Reg. No. : | | | | | | | | | | | |

Q 2394

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2007.

Second Semester

Mechanical Engineering

ME 132 — THERMODYNAMICS

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. State the first law for a closed system undergoing a change of state.

2. What are point functions and path functions and give examples for each.

3. What are the limitations of the first law of thermodynamics?

4. State the Kelvin – Planck and Clausius statements.

5. What are reduced properties? Give their significance.

6. Define Joule – Thomson coefficient.

7. Define wetness fraction of steam.

8. Define dew point temperature.

9. Why excess air is supplied in the combustion of solid fuels?

10. Indicate the methods to analyze the flue gas composition?

PART B — ($5 \times 16 = 80$ marks)

11. (a) A piston and cylinder machine contains a fluid system which passes through a complete cycle of four processes. During a cycle, the sum of all heat transfers is –170 kJ. The system completes 100 cycles per min. Complete the following table showing the method for each itèm, and compute the net rate of work output in kW.

Process	Q (kJ/min)	W (kJ/min)	ΔE (kJ/min)
a – b	0	2170	–
b – c	21000	0	–
c – d	–2100	–	–36000
d – a	–	–	–

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 volume and leaving at 5 m/s, 700 kPa and 0.19 m^3/kg. The internal energy of the air leaving is 90 kJ/kg greater than that of the air entering. Cooling water in the compressor jackets absorbs heat from the air at the rate of 58 kW.

(i) Compute the rate of shaft work input to the air in kW

(ii) Find the ratio of the inlet pipe diameter to outlet pipe diameter.

12. (a) A closed system consists of 1 kg of air which is initially at 1.5 bar and 67°C. The volume doubles as the system undergoes a process according to the law $PV^{1.2} = C$. Find the work done, heat transfer and the change in entropy during this process. For air R = 0.287/kJ/kg k and $\gamma = 1.4$.

Or

(b) A gas is flowing through a pipe at the rate of 2 kg/s. Because of inadequate insulation the gas temperature decreases from 800 to 790°C between two sections in the pipe. Neglecting pressure losses, calculate the irreversibility rate (or rate of energy degradation) due to this heat loss. Take $T_0 = 300$ K and a constant $C_p = 1.1$ kJ/kg K. For the same temperature drop of 10°C when the gas cools from 80°C to 70°C due to heat loss, what is the rate of energy degradation? Take the same values of T_0 and C_p. What is the inference you can draw from this example?

13. (a) Calculate the pressure of steam at a temperature of 500°C and a density of 24 kg/m^3 using

(i) the ideal - gas equation

(ii) the Van der Waals equation

(iii) the Redlich – Kwong equation

(iv) the compressibility factor, and

(v) the steam table.

Or

(b) Prove that $C_p - C_v = -T(\partial V/\partial T)_p^2 (\partial P/\partial V)_T$. What are the facts one can infer from the above equation?

14. (a) (i) Explain with a neat sketch the construction of the Mollier diagram and give its use in thermodynamic process representation. (8)

(ii) Determine the volume change when 1 kg of saturated water is completely vaporized at a pressure of (1) 1 kPa (2) 100 kPa and (3) 10,000 kPa. (8)

Or

(b) Atmospheric air at 1.0132 bar has a DBT of 32°C and a WBT of 26°C. Compute

(i) the partial pressure of water vapour

(ii) the specific humidity

(iii) the dew point temperature

(iv) the relative humidity

(v) the degree of saturation

(vi) the density of the air in the mixture

(vii) the density of the vapour in the mixture and

(viii) the enthalpy of the mixture.

15. (a) (i) Hexane (C_6H_{14}) is burnt with 80% theoretical air. The incomplete, combustion produces CO_2, CO, H_2O and N_2 in products. Calculate the air fuel ratio by mass and also the mass fraction of the constituents of the dry combustion products. (10)

(ii) Briefly explain the properties of solid, liquid and gaseous fuel. (6)

Or

(b) Briefly explain how the adiabatic flame temperature for a given fuel - air mixture gets affected with equivalence ratio.