Q.P.Code: 21492

3 Hrs 80 Marks

NOTE:

- Question No 1 is **COMPULSORY**.
- Attempt any **THREE** questions out of remaining questions.
- Assume suitable data wherever required.
- Illustrate answers with sketches wherever required.
- Use of steam table, Gas table and Mollier chart is permitted.

Q. 1 Solve the following **(any FIVE)** **20**

(a) Define isothermal process. Draw PV and TS diagram and derive equation for work done.
(b) Differentiate between Intensive and extensive properties with example.
(c) Explain Closed, Open and Isolated system with neat sketch.
(d) Explain Carnot cycle with help of P-V and T-S diagram.
(e) What is Joule-Thomson coefficient? State its significance.
(f) Define Calorific value, enthalpy of formation and enthalpy of combustion.

Q. 2 (a) Define available and unavailable energy. **04**

(b) Define dead state and irreversibility. **04**

(c) A perfect gas undergoes a cycle comprises of three processes. It is first compressed isothermally from 1 bar and 27 ˚C to one-eighth of its initial volume. The energy is then added at constant pressure, increasing the temperature of gas and the cycle is completed by isentropic expansion to original conditions. Take Cp =1.25 kJ/kgK and R = 0.5 kJ/kg.K. Determine: (i) maximum cycle temperature and pressure (ii) net work done per kg of gas. Draw P-V diagram. **12**

Q. 3 (a) Define Dryness fraction, Degree of superheat, critical point, triple point. Show the critical and triple point on p-T diagram for water. **08**

(b) Air flows steadily at the rate of 0.5 kg/s through an air compressor entering at 7 m/s velocity, 100 kPa pressure and 0.95 m^3/kg specific volume and leaving at 5 m/s, 700 kPa and 0.19 m^3/kg respectively. The internal energy of the air leaving is 90 kJ/kg greater than of air entering. Cooling water in the compressor jacket absorbs heat from the air at the rate of 58kW. Calculate (i) Power input to the compressor (ii) ratio of inlet pipe diameter to outlet pipe diameter. **12**

Q. 4 (a) A reheat Rankine cycle has steam generated at 50 bar, 500ºC for being sent to high pressure turbine and expanded upto 5 bar before supplied to low pressure turbine. Steam enters at 5 bar, 400ºC into low pressure turbine after being reheated in boiler. Steam finally enters condenser at 0.05 bar and subsequently feed water is sent to boiler. Determine cycle efficiency. **10**

(b) State and prove Clausius inequality theorem. **10**

TURN OVER

Q. 5 (a) Define compression ratio, clearance ratio, cutoff ratio, expansion ratio and mean effective pressure. Show on PV diagram of cycle. **05**

(b) Find the internal energy of 1 kg of steam at a pressure of 10 bar when the condition of the steam is wet with x = 0.5 and superheated with degree of superheat = 50˚C. **05**

(c) Determine the enthalpy of combustion of liquid octane C_8H_{18} at 25 °C and 1 amt using following data: **10**
Enthalpy of formation for CO_2 at 25˚C & 1 atm = −3935000 kJ/kmol
Enthalpy of formation for H_2O (l) = −286 MJ/kmol
Enthalpy of formation for C_8H_{18} (l) = −250 MJ/kmol
Calculate in mJ/kg of C_8H_{18}. Take molar mass of C_8H_{18} = 114 kg/kmol.

Q. 6 (a) In an air standard Diesel cycle, at the beginning of compression, cylinder volume is 1500 cm^3 and at the end of heat addition process it is 150 cm^3. Compression ratio is 15. Air is at 101 kPa and 20˚C at the beginning of compression process. Calculate: pressure at the beginning of heat rejection, net work done and mean effective pressure. **12**

(b) Write Maxwell equations. **04**

(c) Explain low and high calorific values. Write equations also. **04**