SE | III | Mech | Thermodynamics

mk.H.1stHlf12.22

Con. 3758-12.

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(3 Hours) [Total Marks : 100

N.B. (1) Question No. **1** is **compulsory**.
(2) Attempt any **four** questions out of remaining **six** questions.
(3) Assume **suitable data**, if **required**.
(4) Use of steam table, moillier diagram are **permitted**.

1. Solve any **five** of the following :— **20**
   (a) Define a thermodynamic system. Differentiate between open system, closed system and isolated system.
   (b) Show that entropy is property of system.
   (c) Determine the mass of 0·25 m^3 of steam at 5 bar pressure and 0·85 dryness fraction. Proceed to calculate the heat content of 1 m^3 of this steam.
   (d) Define the heat engine, refrigerator, heat pump.
   (e) Explain the term Mach number, Mach cone, Mach line and Mach angle in the context compressible flow.
   (f) Sketch the Rankine cycle on p-v and T-s plots.
   (g) What is cut off ratio ? How does it affect the air standard efficiency of a diesel cycle ?

2. (a) What are the limitation of first law of thermodynamics ? **4**
   (b) What is throttling process ? Define Joules Thomson coefficient, inversion point and inversion curve. **6**
   (c) What do you mean by availability ? A system at 450 K receives 225 kJ/s of heat energy from a source at 1500 K and the temperature of both the system and source remain constant during the heat transfer process. Determine net change in entropy, available energy of heat sources and system and decrease in available energy. Take atmospheric temperature equal to 300 K. **10**

3. (a) Write the statement of second law of thermodynamics and establish the equivalence between them. **10**
   (b) A closed system contains air at pressure 1 bar, temperature 290 K and volume 0·02 m^3 this system undergoes a thermodynamic cycle consisting of the following three process in series :— **10**

   Process 1-2 : Constant volume heat addition till pressure becomes 4 bar.
   Process 2-3 : Constant pressure cooling.
   Process 3-1 : Isothermal heating to initial state.

   Represent the cycle on T-s and p-v plots and evaluate the change in entropy for each process.

4. (a) Explain steady flow energy equation. Apply to nozzle, turbine. **10**
   (b) In a steady flow system, fluid flows at the rate of 15 kg/min. It enters at a pressure of 100 kPa, a velocity of 5 m/s, Internal energy 50 kJ/kg and specific volume 0·45 m^3/kg. It leaves the system at a pressure of 700 kPa, a velocity of 8 m/s, internal energy 160 kJ/kg and specific volume 0·125 m^3/kg. During its flow through system there is a heat loss of 7200 kJ/kg. Assuming entrance and exit pipes to be at the same level. Calculate the shaft work and ratio of inlet pipe diameter to outlet pipe diameter. **10**

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5. (a) Define : (a) wet steam (b) Superheated steam (c) Dryness fraction (d) Saturation temperature. **8**

   (b) Steam turbine working on Rankine cycle is supplied with dry saturated steam at 25 bar and the exhaust takes place at 0·2 bar. For a steam flow rate of 10 kg/s. Determine : (i) quality steam at end of expansion (ii) turbine shaft work (iii) power required to drive the pump (iv) work ratio (v) Rankine efficiency (vi) heat flow in the condenser. **12**

6. (a) Prove the thermal efficiency of Otto cycle. **8**

   (b) In an air standard diesel cycle the stroke is 30 cm and dia. is 25 cms. Pressure and temperature at the start of compression is 100 kPa and 27°C. The cut off takes place at 8% of the stroke and the compression ratio is 16. Find (i) Pressure and temperature at all points. (ii) Heat added, heat rejected and net work done. (iii) Mean effective pressure. **12**

7. (a) Explain the effect of variation in back pressure on C-D nozzle performance. **8**

   (b) Explain the concept of stagnation properties. A supersonic plane flies at 2000 km/hr at an altitude of 9 km above sea level in standard atmosphere. If the pressure and density of air at this altitude are stated to be 30 kN/m^2 absolute and 0·45 kg/m^3, make calculations for the pressure, temperature and density at the stagnation point on the nose of the plane. Take R = 287 J/kg K and γ = 1·4. **12**
