Total number of printed pages – 7

B. Tech
BENG 1103

Second Semester Examination – 2007

THERMODYNAMICS

Full Marks – 70

Time – 3 Hours

*Answer Question No. 1 which is compulsory and any **five** from the rest.*
The figures in the right-hand margin indicate marks.
Use of steam table is permitted.

1. Answer the following questions : 2×10

   (i) State Zeroth law of thermodynamics.

   (ii) In throttling, the enthalpy remains constant, justify.

   (iii) Explain point function and path function. Give two examples from each.

P.T.O.

(iv) Explain the principle of measurement of pressure with Burdon tube Pressure gauge.

(v) How the concept of quality of energy is understood from second law of thermodynamics ?

(vi) Draw an isobaric line on h-s diagram and explain its shape.

(vii) Justify that the COP of a heat pump is greater than the COP of Refrigerator by unity.

(viii) Explain the concept of control volume approach.

(ix) Show the Carnot cycle in T-S diagram and what does its area signifies ?

(x) Justify that it is impossible to attain zero absolute from the knowledge of second law of thermodynamics.

2. (a) Prove that internal energy is a point function. 4

(b) A mass of 8 kg gas expands within a flexible container so that the p ~ v relationship is of the form $pv^{1.2}$ = constant. The initial pressure is 1000 kPa and initial volume is 1 m^3. The final pressure is 5 kPa. If the specific internal energy of the gas decreases by 40 kJ/Kg, find the heat transfer and its direction. 6

3. (a) Derive the steady flow energy equation. 4

(b) In an aircraft engine, compressed air at 3 bar and 450 K enters a combustion chamber in which heat is added at constant pressure to the air by the combustion of a fuel. Air is thus heated to a temperature of 1250 K. Thereafter it expands through a turbine up to 1000 K.

Find (i) Heat added in the combustion chamber (ii) Work done in the turbine per kg of air. 6

4. (a) Prove that Kelvin-Plank statement and Clausius statement are equivalent 4

(b) Two Carnot engines A and B are connected in series between two thermal reservoirs maintained at 1000 K and 100 K respectively. Engine 'A' receives 1680 kJ of heat from the high temperature reservoir and rejects heat to the Carnot engine 'B'. Engine 'B' takes in heat rejected by engine 'A' and rejects heat to the low temperature reservoir. If engines A and B have equal thermal efficiencies, determine (i) the heat rejected by engine 'B' (ii) the temperature at which engine 'A' rejects heat (iii) the work done. 6

5. (a) Establish the Clausius inequality. 4

(b) Find the thermal efficiency and work output of the following thermodynamic reversible cycle (circular). 6

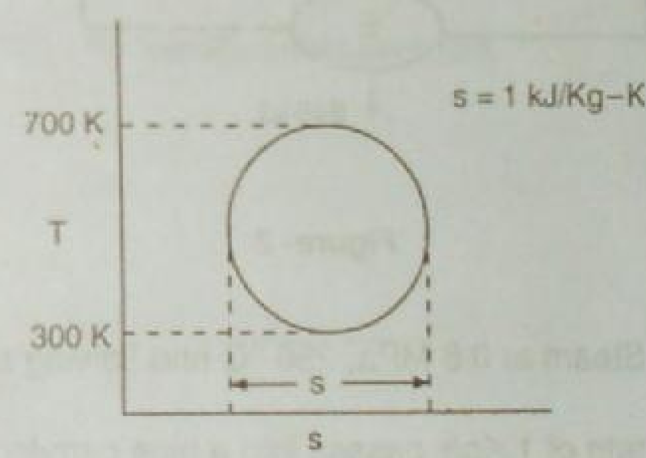

Figure - 1

6. (a) Prove that mixing process is an irreversible process. 4

(b) A reversible engine, as shown in Fig. 1, during a cycle of operations draws 5 MJ from 400 K reservoir and does 840 kJ of work. Find the amount and direction of heat interaction with other reservoirs. 6

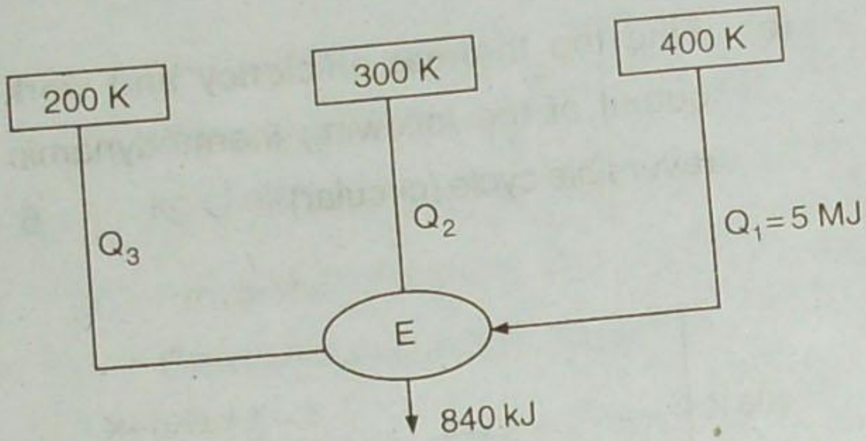

Figure - 2

7. Steam at 0.8 MPa, 250 °C and flowing at the rate of 1 Kg/s passes into a pipe carrying wet steam at 0.8 MPa, 0.95 dry. After adiabatic mixing, the flow rate is 2.3 Kg/s. Determine the condition of steam after mixing. The mixture is expanded in frictionless nozzle isentropically to a pressure of 0.4 MPa. Determine the quality of steam leaving the nozzle. 10

8. Write short notes on any *two* : 5+5

   (i) Irreversibility and lost work

   (ii) Flow through diffusers

   (iii) Temperature measurement.
