53 (ME 301) BATH

2018

BASIC THERMODYNAMICS

Paper : ME 301

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions out of **six**.*

1. *(a)* What is zeroth law of thermodynamics ? 2

(b) Compare heat transfer with work transfer. 2

(c) State Kelvin Planck's statement. 2

(d) What is the entropy principle ? 2

(e) What is flow and non-flow process ? 2

(f) Define thermodynamic equilibrium. 3

(g) What is the triple point of water ? Give the values of properties at that point. 3

(h) What do you mean by latent heat of vaporization ? 2

(i) What is a pure substance ? Give example. 2

2. (a) A tube contains an oil of specific gravity 0·9 to a depth of 120*cm*. Find the gauge pressure at this depth (in kN/m^2). 5

(b) An artificial satellite revolves round the earth with a relative velocity of 800m/s. If acceleration due to gravity is $9m/s^2$ and gravitational force is 3600N, calculate its kinetic energy. 5

(c) Show that $C_P - C_V = R$. 6

(d) Define 'internal energy' and prove that it is a property of a system. 4

3. (a) The properties of a closed system change following the relation between pressure and volume as $PV = 3$, where (P) is in bar, V is in m^3. Calculate the work done when the pressure increases from 1·5 *bar* to 7·5 *bar*. 6

(b) A mass of gas is compressed in a quasi-static process from $80kPa$, $0{\cdot}1m^3$ to $0{\cdot}04MPa$, $0{\cdot}03m^3$. Assuming that the pressure and volume are related by $PV^{1{\cdot}35}$ = constant, find the work done by the gas system. 6

(c) The pressure and volume relation during a non-flow reversible process is given by

$$P = \left(V^2 + \frac{8}{V}\right) bar$$

The volume changes from $V_1 = 6m^3$ and $V_2 = 2m^3$. Calculate the work done. The heat rejected during the process is $200kJ$. Determine the change in internal energy. 8

4. (a) In a system $80kJ$ of heat is supplied from state 1 to state 2 by constant volume process. The internal energy at state 1 is $90kJ$. The system rejects $95kJ$ of heat from state 2 to state 3 by constant pressure process and $30kJ$ of work is done on it. The system is brought back from state 3 to state 1 by a reversible adiabatic process. Calculate the adiabatic work and the values of internal energy at state 2 and state 3. 7

(b) A steam turbine developing $34kW$ receives steam at $15bar$ with an internal energy of 2720 kJ/kg and specific volume of $0{\cdot}17m^3/kg$ and velocity of $110m/s$. Steam is exhausted from turbine at $0{\cdot}1bar$ with internal energy $2177kJ/kg$ and specific volume $15m^3/kg$ and velocity 320 m/s. The heat loss over the surface of the turbine is $20kJ/kg$. Neglecting change in potential energy, determine work done per kg of steam. 7

(c) Explain the general steady flow energy equation. 3

(d) Explain the various forms of energy. 3

5. (a) A Carnot engine works between temperature limits of $825°C$ and $125°C$. The engine receives $3600kJ$ of heat per minute. Determine the efficiency of the engine and the amount of heat rejected to the sink per second. 7

(b) Show that

$$COP_{Heat\ Pump} = COP_{Refrigeration} + 1$$

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(c) Describe the working of a Carnot cycle with a neat diagram. 8

6. *(a)* A vessel of volume $0{\cdot}04 m^3$ contains a mixture of saturated water and saturated steam at a temperature of $250°C$. The mass of the liquid present is $9kg$. Find the pressure, the mass, the specific volume, the enthalpy, the entropy and internal energy. 12

(b) A Carnot cycle operates between source and sink temperatures of $250°C$ and $-15°C$. If the system receives $90kJ$ from the source, find :

(i) Efficiency of the system

(ii) The net work transfer

(iii) Heat rejected to sink.

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