C 1256 (Pages : 3) Name.....

Reg. No.....

FOURTH SEMESTER B.TECH. (ENGINEERING) [14 SCHEMES] DEGREE EXAMINATION, APRIL 2016

ME 14 403—THERMODYNAMICS

Time : Three Hours Maximum : 100 Marks

Part A

Answer **eight** *questions.*

1. Air of pressure 1.02 bar at a temperature of 22°C, initially occupying a cylinder volume of 0.015 m^3, is compressed reversibly and adiabatically to a pressure of 6.8 bar. Calculate (i) Final temperature ; (ii) Work done on the air.
2. Specify the significance of continuity equation.
3. State the significance of second law efficiency.
4. A Carnot heat engine operates between T_1 (source) and 297 K (sink). If the engine receives 650 kJ of heat and rejects 250 kJ of it to the sink, determine T_1 and thermal efficiency of the heat engine.
5. Define the term COP as applied to a refrigerator and a heat pump. Show that $COP_{HP} = 1 + COP_{Ref}$.
6. A mass of 200 g of saturated liquid water is completely vaporized at a constant pressure of 100 kPa. : Determine (a) the volume change ; and (b) the amount of energy transferred to the water.
7. Steam enters the turbine at 3 MPa and 350°C and is condensed in the condenser at a pressure of 10 kPa. Determine the thermal efficiency and quality of steam at turbine exit.
8. What is critical point ? How is it different from triple point of pure substance?
9. A fuel contains 90 % C, 3.3 % H_2, 3 % O_2, 0.8 % N_2, 0.9 % S_2 and remaining incombustible mass. Find chemically correct air fuel ratio and composition of exhaust gas on percentage mass basis.
10. What is a formation reaction and what is meant by standard enthalpy of formation ? What convention is adopted in reporting the standard enthalpies of formation ?

(8 × 5 = 40 marks)

Part B

Answer **all** *questions.*

11. In a remote area, water is to be supplied from underground water source, whose free surface is 100 m. below ground level, using a water pump. This water is to be stored in a water tank at a height of 10 m. from the ground level. This pump is connected with an inlet pipe of diameter 20 cm. and outlet pipe of diameter 30 cm. determine the power input to this pump for steady water supply of 20 L/s. assume no heat interaction during this process.

Or

12. 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 C_p = 1.25 kJ/kgK and R = 0.5 kJ/kgK. Calculate the maximum cycle temperature and pressure. Also, find the network transfer per kg.

13. A system at 500 K receives 10000 kJ of heat from a source at 1000 K. The temperature of the surroundings is 300 K. Assuming that the temperatures of the system and the system and the source remains constant during heat transfer, find (i) the entropy produced during heat transfer, (ii) decrease in available energy.

Or

14. Two Carnot engines A and B are connected in series between two thermal reservoirs maintained at 1000 K and 100 K respectively. The engine A receives 1680 kJ of heat from the high temperature reservoir and rejects heat to the Carnot engine B. The engine B takes in the heat rejected by the engine A and rejects heat to the low temperature reservoir at 100 K. If the engines A and B have equal thermal efficiencies, determine :

    (i) The heat rejected by the engine B.

    (ii) The work done by the engines A and B.

    (iii) If the engines A and B deliver equal work, determine the amount of heat taken in by the engine B and the efficiencies of the engines A and B respectively.

15. (i) Derive Maxwell's relations from basic equations of thermodynamic properties. (7½ marks)

    (ii) Derive Clausius-Clapeyron equation. (7½ marks)

Or

16. A gas consisting of 3.3 K moles of CO_2 and 6.5 moles of CH_4 gas is stored in a tank at 20 MPa and 300 K. Determine the volume of the tank by using (i) Ideal gas law ; (ii) Compressibility factor and Amagat's law ; and (iii) Percentage deviation from ideal value.

17. (i) What is an Orsat apparatus and how is it used ? (5 marks)

(ii) The combustion of methane (CH_4) gas with dry air gave the following Orsat analysis : 8 % CO_2 ; 4.32 % O_2 and 1.7 % CO. Determine the actual air-fuel ratio and the percent theoretical air used for combustion.

(10 marks)

Or

18. (i) What is meant by adiabatic flame temperature ? Explain the factors involved in it.

(7½ marks)

(ii) Describe the criterion of equilibrium for a chemically reacting system. (7½ marks)

[4 × 15 = 60 marks]