53 (ME 301) BTDM

2014

BASIC THERMODYNAMICS

Paper : ME 301

Full Marks : 100

Pass Marks : 30

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions out of seven.*

1. *(a)* What is the zeroth law of thermodynamics ? 2

(b) What is the difference between intensive and extensive properties ? 3

(c) Define isothermal, isobaric and isochoric processes. 6

(d) What is a steady-flow process ? 2

(e) What is the difference between gauge pressure and absolute pressure ? 3

(f) Explain briefly the various types of thermodynamic equilibrium. 4

2. (a) Define enthalpy. How is it related to internal energy ? 3

(b) Define specific heat at constant volume and specific heat at constant pressure. 3

(c) Prove that a heat pump is more efficient than a refrigerator. 5

(d) A heat engine, one heat pump, and a refrigerator are embedded between two heat reservoirs – one at 600*K* while the other at 300*K*. Determine : 3+3+3=9

(i) the efficiency of the heat engine

(ii) the COP of the heat pump

(iii) the COP of the refrigerator

3. (a) A Carnot heat engine and a refrigerator operate between the same two temperature limits. The efficiency of the heat engine is 50%. Find the COP of the refrigerator. 5

(b) Describe the working of a Carnot cycle. 6

(c) What do you mean by the term 'Entropy' ? 2

(d) A heat engine receives heat at the rate of $1500\,kJ/min$ and gives an output of $8{\cdot}2kW$. Determine :

(i) the thermal efficiency

(ii) the rate of heat rejection. 4

(e) Give Clausius and Kelvin-Planck statement of second law of thermodynamics. 3

4. (a) A house required $2\times10^5\,kJ/h$ for heating in winter. Heat pump is used to absorb heat from cold air outside in winter and send heat to the house. Work required to operate the heat pump is $3\times10^4\,kJ/h$. Determine :

(i) Heat abstracted from outside in kW.

(ii) COP 5

(b) A Carnot cycle operates between source and sink temperature of 250°C and –15°C. If the system receives 90*kJ* from the source, find : 7

(i) Efficiency of the system

(ii) The net work transfer

(iii) Heat rejected to sink.

(c) An engine of 250*mm* bore and 375*mm* stroke works on Otto cycle. The clearance volume is $0{\cdot}00263\ m^3$. The initial pressure and temperature are 1 *bar* and $50°C$. If the maximum pressure is limited to 25 *bar*, find : 8

(i) The air standard efficiency of the cycle

(ii) The *m.e.p* for the cycle.

5. (a) The efficiency of an Otto cycle is 60% and $\gamma = 1{\cdot}5$. What is the compression ratio ? 3

(b) Describe the Otto cycle using P-V and T-S diagram. 10

(c) Define dryness fraction. 2

(d) Define the following : 5

(i) Wet steam

(ii) Dry and saturated steam

(iii) Super heated steam

6. (a) Describe the phase-change processes of pure substance. 10

(b) What do you mean by critical point ? 2

(c) Define latent heat of fusion and latent heat of vaporization. 4

(d) What is a heat engine ? Give the classification of a heat engine. 2+2=4

7. (a) Describe the working principles of four strokes SI engine. 10

(b) Compare SI and CI engines. 6

(c) Define cubic capacity and swept volume. 4
