Registration No. :

Total number of printed pages – 4

B. Tech

BENG 1103/ BE 2103 (O/N)

First Semester Examination – 2010

THERMODYNAMICS

(Old and New Course)

Full Marks – 70

Time : 3 Hours

*Answer Question No. 1 which is compulsory and any **five** from the rest.*
The figures in the right-hand margin indicate marks.

1. Answer the following questions :   2 ×5

    (a) (i) Write two property rule for a pure substance.

         (ii) Write the standard atmospheric pressure in kN/m^2, bar, mm of Hg
               and mm of H_2O.

         (iii) A heat engine operates between two temperature limits T_1 and T_2
               with an efficiency of 0.4. What will be the COP of a refrigerator
               operating between the same temperature limits ?

         (iv) Two reversible engines operating between same temperature limits.
               One engine is operating with petrol and the other one is operating
               with diesel. Which engine will have higher efficiency and why ?

(v) In a power plant turbine output is 1000 kW. Pump consumes 50 kJ/s and the boiler receives heat of an amount 3000 kJ/s. What will be the thermal efficiency of the plant ?

(b) Define and explain the following terms :   2×5

(i) Intensive property

(ii) Isentropic process

(iii) Enthalpy

(iv) Ton of refrigeration

(v) Throttling

2. A mass of air in an insulated rigid tank is stirred by means of a paddle wheel whose shaft protrudes into the tank and is externally connected to an electric motor. Air is allowed to escape out of the tank through a carefully controlled valve such that the temperature of air remaining in the tank at any instant has the same value. At a certain instant the temperature of air in the tank is 160° C and the current drawn by the motor connected to the mains at 220 V is 0.505 amps. The electro-mechanical efficiency of the motor is 90%; find the rate of flow of air out of the tank in kg/h. Assume for air $u = u_0 + 0.718t$; $pv = 0.287(t + 273)$ where p in kPa ; u in kJ/kgK ; t in °C, u in m³/kg.

10

3. A heat engine is used to drive a heat pump. The heat coming out of the heat engine and the heat pump are used to heat the water for the radiator of a

building. The efficiency of the heat engine is 30% and the COP of the heat pump is 4. How much heat is transferred to the radiator water for every kJ heat transferred to heat engine ?　　　　10

4. A certain mass of air initially at 150 kPa, 0.13 m³ is compressed in a reversible polytropic process at 700 kPa. During this process, heat transfer to air is 20 kJ and the internal energy of air increases by 50 kJ. Find the final volume of air. Assume $C_p = 1.005$ kJ/kgK, $C_v = 0.718$ kJ/kgK.　　10

5. At 30° C, 0.3 m³ of helium at 20 bar is mixed with 0.7 m³ of Oxygen at 6 bar and 2°C by opening the value between the two tanks. The final temperature of the mixture is 27°C. Calculate :　　　　10

   (a) the magnitude and direction of heat transfer,

   (b) the pressure of the mixture.

   Assume for helium R = 2077 J/kgK; C_v = 3116 J/kgK and for Oxygen R = 260 J/kgK, C_v = 662 J/kgK.

6. Steam enters the nozzle of an impulse turbine at 10 bar, 300°C with a velocity of 50 m/s. The exit pressure is 1 bar. Find the exit area of the nozzle; assuming the expansion to be reversible and adiabatic for a steam flow rate of 1.2 kg/s.　　　　10

7. Explain with neat sketch how the electrical power is generated in a thermal power plant.　　　　10

<div align="center">Or</div>

Steam at a pressure of 118 bar and 400°C expands adiabatically to a pressure of 38 bar. The final condition of steam is dry, saturated. Find the work done by the steam. State whether the process is reversible or irreversible.

8. Write notes on the following :

    (a) Mollier's diagram.   3

    (b) Different modes of heat transfer.   3

    (c) Temperature measuring devices.   4