BACHELOR OF ENGINEERING (CIVIL ENGINEERING) FIRST YEAR FIRST SEMESTER SUPPLEMENTARY EXAMINATION 2024

Thermodynamics and Heat Power

Time: - 03 hours Full Marks: -100

Answer any five questions

All parts of the same question must be answered together
Data, consistent with the problem may be assumed if necessary

1. Answer the following questions: 20
a) Define and classify thermodynamic property.
b) State and explain the first law for a closed system undergoing a cycle.
c) What do you understand by the entropy principle?
d) Differentiate between Otto cycle and Diesel cycle.

2. a) Show that the efficiency of the Otto cycle depends only on the compression ratio. 10
b) In an air standard Diesel cycle, the compression ratio is 15 and at the beginning of the isentropic compression, the temperature is 20^0C and the pressure is 0.1 MPa. Heat is added until the temperature at the end of the constant pressure process is 1500^0C. Calculate (i) the cut-off ratio, (ii) the heat supplied per kg of air, and (iii) the cycle efficiency. 10

3. a) Define Heat and Work. When is work said to be done by a system? 6
b) Show the following expansion processes on *p-v* plane: (i) reversible isobaric process, (ii) reversible isochoric process. 4
c) A mass of 8 kg gas expands within a flexible container so that the *p-v* relationship is of the form $pv^{1.2}$ = const. The initial pressure is 1000kPa and the initial volume is 1 m^3. The final pressure is 5 kPa. If specific internal energy of the gas increases by 40kJ/kg, find the heat transfer in magnitude and direction. 10

4. a) What is a steady flow process? Write the steady flow energy equation explaining various terms in it. 6
b) The enthalpy and the velocity of the fluid passing at the inlet to a certain nozzle are 3000 kJ/kg and 60 m/s respectively. At the discharge end, the enthalpy is 2762 kJ/kg. The nozzle is horizontal and there is negligible heat loss from it. (i) Find the velocity at exit from the nozzle. (ii) If the inlet area is 0.1 m^2 and the specific volume at inlet is 0.187m^3/kg, find the mass flow rate. (iii) If the specific volume at the nozzle exit is 0.498m^3/kg, find the exit area of the nozzle. 14

5. a) What is PMM2? Why is it impossible? 4
b) State and explain the second law of thermodynamics. 6
c) A reversible power cycle is used to drive a reversible heat pump cycle. The power cycle takes in Q_1 heat units at T_1 and rejects Q_2 at T_2. The heat pump abstracts Q_4 from the sink at T_4 and discharges Q_3 at T_3. Develop the expression $Q_4/Q_1 = T_4(T_1 - T_2)/T_1(T_3 - T_4)$ 10

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6. a) Establish the inequality of Clausius. 10

b) Liquid water of mass 10 kg and temperature 20^0C is mixed with 2 kg of ice at -5^0C till equilibrium is reached at 1 atm pressure. Find the entropy change of the system. Given: C_p of water 4.187 kJ/kg K, C_p of ice 2.09 kJ/kg K and latent heat of fusion of ice 334 kJ/kg. 10

7. Write short note on the followings (***any four***): 20

a) Phase, b) Thermal energy reservoir c) Entropy, d) Free expansion, e) Thermodynamic system.