(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 0430 Roll No. | | | | | | | | | | |

B.Tech.

(SEMESTER-III) THEORY EXAMINATION, 2012-13

THERMODYNAMICS

Time : 2 Hours] *[Total Marks : 50*

Notes : (1) Use of Steam Tables and Mollier Chart is permitted.

(2) Assume the missing data, if any suitably and state assumption made.

Section – A

1. Answer **all** questions : **5 × 2 = 10**

(a) What is meant by thermodynamic equilibrium ?

(b) What is Zeroth law of thermodynamics ?

(c) Distinguish between flow work and non-flow work.

(d) Distinguish between a heat pump and a heat engine.

(e) Distinguish between Helmoltz function and Gibbs function.

Section – B

2. Attempt any **three** questions from this section. **5 × 3 = 15**

(a) Explain the working of a Carnot engine and its limitations.

(b) Heat is added at constant pressure to air at 1 bar, 0.002 m^3 and 20 °C until the temperature reaches 240 °C. Determine the work interaction, heat transfer and change of internal energy.

(c) State Kelvin-Planck statement of second law of thermodynamics. Prove that the violation of Clausius statement leads to violation of Kelvin-Planck statement.

(d) Air at 20 °C and 1.05 bar occupies 0.025 m^3. The air is heated at constant volume until the pressure is 4.5 bar and then cooled at constant pressure back to original temperature. Determine (i) Net heat-transfer and (ii) Net change of entropy.

(e) 3 kg of steam at 18 bar occupies a volume of 0.225 m^3. The steam expands at constant volume to a pressure of 10 bar. Determine final dryness fraction, final internal energy change in entropy and work done.

Section – C

Answer **all** questions from this section : **5 × 5 = 25**

3. Answer any **one** part.

(a) Distinguish between spark ignition engine and compression ignition engine.

(b) Derive an expression for the displacement work in a resisted polytropic process.

(c) Define critical temperature and critical pressure. Draw a neat sketch of temperature-volume diagram for water, showing liquid and vapour phases. Mark all the salient points on the diagram.

4. Answer any **one** part.

(a) A mixture of ideal gases contains 3 kg of nitrogen and 5 kg of CO_2. The partial pressure of CO_2 in the mixture is 155 KPa. Find (i) Partial pressure of Mil-Vogen (ii) Gas constant for mixture (iii) Molecular weight of mixture.

(b) A steam turbine receives a steam flow of 4500 kg/hr and delivers 4800 kW. The heat loss from the turbine is negligible. Find the change in enthalpy across the turbine of the velocity of the steam at entrance is 60 m/sec. and at exit is 360 m/sec. The iniet pipe is 4 m above the exhaust.

5. Answer any **one** part.

(a) Separating throttling calorimeter was used to determine the dryness fraction of steam flowing through a steam main at 9 bar. The pressure and temperature after throttling was 1 bar and 115 °C respectively. The mass of steam condensed after throttling was 1.8 kg and mass of water collected in the separating calorimeter was 0.16 kg. Determine the dryness fraction of steam flowing through the steam main. Take C_p for steam = 2.1 kJ/kg.K.

(b) The following particulars were obtained in a trial on a four stroke gas engine :

Duration of trial = 1 hour

Revolutions = 14000

Number of missed cycle = 500

Net brake load = 1470 N

Mean effective pressure = 7.5 bar

Gas consumption = 20000 litre

Calorific value of fuel = 21 kJ/litre

Cylinder diameter = 250 mm

Stroke = 400 mm

Effective brake drum circumference = 4 m

Compression ratio = 6.5 : 1

Determine (i) Brake power (ii) Mechanical efficiency.

6. Answer any **one** of the following :

(a) 1.5 kg of Nitrogen contained in a cylinder at pressure of 5 bar and temperature 300 K expands three times its original volume in a constant pressure process. Determine (i) Initial volume (ii) Final temperature (iii) Work done by gas (iv) Heat added (v) Change in internal energy.

Assume for nitrogen C_p = 1.05 kJ/kg.K R = 295 J/kg.K

(b) A reversible engine operates between 3 heat reservoirs 727 °C, 527 °C and 327 °C and rejects heat to a reservoir at 27 °C. The engine develops 10 kW and rejects 412 kJ/min. If heat supplied at 727 °C is 60 percent of heat supplied by the reservoir at 327 °C, find the quantity of heat supplied by each reservoir.

7. Attempt any **one** part.

(a) Define and explain steady flow energy equation.

(b) Show that the change of entropy in a thermodynamic process is given by $S_2 - S_1 = mC_V \log_e\left(\frac{T_2}{T_1}\right) + mR \log_e\left(\frac{V_2}{V_1}\right)$.

(c) Discuss the factors which cause irreversibility in a thermodynamic process.
