple point.

(b) A steam power plant operates between 2 MPa and 10 KPa, the Turbine inlet temperature being 300° 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. 6+14=20

6. (a) Define: Compressor efficiency, Turbine efficiency.

(b) Derive an expression for heat transfer in condenser used in a Rankine cycle.

(c) Steam at 0.6 MPa, 200° C enters into an insulated nozzle with a velocity of 50 m/sec. It leaves the nozzle at a pressure of 0.15 MPa and a velocity of 600 m/sec. Determine all the properties of steam at the nozzle exit and plot the process on h-s diagram with proper labeling. 4+4+12=20

7. (a) How refrigeration and heat pump systems are evaluated?

(c) A cylinder fitted with a piston has a volume of 0.1 m^3 and contains 1.0 kg of steam at 0.4 MPa. Heat is transferred to the steam until the temperature is 300° C while the pressure remains constant. Determine the work done, change in internal energy and the heat transfer for this process. Also represent the above process on p-v, T-v, T-s and h-s plane. 4+16=20