Total No. of Questions—8] [Total No. of Printed Pages—4+2

Seat No.	

[4757]-1012

S.E. (Mechanical/Automobile/Mechanical Sandwich)

(I Sem.) EXAMINATION, 2015

THERMODYNAMICS

(2012 PATTERN)

Time : Two Hours **Maximum Marks : 50**

N.B. :— (*i*) Solve any *four* questions (Q. No. **1** *or* Q. No. **2**, Q. No. **3** *or* Q. No. **4**, Q. No. **5** *or* Q. No. **6**, Q. No. **7** *or* Q. No. **8**).

(*ii*) *All* the four questions should be solved in one answer book and attach extra supplement if required.

(*iii*) Draw neat and labelled diagrams whenever necessary.

(*iv*) Use of steam tables, Mollier charts, scientific calculator is allowed.

(*v*) Assume suitable data whenever necessary.

(*vi*) Figures to the right indicate full marks.

1. (*a*) State Kelvin-Planck and Clausius statement of the second law of thermodynamics and prove that the violation of Kelvin-Planck statement results into violation of Clausius statement. [6]

(*b*) In a certain heat exchanger, 50 kg of water is heated per minute from 50°C to 110°C by hot gases which enter the heat exchanger at 250°C. If the flow rate of gases is 100 kg/min, estimate the net change of entropy. Assume no loss of heat to surroundings. C_p(water) = 4.186 kJ/kg-K, C_p(gas) = 1 kJ/kg-K. [6]

P.T.O.

Or

2. (*a*) Derive expression for the following quantities for an ideal gas undergoing a constant temperature process : [6]

(*i*) Non-Flow System—Work done, Change in internal energy, Heat transfer

(*ii*) Flow System—Work done, Heat transfer, Entropy change.

(*b*) A heat engine working on Carnot cycle absorbs heat from three thermal reservoirs at 1000 K, 800 K and 600 K. The engine does 10 kW of net work and rejects 400 kJ/min. of heat to a heat sink at 300 K. If the heat supplied by the reservoir at 1000 K is 60% of the heat supplied by the reservoir at 600 K, make calculations for the quantity of heat absorbed by each reservoir. [6]

3. (*a*) State the assumptions made for air standard cycle. Derive an expression for the air standard efficiency and mean effective pressure of an Otto cycle. [6]

(*b*) Steam of mass 10 kg and pressure 1000 kPa, 0.85 dry, is heated at constant pressure till the volume is doubled. Determine :

(*i*) Final quality of steam

(*ii*) Heat added

(*iii*) Change in Internal Energy. [6]

Or

4. (*a*) Sketch and explain the construction and working of a separating and throttling calorimeter used for determining the dryness fraction of steam in a boiler. [6]

(*b*) A system at 450 K receives 225 kJ/s of heat energy from a source at 1500 K, and the temperature of both the system and source remains constant during the heat transfer process. Represent the process on temperature-entropy diagram and determine :

(*i*) Net change in entropy

(*ii*) Available energy of heat source and system

(*iii*) Decrease in available energy.

Take atmospheric temperature equal to 300 K. [6]

5. (*a*) Describe briefly the advantages which you would expect to be gained from incorporating an economizer, air preheater, and a superheated in a steam generating plant. By line diagram, indicate the position of these accessories in a typical boiler plant. [6]

(*b*) The following data relates to a trial on boiler using economizer, air preheater and superheater :

Condition of steam at exit of boiler = 20 bar, 0.96 dry

Temperature of steam at exit of superheater = 300°C

Steam evaporation rate/kg of fuel = 12 kg

Room temperature, t_0 = 25°C

Temperature of feed water at exit of economizer, t_1 = 50°C

Temperature of air at exit of air preheater, t_a = 70°C

The temperature of flue gases at inlet to superheater, economizer, air preheater and exit of air preheater are respectively 650°C, 430°C, 300°C and 180°C respectively.

Assume that air supplied is 19 kg/kg of fuel of calorific value of 45,000 kJ/kg, find :

(*i*) Equivalent evaporation with and without economizer, from and at 100°C.

(*ii*) Thermal efficiency of the boiler with and without economizer.

(*iii*) Thermal efficiency of superheater, economizer and air preheater. [7]

Or

6. (*a*) Define steam generator and write down the classification of boilers. [6]

(*b*) In a certain boiler installation, a steel chimney of 30 m height produces and natural draught equivalent to 17.75 mm of water

column. The mean temperature of the boiler house is 298 K and that of hot gases leaving the chimney is 633 K. If the boiler uses 1350 kg of coal per hour, make calculations for :

(*i*) Air supplied per kg of coal burnt on the grate,

(*ii*) Draught in terms of column of hot flue gases,

(*iii*) Density and mass flow rate of hot gas. [7]

7. (*a*) Define mass fraction and mole fraction with example and explain the method of writing the complete combustion equation of a C_8H_{18} with air. [6]

(*b*) A sample of coal supplied to a boiler has the following composition by mass :

Carbon = 87%, Hydrogen = 3%, Oxygen = 3%, Nitrogen = 1%, Sulphur = 1% and the remainder is ash. If 15% of excess air is supplied for combustion. Find :

(*i*) The theoretical amount of air required for complete combustion of fuel

(*ii*) The mass analysis of flue gas per kg of fuel. [7]

Or

8. (*a*) For what purpose a Bomb calorimeter is used ? Discuss its working with the help of a neat sketch. [6]

(*b*) The following data pertains to a test run made to determine the calorific value of a sample of coal :

Mass of coal burnt = 0.85 gm, Mass of fuel wire burnt and its calorific value is 0.028 gm and 6700 kJ/kg respectively, mass of water in calorimeter = 1800 gm, initial and final temperature of water = 16.5°C and 20.25°C, water equivalent of calorimeter = 350 gm, the coal contains 3% moisture by weight and R.T. = 20°C. Make calculations for the higher and lower calorific values of the coal sample. Consider latent heat of condensation of steam 2460 kJ/kg. [7]