Code : 021407

B.Tech 4th Semester Exam., 2016

THERMODYNAMICS

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

(ii) There are ***NINE*** *questions in this paper.*

(iii) Attempt ***FIVE*** *questions in all.*

(iv) Question No. ***1*** *is compulsory.*

(v) Use of steam table, Mollier chart and psychometric charts is allowed.

1. Write True or False of the following (any *seven*) : 2×7=14

(a) Isolated system has fixed mass and energy.

(b) Specific volume is the extensive property of a thermodynamic system.

(c) A gas performs no work in the process of free expansion.

(d) Change in the internal energy of a closed system is equal to the heat transferred in a constant volume process involving no work other than p.d.v. work.

(e) Enthalpy of the fluid before throttling is not equal to the enthalpy of the fluid after throttling.

(f) Work is said to be a low grade energy and heat a high grade energy.

(g) The cyclic integral of $\frac{dQ}{T}$ for a reversible cycle is greater than zero.

(h) The slop of an isobar on Mollier diagram is equal to the absolute temperature.

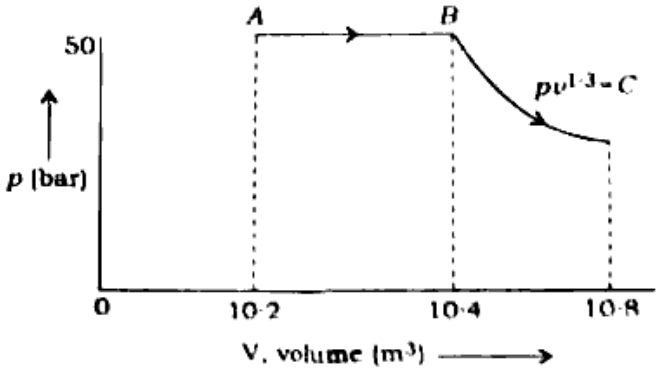
(i) Heat addition process in the Rankine cycle is reversible and at constant process whereas in the Carnot cycle it is reversible and isothermal.

(j) For same maximum pressure, temperature and heat rejection, the efficiency of Diesel cycle is greater than efficiency of Otto cycle.

2. (a) Explain thermodynamic equilibrium. 3

(b) Explain Quasi-static process briefly. 3

(c) Determine the total work done by a gas system following an expansion process as shown in the figure : 8



3. Air flows steadily at the rate of 0·8 kg/s through an air compressor, entering at 10 m/s velocity, 100 kPa pressure and 1·0 m^3 / kg volume and leaving at 8 m/s, 700 kPa and 0·2 m^3 / kg. The internal energy of the air leaving is 100 kJ/kg greater than that of the air entering. Cooling water in the compressor jackets absorbs heat from the air at the rate of 60 kW, (i) compute the rate of shaft work input to the air in kW and (ii) find the ratio of the inlet pipe diameter to the outlet pipe diameter. 14

4. A reversible heat engine operates between two reservoirs at temperatures of 900 K and 400 K. The engine drives a reversible refrigerator which operates between 400 K and 250 K. The heat transfer to the heat engine is 2000 kJ and the net work output of the combined engine refrigerator plant is 400 kJ.

   (a) Evaluate the heat transfer to the refrigerator and the net heat transfer to the reservoir at 400 K.

   (b) If the efficiency of the heat engine and the COP of refrigerator are each 60% of their maximum possible value, evaluate the heat transfer to the refrigerator and the net heat transfer to the reservoir at 400 K. 14

5. *(a)* Explain and prove Carnot's theorem. 4

   (b) One kg of water at 283 K is brought into contact with a heat reservoir at 363 K. When the water has reached 363 K, find the entropy change of the universe. If water is heated from 283 K to 363 K by first bringing it in contact with a reservoir at 333 K and then with a reservoir at 363 K, what will the entropy change of the universe be? Comment on the two different values of entropy change of the universe. 10

6. *(a)* Derive and explain Maxwell's four equations 4

   (b) Steam initially at 15 bar, 573 K expands isoentropically in a steam turbine to 313 K. Determine the ideal work output of the turbine per kg of steam. 10

7. Derive the expression of thermal efficiency of a Diesel cycle and with the help of *P-V* and *T-S* diagrams. Compare the thermal efficiencies of Otto cycle and Diesel cycle for the same compression ratio and heat rejection. 14

8. A steam power station uses the following cycle :

   Steam at turbine inlet 150 bar, 550 °C, reheat at 40 bar to same boiler outlet temperature. Condenser at 0·1 bar.

   Assuming ideal processes, find the—

   (a) quality of steam at turbine exhaust;

   (b) cycle efficiency

   (c) steam rate 14

9. One kg of dry air at 20 °C and 40% RH is mixed adiabatically with two kg of dry air at 40 °C and 40% RH. Find the final condition of air. 14

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