Code : 021407

B.Tech. 4th Semester Exam., 2015

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 psychrometric charts is allowed.

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

(a) Volume is the extensive property of a thermodynamic system.

(b) A closed system is one in which neither mass nor energy cross the boundary of the system.

(c) If the reversible process takes place at constant pressure, change in enthalpy in a closed system is equal to the heat transfer.

(d) A real gas obeys perfect gas law at very high temperature and low pressure.

(e) The entropy of universe tends to zero.

(f) The Clausius-Clapeyron equation gives the slope of a curve in p-T diagram.

(g) The state of a wet vapour cannot be specified only by pressure and dryness fraction.

(h) When DBT, WBT and DPT are identical it means that the air is saturated.

(i) In a Rankine cycle heat is rejected reversibly at constant volume.

(j) A gas turbine works on Brayton cycle.

2. *(a)* State and explain zeroth law of thermodynamics. 4

(b) One kg of air at 1 bar and 300 K is compressed adiabatically till its pressure becomes 5 times the original pressure. Then it is expanded at constant pressure and finally cooled at constant volume to return to its original state. Calculate heat transfer, work transfer and change in internal energy for each process and for the cycle. 10

3. Air at 288 K passes through a heat exchanger at a velocity of 30 m/s where its temperature is raised to 1073 K. It then enters a turbine with the same velocity of 30 m/s and expands until the temperature falls to 923 K. On leaving the turbine, air is

taken at a velocity of 60 m/s to a nozzle where it expands until the temperature has fallen to 773 K. Calculate for the air flow rate of 2 kg/s—*(a)* the rate of heat transfer to the air in the heat exchanger; *(b)* the power output from the turbine assuming no heat loss and *(c)* the velocity at exit from the nozzle assuming no heat loss. 14

4. *(a)* Show that the COP of a heat pump is greater than the COP of a refrigerator by unity. 4

(b) A heat engine working on Carnot cycle exchanges heat from three reservoirs at 200 K, 300 K and 400 K. If it draws 5 MJ from the 400 K reservoir and does 840 kJ of work during a cycle of operation, find the amount and direction of heat interaction with other reservoirs. 10

5. *(a)* An inventor claims to have designed an engine which receives 2·5 kJ of heat and produces 0·625 kJ of useful work between source at 60 °C and sink at 263 K. Is this claim valid? 7

(b) *m* kg of air at T_1 is adiabatically mixed with same mass of air at T_2 in a container. Find the change of entropy and prove that this change is always positive. 7

6. *(a)* Derive the expression of thermal efficiency of diesel cycle. 9

(b) With the help of p-v and T-s diagrams, show that for the same maximum pressure and temperature of the cycle $\eta_{Diesel} > \eta_{Otto}$. 5

7. A vessel of volume 0·04 m^3 contains a mixture of saturated water and saturated steam at a temperature of 250 °C. The mass of the liquid present is 9 kg. Find the pressure, mass, specific volume, enthalpy, entropy and internal energy. 14

8. Steam at 20 bar, 360 °C is expanded in a steam turbine plant to 0·08 bar. If the plant works on Rankine cycle, find network and cycle efficiency.

If the turbine and pump have each 80% efficiency, find the percentage change in network cycle efficiency. 14

9. 120 m^3/min of air at 35 °C DBT and 45% RH is adiabatically mixed with 325 m^3/min of air at 20 °C DBT and 10 °C DPT. Determine the specific humidity, DBT, and DPT of the mixture without using psychrometric chart. 14

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