Prelim Paper **Thermodynamics**

Time: 3 Hrs.] **[Marks : 80**

N.B.:
(1) Question No. **1** is **compulsory**.
(2) Solve any three questions from remaining five question.
(3) Assume suitable data.
(4) Use of Mollier Chart and Steam Table is permitted.

1. Explain any FOUR of the following : **[20]**

(a) Prove that energy is a property of the system.

(b) Explain clausius inequality.

(c) For the same compression ratio and heat supplied compare Otto Diesel and Dual cycle with the help of P-V and T-S diagram.

(d) Represent the following processes on PV and TS diagram starting from the same point.

(i) Isentropic process (ii) Isobaric process

(iii) Isochoric process (iv) Isothermal process

(v) Polytrophic process.

(e) 2 kg of steam is at 10 bar and 0.8 dry. Determine its enthalpy, entropy and volume (use steam table.)

2. (a) In a gas turbine the gas enters at the rate of 5 kg/s with a velocity of 50 m/s and enthalpy of 900 kJ/kg and leaves the turbine with a velocity of 150 m/s and enthalpy of 400 kJ/kg. The loss of heat from the gases to the surroundings is 25 kJ/kg. Assume for gas R = 0.285 kJ/kg k and C_p = 1.004 kJ/kg k and the inlet conditions to be at 10 kPa and 27 °C. Determine the power output of the turbine and the diameter of the inlet pipe. **[10]**

(b) Explain, how reheating and regeneration in Rankine cycle is beneficial. **[6]**

(c) State the need of multistage reciprocating air compressor. **[4]**

3. (a) A reversible heat engine operates between two reservoirs at temperatures of 600°C and 40°C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 40°C and –20°C. The heat transfer to the heat engine is 2000 KJ and the network output of the combined engine refrigerator plant is 360 KJ. **[10]**

Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40°C.

(b) Determine the maximum mark obtainable from a Heat engine exchanging heat with two finite bodies of equal heat capacities at temperatures T_1 & T_2 ($T_1 > T_2$). **[6]**

(c) What is an irreversibility? State its types and causes. **[4]**

4. (a) Steam at 20 bar, 360 °C is expanded in a steam turbine to 0.08 bar. It then centers a condenser. Where it is condensed to saturated liquid water the pump feedsback the water into the boiler. **[10]**

Assuming ideal processes, find per kg of steam the network and the cycle efficiency.

(b) State and derive steady flow energy equation and apply it to a turbine and nozzle. **[5]**

(c) State & explain Maxwell relations. **[5]**

5. (a) A system contains 0.15 m^3 of air at 3.8 bar and 150°C. A reversible adiabatic expansion takes place till pressure falls to 1.03 bar. The gas is then heated at constant pressure till enthalpy increases by 60.7 KJ. Determine total work done. If these processes are replaced by a single reversible polytrophic process giving same work between initial and final states. Determine index of expansion. **[10]**

(b) Write the statement of second low of thermodynamic and establish the equivalence between them. **[5]**

(c) Derive the expression for cycle efficiency of otto cycle. **[5]**

6. (a) A single stage reciprocating air compressor has a swept volume of 2000 cm^3 and runs at 800 r.p.m. It operates on a pressure ratio of 8, with a clearance of 5% of the swept volume. Assume NTP room conditions and at inlet (P = 101.3 KPa, t = 15°C), and polytrophic compression and expansion with n = 1.25. **[10]**

Calculate

(i) Indicated power
(ii) Volumetric efficiency
(iii) mass flow rate
(iv) FAD
(v) Isothermal efficiency and
(vi) The actual power needed to drive the compressor, if mechanical efficiency is 0.85.

(b) An air standard dual cycle has a compression ratio of 16 and compression begins at 1 bar 50°C. The maximum pressure is to bar. The heat transferred to air at constant pressure is equal to that at constant volume. **[10]**

Estimate

(i) The pressures and temperatures at the cardinal points of the cycle,
(ii) The cycle efficiency, and
(iii) The m.e.p. of the cycle, cr = 0.718 KJ/kg K

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