S 9222

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2006.

Second Semester

Mechanical Engineering

ME 132 — THERMODYNAMICS

Time : Three hours Maximum : 100 marks

Answer ALL questions.

Use of steam tables, Mollier diagram and Psychrometric chart permitted.

PART A — (10 × 2 = 20 marks)

1. Distinguish between intensive properties and extensive properties by giving examples.

2. Deduce an expression for the work done by a gas in a system during the reversible polytropic process.

3. Enunciate the Clausius statement of second law of thermodynamics.

4. Mention any four factors which render processes irreversible.

5. Show the throttling process in H-S diagram.

6. Sketch the sensible heating process on a skeleton psychrometric chart.

7. A system contains air in the form of liquid-vapour mixture in equilibrium. Can this mixture be treated as pure substance? Justify your answer.

8. Sketch a skeleton compressibility chart and indicate its uses.

9. Using Amagat's model derive the expression for calculation of entropy change during mixing of two non reacting ideal gases.

10. Define equivalence ratio.

PART B — (5 × 16 = 80 marks)

11. (a) Air of mass 0.5 kg is compressed reversible and adiabatically from 80 kPa, 60°C, to 0.4 MPa, and is then expanded at constant pressure to the original volume. Sketch the process on p-v plane and determine the heat transfer and work transfer. For air assume R = 0.287 kJ/kgK and C_v = 0. 713 kJ/kgK. (16)

Or

(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 5m/s. 700 kPa, and 0.19 m^3/kg. The internal energy of air leaving is 90 kJ/kg greater than that of the air entering. Cooling water in the compressor jackets absorb heat at the rate of 58 kW. Calculate the rate of shaft work input to the compressor. (16)

12. (a) (i) Prove that Kelvin-Planck statement and Clausius statement of Second law of thermodynamics are equivalent. (8)

(ii) Two reversible heat engines A and B are arranged in series with A rejecting heat directly to B through an intermediate reservoir. Engine A receives 200 kJ of heat from a reservoir at 421°C, and engine B is in thermal communication with a sink at 4.4° C. If the work output of A is twice that of B find (1) the intermediate temperature between A and B, (2) the efficiency of each engine and (3) the heat rejected to the cold sink. (8)

Or

(b) (i) State and prove Clausius inequality and hence deduce that the property entropy exist. (6)

(ii) A steam turbine receives steam at a pressure of 1 MPa, 300° C. The steam leaves the turbine at a pressure of 15 kPa. The work out put of the turbine is measured and is found to be 600 kJ/kg of steam flowing through the turbine. Determine the efficiency of the turbine. (10)

13. (a) Deduce the Maxwell relations and deduce the Clausius-Clapeyron equation. (16)

Or

(b) A mixture of ideal gases consists of 3 kg of N_2 and 5 kg of CO_2 at a pressure of 300 kPa and at 20° C. Find (i) the mole fraction of each constituent, (ii) equivalent molecular weight of the mixture, (iii) equivalent gas constant of the mixture, (iv) the partial pressures and partial volumes, (v) volume and density of the mixture and (vi) C_p and C_v of the mixture. Assume the value of C_p/C_v for CO_2 = 1.286 and for N_2 = 1.4. (16)

14. (a) A rigid vessel having a volume of 5 m^3 contains 0.05 m^3 of saturated liquid water and the rest of the volume as saturated vapour at 0.1 MPa. Heat is transferred until the vessel is filled with superheated vapour. Determine the heat transfer and work done during the process. (16)

Or

(b) Explain the following: Dew point, adiabatic saturation process, dry bulb temperature and relative humidity. (16)

(a) Describe the construction of Orsat apparatus using a neat sketch and explain how the mole fractions of the flue gas constituents is determined? (16)

Or

(b) Methane (CH_4) is burned with atmospheric air. The analysis of the products on a dry basis is as follows : CO_2 - 10.00%, O_2 - 2.37%, CO - 0.53%, and N_2 - 87.10% . Calculate the air-fuel ratio, percentage of theoretical air and determine the combustion equation. (16)
