B.Tech. MECHANICAL ENGINEERING (COMPUTER INTEGRATED MANUFACTURING) / BTMEVI

Term-End Examination,

December 2019

BME-019 : ENGINEERING THERMODYNAMICS

Time : 3 Hours] *[Maximum Marks : 70*

*Note : (i) Attempt **any seven** questions.*
*(ii) All questions carry **equal** marks.*
(iii) Use of scientific calculator is permitted.
(iv) Use of steam table is also permitted.

1. a) A temperature scale of a certain temperature is given by the relation $t = a\, l_n\, p + b$, where a and b are constants and p is thermometric property of the fluid in the thermometer. If at the ice point and steam point, thermometric properties are found to be 1.5 and 7.5 respectively, what will be the temperature corresponding to the thermometric property of 3.5 on Celsius scale. 5

   b) State and explain the Zeroth law of thermodynamics. 5

2. a) In a Non-flow reversible process, the pressure and volume are related by $p = v^2 + \frac{10}{v}$ where p is in N/m^2 abs, and v is volume in m^3.
   During the process the volume changes from $1.5m^3$ to $4.5m^3$ and heat added is 3000 Joules, determine the change in internal energy. 5

b) A closed system undergoes a thermodynamic cycle ABCDA. The heat transfers per minute-during processes AB, BC, and CD are –500 kJ, 10,000 kJ, and –1000 kJ respectively. The work transfer per second during processes AB, BC, CD and DA are –10,000 kJ, Zero, 17,000 kJ, and –1000 kJ respectively. Find the rate of heat transfer during the process DA and net rate of work input in kW. 5

3. a) When a system is taken from state 'a' to state 'b' as shown in figure 1 along the path acb, 2 kJ of heat flows into the system and the system does 8 kJ of work. 5

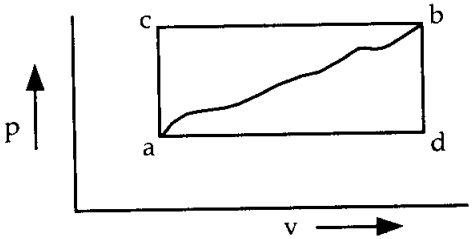

Figure 1

i) How much heat flows into the system along path adb if the work done by the system is 2.5 kJ?

ii) The system is returned from state 'b' to state 'a' along the curved path ba. The work done on the system is 5 kJ. Does the system absorb or give out heat and how much.

b) A Freezer is to be maintained at a temperature of 288K when the ambient temperature is 306K. In order to maintain the freezer box at 238K, it is necessary to remove heat from it at the rate of 2460 J/sec. What is the maximum possible co-efficient of performance of the freezer and what is the minimum power that must be supplied to the freezer? 5

4. a) An inventer claims to have developed a cyclic engine which exchanges heat with reservoirs at 130°C and −40°C. It receives only 2100 kJ/min of heat and develops 17.66 kW. Is his claim feasible. 5

   b) A domestic food freezer maintains a temperature of −15°C. The ambient air temperature is 30°C. If heat leaks into the freezer at the continuous rate of 1.75 kJ/sec, what is the minimum power required to pump this heat out continuously? 5

5. a) A Carnot engine rejects heat to a cooling pond at 27°C. The heat rejected to the pond is 840 kW/min. If the efficiency of the engine is 30%. Find the power of the engine and temperature of the engine. 5

   b) A reversible engine operates between source at 927°C and two sinks, one at 127°C, and another at 27°C. The heat rejected to both sinks is same, what is the efficiency of the engine? 5

6. Find the specific enthalpy and specific entropy of steam when the pressure is 1MPa and specific volume is 0.16 m^3/kg. If 5 kg of the steam at the above state is heated at constant pressure to a temperature of 250°C, calculate the heat transfer during the process. 10

7. a) Explain "Triple point of water" and show it on P-T diagram. 5

   b) Define the following terms: 5

      i) Sensible heat of water

      ii) Latent heat of vaporization

      iii) Total heat of steam

      iv) Dryness fraction of steam

      v) Volume of superheated steam

8. Determine the quantity of heat required to generate 5 kg of steam at a pressure of 8 bar absolute, from water at a temperature of 40°C. 10

   i) When dryness fraction of steam is 0.98

   ii) Superheated up to 300°C.

   Assume mean specific heat of superheated steam is 2.3 kJ/kg K.

9. a) Explain why the Rankine cycle rather than Carnot cycle is used as a standard of reference for the performance of steam plants. 5

   b) Sketch a schematic diagram of a steam power plant and explain the various processes of Rankine cycle on T-S and P-V diagrams. 5

10. a) What is Entropy? State and explain the second law of Thermodynamics. 5

    b) Briefly explain the Kelvin-Planck and Clausius statements of second law of Thermodynamics. 5