53 (ME 301) BTDM

2017

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.*

1. *(a)* Explain what do you mean by the thermodynamic property of a system. How will you classify it ? 1+2=3

   (b) In what forms can energy cross the boundaries of a system ? 1

   (c) Distinguish between stored energy and energy in transit. 3

(d) Does a work transfer between a system and its surroundings always mean a change in the volume of the system? Justify your answer through reasoning and examples. 3

(e) Show that $C_p - C_v = R$. 6

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

2. (a) A Bourdon pressure gauge reads a pressure of $1{\cdot}75 MPa$ gauge. If the barometric height is $757 mm Hg$, determine the absolute pressure in megapascals. 4

(b) To a closed system $150 kJ$ of work is supplied. If the initial volume is $0{\cdot}6 m^3$ and pressure of the system changes as $p = 8 - 4V$, where (p) is in bar and (V) is in m^3, determine the final volume and pressure of the system. 6

(c) Define Enthalpy. How is it related to internal energy ? 2

(d) What is PMM1 ? Justify with reason whether it is feasible or not. 4

(e) 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). 4

3. (a) A closed system of constant volume experiences a temperature rise of 25°*C* when a certain process occurs. The heat transferred in the process is 30*kJ*. The specific heat at constant volume for the pure substance comprising the system is 1·2*kJ*/*kg* °*C*, and the system contains 2·5*kg* of this substance.

Determine :

(i) The change in internal energy

(ii) The work done. 4

(b) A fluid system undergoes a non-flow frictionless process following the pressure-volume relation as $P = \frac{5}{V} + 1{\cdot}5$, where (P) is in bar and (V) is in m^3. During the process the volume changes from $0{\cdot}15m^3$ to $0{\cdot}05m^3$ and the system rejects $45kJ$ of heat.

Determine :

(i) Change in internal energy

(ii) Change in enthalpy. 6

(c) A steam turbine developing $400kW$ receives a flow of $20000kg/hour$ of steam. The inlet and outlet velocities of steam are $100m/s$ and $320m/s$ respectively. The inlet pipe is $4m$ above exhaust. Determine the change in enthalpy neglecting heat loss from the turbine. 4

(d) In a steam power plant the boiler is supplied with 60*kg* of water per minute. The enthalpy and velocity of water entering the boiler are 840*kJ/kg* and 5*m/s* respectively. The water receives 2300*kJ/kg* of heat at constant pressure in the boiler. The boiler inlet is 3*m* above the turbine exit. The steam leaves the turbine with a velocity of 3000*m/min* and its enthalpy is 2640*kJ/kg*. The heat losses from the turbine and boiler to the surroundings is 1260*kJ/min*. Determine the power output of the turbine. 6

4. (a) Define heat engine, refrigerator and heat pump. 6

(b) Give the following statements of second law of thermodynamics. 2+2=4

(i) Clausius statement

(ii) Kelvin-Planck statement.

(c) Find the co-efficient of performance and heat transfer rate in the condenser of a refrigerator in *kJ/h* which has a refrigeration capacity of 12000*kJ/h* when power input is 0·75*kW*. 4

(d) A house required $2 \times 10^5 kJ/h$ for heating in winter. Heat pump is used to absorb heat from cold air outside in winter and send heat to the house. Work required to operate the heat pump is $3 \times 10^4 kJ/h$.

Determine :

(i) Heat abstracted from outside

(ii) Co-efficient of performance. 6

5. (a) Describe the process of formation of steam and give its graphical representation also. 8

(b) Find the thermal efficiency of a Carnot engine whose hot and cold bodies have temperatures of $170°C$ and $20°C$ respectively. 2

(c) A vessel having a capacity of $0{\cdot}05 m^3$ contains a mixture of saturated water and saturated steam at a temperature of $245°C$. The mass of the liquid present is $10 kg$. Find the following :

(i) The pressure

(ii) The mass

(iii) The specific volume

(iv) The specific enthalpy

(v) The specific entropy

(vi) The specific internal energy.

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6. (a) What is a Rankine cycle? Draw it on p-V and T-s diagram and describe its different processes. 10

(b) Describe the working of a Carnot cycle with a neat diagram. 10

7. Write short notes on : ***(any five)*** 5×4=20

(a) Types of energy

(b) Thermodynamic equilibrium

(c) Flow process

(d) Differences between macroscopic and microscopic approaches of thermodynamics

(e) Show that
$COP_{heat\ pump} = COP_{Refrigeration} + 1$

(f) Pressure measuring instrument.
