Reg. No. :

Question Paper Code : S 4706

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2009.

Second Semester

Mechanical Engineering

ME 132 — THERMODYNAMICS

(Regulation 2001)

Time : Three hours | Maximum : 100 marks

Approved Thermodynamic charts and tables permitted for use.

However they shall not contain any handwritten material.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define mechanical, chemical and thermal equilibrium.

2. What are point functions? Give example.

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

4. Define the terms source and sink.

5. Give the use of generalized compressibility chart.

6. What are reduced properties?

7. Define the terms : Degree of superheat, degree of subcooling.

8. What is quality of steam?

9. What do you understand by higher heating value and lower heating value of a fuel?

10. What are Theoretical air and excess air?

PART B — (5 × 16 = 80 marks)

11. (a) One kg of ice at –5°C is exposed to the atmosphere which is at 20°C. The ice melts and comes into thermal equilibrium with the atmosphere (i) determine the entropy increase of the universe (ii) what is the minimum amount of work necessary to convert the water back to ice at –5°C? Assume C_p for ice as 2.093 kJ/kg K and the latent heat of fusion of ice as 333.3 kJ/kg K. (16)

Or

(b) (i) Prove that for an ideal gas $C_p - C_v = R$. (8)

(ii) Apply the steady flow energy equation to a Turbine and deduce an expression for work. (8)

12. (a) A room for four persons has two fans, each consuming 0.18 kW power, and three 100 W lamps. Ventilation air at the rate of 80 kg/h enters with an enthalpy of 84 kJ/kg and leaves with an enthalpy of 59 kJ/kg. If each person puts out heat at the rate of 630 kJ/h determine the rate at which heat is to be removed by a room by a room cooler, so that a steady state is maintained in the room. (16)

Or

(b) Two reversible heat engines A and B are arranged in series A rejecting heat directly to B. Engine A receives 200 kJ at a temperature of 421°C from a hot source, while engine B is in communication with a cold sink at a temperature of 4.4°C. If the work output of A is twice that of B, find :

(i) The intermediate temperature between A and B, (8)

(ii) The efficiency of each engine. (8)

13. (a) A mixture of ideal gases consists of 3 kg of nitrogen and 5 kg of carbon dioxide at a pressure of 300 kPa and a temperature of 20°C. Find :

(i) the mole fraction of each constituent

(ii) the equivalent molecular weight of the mixture

(iii) the equivalent gas constant of the mixture

(iv) the partial pressures and the partial volumes.

Or

(b) (i) A volumetric analysis of a gaseous mixture yields the following results :

$CO_2 = 12.0\%$, $O_2 = 4.0\%$, $N_2 = 82.0\%$, $CO = 2.0\%$.

Determine the analysis on mass basis and determine the molecular weight and the gas constant on mass basis for the mixture. Assume ideal gas behaviour. (10)

(ii) State any one equation of state for real gas and show how the deviation from ideal gas behaviour is accounted for. (6)

14. (a) An air–water vapour mixture at 0.1 Mpa, 30°C, 80% RH has a volume of 50 m^3. Calculate the specific humidity, dew point, wet bulb temperature, mass of dry air and mass of water vapour. (16)

Or

(b) (i) A compressor is used to bring saturated water vapour at 1 Mpa up to 17.5 MPa, where the actual exit temperature is 650°C. Find the isentropic compressor efficiency and entropy generation. (10)

(ii) Define specific humidity, relative humidity and dew point. (6)

15. (a) (i) Explain the terms : Sensible enthalpy, absolute enthalpy, enthalpy of formation, and equivalence ratio. (8)

(ii) By applying the first law of thermodynamics to a constant pressure adiabatic combustor, explain how the adiabatic flame temperature can be determined for a given fuel–air mixture. (8)

Or

(b) (i) Define enthalpy of formation. (4)

(ii) Explain the method of calculating adiabatic flame temperature of a fuel. (12)
