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B037314(037)

B. Tech. (Third Semester) Examination, Nov.-Dec. 2020

(Mechanical Engg. Branch)

ENGINEERING THERMODYNAMICS

Time Allowed : Three hours

Maximum Marks : 100

Minimum Pass Marks : 35

***Note** : Attempt all questions. Each question carries equal makrs. Part (a) is compoulsory and answer any **two** from (b), (c) and (d). Use standard notations. Steam table and Mollier chart is permitted.*

1. (a) Define zeroth law of thermodynamics and give any practical example of it. 4

   (b) Explain with diagram and interaction with system and surrounding of shaft work. Displacement work, flow work and electrical word. 8

(c) Describe perpetual motion of first kind and limitation of first law of thermodynamics. 8

(d) When a system is taken from state *a* and *b* as shown in figure 1 along path *acb* 84 kJ of heat flow into the system, and the system does 32 kJ of work.

(i) How much will the heat that flows into the system along path *adb* be, if the the work sone is 10·5 kJ?

(ii) When the system is returned from *b* to *a* along the curved path, the work done on the system is 21 kJ. Does the system absorbs or liberate heat, and how much of the heat is absorbed or liberated?

(iii) If $U_a = 0$ and $U_d = 42\,\text{kJ}$. Find the heat absorbed in the processes *ad* and *db*.

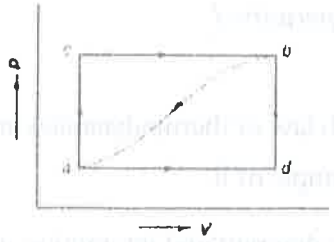

Fig.1

2. (a) Describe Energy Reservoirs. 4

(b) Prove the equivalence of Kelvin-Planck's and Clausius statements. 8

(c) Show that the COP of heat pump is greater than the COP of a refrigerator by unity. 8

(d) Air at 20°C and 1·05 bar occupies 0·025 m^3. The air is heated at constant volume unitil the pressure is 4·5 bar, and then cooled at constant pressure back to original temperature. Calculate the net heat flow from the air. 8

3. (a) What is available and unavailable energy? 4

(b) Derive an expression for the energy of any finite body of heat capacity C and temperature T. 8

(c) Calculate the available energy in 40 kg of water at 75°C with respect to the surrounding at 5°C, the pressure of water being 1 atm. 8

(d) Air enters a compressor at 1 bar, 30°C, which is also the state of the environment. It leaves at 3·5 bar, 141°C and 90 m/s. Neglecting inlet velocity and P.E. effect, determine (a) whether the

compression is adiabatic or polytropic, (b) if not adiabatic, the polytropic index, (c) the isothermal efficiency, (d) the minimum work input and irreversibility, and (e) dthe second law efficiency.

Take C_p of air = 1·0035 kJ/kg K. 8

4. (a) Write the Vander Waals' equation (for a real gas) and its limitations. 4

(b) A steel flask of 0·04 m^3 capacity is to be used to store nitrogen at 120 bar, 20°C. The flask is to be protected against excessive pressure by a fusible plug which will melt and allow the gas to escape if the temperature rises too high.

(i) How many kg of nitrogen will the flask hold at the designed conditions?

(ii) At what temperature must the fusible plug melt in order to limit the pressure of a full flask to a maximum of 150 bar. 8

(c) Explain the following terms relating to steam formation :

(i) Sensible heat of water

(ii) Latent heat of steam

(iii) Superheated steam

(iv) Enthalpy of wet steam, and 8

(d) Vessel of 0·35 m^3 capacity contains 0·4 kg of carbon monoxide (molecular weight = 28) and 1 kg of air at 20°C.

Calculate :

(i) The partial pressure of each constituent

The gravimetric analysis of air is to be taken as 23·3% oxygen (molecular weight = 32) and 76·7% nitrogen (molecular weight = 28). 8

5. (a) Define pure substance and give suitable example. 4

(b) Explain pressure-temperature diagram for a pure substance. 8

(c) A vessel having a capacity of 0·05 m^3 contains a mixture of saturated water and saturated steam at a temperature of 245°C. The mass of the liquid present is 10 kg. 8

Find the following :

(i) The pressure

(ii) The mass

(iii) The specific volume

(iv) The specific enthalpy

(d) 1000 kg of steam at a pressure of 16 bar and 0·9 dry is generated by a boiler per hour. The steam passes through a superheater via boiler stop valve where its temperature is raised to 380°C. If the temperature of feed water is 30°C.

Determine :

(i) The total heat supplied to feed water per hour to produce wet steam

(ii) The total heat absorbed per hour in the superheater.

Take specific heat for superheated steam as 2·2 kJ kg K. 8