Sem-IV / Applied Thermodynamics / PROD / 10-6-1

QP Code :NP-19830

(3 Hours) **[Total Marks : 80**

N.B. : (1) Question No. **1** is **compulsory**.
(2) Attempt any **three** out of remaining **five** questions.
(3) Assumem **suitable** if data if **required**.
(4) Use of steam table and moiller chart permitted.

1. Attempt any **five** :– **20**
   (a) Explain Intensive and extensive properties with examples.
   (b) 2 kg of steam is at 8 bar and 0·8 dry. Determine its enthalpy and volume.
   (c) What is cut off ratio ? How does if effect the thermal efficiency of the cycle ?
   (d) Prove that Internal Energy is a property of the system.
   (e) Explain the term co-efficient of performance in content of :–
   (i) Refeigerator (ii) Heat pump.
   Prove that $(COP)_{HP} = (COP)_{Ref} + 1$.
   (f) Explain clausius inequality.
   (g) Define :–
   (i) Availability (ii) Irreversibility.

2. (a) A system containing 0·2 m3 of air at a pressure of 4 bar and 160°C expands adiabaticaly to prssure of 1·06 bar and after this the gas is heated at the constant pressure till the enthalpy increases by 65 KJ. Calculate the work wone. Now Imagine that these processes are replaced by a single reversible polytropic process producing same work between Initial and final state. Find the Index of expansion in this case. **10**
   C_p of air = 1·005 KJ/kg. K.
   (b) (i) Explain steady flow energy equation. Apply to nozzle, turbine. Boiler and compressor. **6**
   (ii) State and explain Kelvin-planks and claussius statements of second law of thermodynamics. **4**

3. (a) In a steady flow process, the fluid flows through a machine at the rate of 15 kg/min. the entrance and exit parameters of the machine are velocity 5 m/s and 8 m/s. pressure 100 KPa and 700 KPa, specific volume 0·45 m^3/kg and 0·125 m^3/kg respect. The working fluid leaves the machine with internal energy 160 KJ/kg greater than that at the entrance and during the process 7200 KJ/min of heat is cost to the sorrounding. Assume entrance and exit pipe to be at the same level. Calculate the shaft work and the ratio of inlet pipe diameter to the outlet pipe diameter. **10**

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(b) (i) Prove that, for a polytropic process heat transfer is given by – 5

$$Q = \frac{r-n}{r-1} \times \text{work done.}$$

(ii) State and prove carnol's theorem. 5

4. (a) Three Carnot engines R1, R2 and R3 operate in series between two heat reservoirs which are at temperatures of 1000 K and 300 K. Calculate Intermediate temperatures if amount of work produced by those engines is in the proportion of 5 : 4 : 3. 10

(b) (i) Explain in brief Joule Thomson porous plug experiment. Draw an Inversion curve and explain the significance of Joule Thomson co-efficient. 6

(ii) State and explain the principle of Increase of entropy of the universe. 4

5. (a) In an engine working on Dual cycle, the temperature and pressure at the begining of the cycle are 310 K and 1 bar. the compression ratio is 9. The maximum pressure is limited to 68 bar and the total heat supplied per kg of air is 1750 KJ. Determine : 10

(i) Pressure and temperature at all the points.

(ii) Air standard efficiency

(iii) Work Wone per cycle.

(b) In a Rankine cycle, the steam at the Inlet to the turbine is at 100 bar and 450ºC and the exhaust pressure is 0·5 bar. Determine the pump work, Turbine Work. Condenser heat flow, drynmess fraction at the end of expansion and Rankine efficiency. 10

6. (a) Show that, for the maximum work to be done per kg of air in otto cycle between given upper and lower limits of absolute temperature T_3 and T_1 respectively. The ratio of compression should have the value – 10

$$r = \left(\frac{T_3}{T_1}\right)^{1.25} \text{ where } r = 1{\cdot}4$$

(b) Determine the quality of steam in the following cases :– 10

(i) The absolute pressure of steam is 5 bar and specific volume is 0·32 m^3/kg.

(ii) The absolute pressure of steam is 8 bar and temperature is 200°C.

(iii) The absolute pressure of steam is 10 bar and enthalpy is 2605 KJ/kg.

(iv) The absolute pressure of steam is 10 bar and enthalpy is 2940 KJ/kg.

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