C 48860 ME (Pages 3) Name.....

Reg. No.....

FOURTH SEMESTER B.TECH. (ENGINEERING) DEGREE EXAMINATION, JUNE 2008

ME 04 403—THERMODYNAMICS

(2004 Admissions)

Time : Three Hours Maximum : 100 Marks

Part A

I. (a) What is an indicator diagram ?

(b) Define the isothermal, isobaric and isochoric processes.

(c) How do you distinguish between internal and external irreversibilities ?

(d) What do you understand by entropy transfer ? Why is entropy transfer associated with heat transfer and not with work transfer ?

(e) What is the difference between the critical point and the triple point ?

(f) What is the physical significance of the two constants that appear in the van-der Waals equation of state ? On what basis are they determined ?

(g) Calculate the Air-fuel ratio required for complete combustion of methene on mass basis.

(h) What is enthalpy of combustion ? How does it differ from the enthalpy or reaction ?

(8 × 5 = 40 marks)

Part B

II. (a) (i) From the first law and using the ideal gas property relations prove that $PV^{\gamma} = C$ represent the reversible adiabatic process.

(7 marks)

(ii) A system receives 200 kJ of energy as heat, at constant volume. Then it is cooled at constant pressure when 50 kJ of work was done on the system while it rejects 70 kJ of heat. Supposing the system is restored to the initial state by an adiabatic process, how much work will be done by the system ?

(8 marks)

Or

(b) In an isentropic flow through nozzle, air flows at the rate of 600 kg/hr. Air at inlet to the nozzle, pressure is 2 MPa and temperature is 127°C. The exit pressure is 0.5 MPa. Initial air velocity is 300 m/s, determine :

(i) Exit velocity of air.

(ii) Inlet and exit area of the nozzle.

(15 marks)

Turn over

III. (a) A reversible engine is supplied with heat from two constant temperature sources at 900 K and 600 K and rejects heat to a constant temperature sink at 300 K. If the engine executes a number of cydes while developing, 100 kW, and rejecting 3600 kJ of heat per minute, determine the heat supplied by each source per minute and efficiency of the engine.

(15 marks)

Or

(b) A closed system contains 10 kg of air at 600 K and 5 bar pressure. If the atmospheric temperature and pressure are 27°C and 1 bar respectively, determine the availability if it goes through ideal work producing process. Determine the : (i) loss in availability ; (ii) If the air is cooled at constant pressure to the atmospheric temperature without bringing it to complete dead state, determine the availability and effectiveness.

(15 marks)

IV. (a) Air undergoes an adiabatic non-flow process from an initial pressure of 6 bar and 200°C to a pressure of 1.03 bar. The entropy increase during the process is 0.175 $\frac{kJ}{kgK}$. If the expansion follows the law pv^n = constant, calculate the value of n. Also calculate the work done per kg and company it with equivalent isentropic work.

For air $C_p = 1.0035 \frac{kJ}{kgK}$ $R = 0.287 \frac{kJ}{kgK}$

$C_v = 0.7165 \frac{kJ}{kgK}$.

Or

(b) One kg of steam at 1 bar and 150°C is generated from water 1 bar and 50°C. Then it is cooled at constant volume till it becomes dry saturated.

Find :

(i) Final pressure ;

(ii) Heat transferred in each case ; and

(iii) Change in internal energy for the entire process.

Take :

C_{pw} = 4.2 kJ/kg K and

C_pS = 2.25 kJ/kgK

(15 marks)

V. (a) A mixture of 1 k mol of H_2O and 2 k mol of O_2 is heated to 400 K at a pressure of 1 atm. Determine the equilibrium composition of the mixture, assuming that only H_2O, OH, O_2 and H_2 are present.

(15 marks)

Or

(b) Propane (C_3H_8) is burnt with 90% theoretical air. The incomplete combustion produces CO_2, CO, H_2O and N_2 in the products.

Calculate the air-fuel ratio by mass and also the mass fraction of the constituents of the dry combustion products.

(15 marks)

[4 × 15 = 60 marks]