Total number of printed pages–5

53 (ME 301) BATD

2021

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) Define thermodynamics. State the various laws of thermodynamics.   6

   (b) What is the relationship between a system and its environment when the system is (i) adiabatic, (ii) isolated ?

   3

   (c) State the difference between extensive, intensive and specific properties of a thermodynamic system.   4

   (d) Explain the terms—state, path, process and cycle.   5

(e) Differentiate between homogeneous and heterogeneous system. 2

2. (a) Differentiate between absolute and gauge pressure. 3

(b) A system has a mass of 4kg and it is moving at a velocity of 50m/s and height 100m above the sea level. Determine its potential energy and kinetic energy relative to the earth. 5

(c) The pressure measured by a pressure gauge is $5000 kN/m^2$. Barometric pressure of the atmosphere is 760mm of mercury. Find the absolute pressure. 6

(d) State whether the following properties of a system are intensive or extensive :

Pressure, temperature, mass, density, volume, sp. volume, altitude, surface area, kinetic energy, velocity, electric charge. 6

3. (a) Explain the term energy. Explain various forms of energy. 5

(b) Discuss the second law of thermodynamics with Kelvin-Planck and Clausius statements. 6
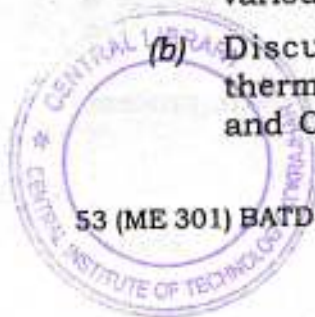
(c) Define thermodynamic work. What are +ve and (–)ve work interactions ? 5

(d) In what respects are the heat and work interactions *(i)* similar and *(ii)* dissimilar ? 4

4. (a) A non-flow reversible process occurs for which pressure and volume are correlated by the expression $p = \left(V^2 + 6/V\right)$ where p is in *bar* and V is in m^3. What amount of work will be done when volume changes from 2 to $4m^3$? 6

(b) Consider a gas enclosed in a piston-cylinder arrangement. The gas is initially at $150kPa$ and occupies a volume of $0.03m^3$. The gas is now heated until the volume of the gas increases to $0.1m^3$. Calculate the work done by the gas if volume of the gas is inversely proportional to the pressure. 6

(c) The pressure-volume correlation for a non-flow reversible process is given by $p = (8 - 4V)$ *bar*, where V is in m^3. If $150kJ$ of work is supplied to the system, determine the final pressure and volume of the system. Take initial volume $= 0.6m^3$. 8

5. (a) In a gas turbine unit, the gases flow through the turbine is $15 kg/s$ and the power developed by the turbine is $12000 kW$. The enthalpies of gases at the inlet and outlet are $1260 kJ/kg$ and $400 kJ/kg$ respectively, and the velocity of gases at the inlet and outlet are $50 m/s$ and $110 m/s$ respectively. Calculate : 8

(i) the rate at which heat is rejected to the turbine, and

(ii) the area of the inlet pipe given that the specific volume of the gases at inlet is $0.45 m^3/kg$.

(b) A Carnot cycle operates between source and sink temperatures of $250°C$ and $-15°C$. If the system receives $90 kJ$ from the source, find : 6

(i) Efficiency of the system

(ii) The net work transfer

(iii) Heat rejected to sink.

(c) A heat engine is suppling heat at the rate of $1700 kJ/min$ and gives an output of $9 kW$. Determine the thermal efficiency and the rate of heat rejection. 6
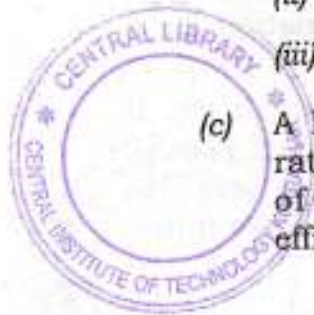
6. (a) What is a pure substance? What is meant by phase of a substance? 3

(b) What is the main feature of triple point? State the values of pressure and temperature at the triple point of water. 3

(c) Define quality and dryness fraction of steam. 3

(d) Differentiate between internal and external combustion engines. 4

(e) Explain with suitable sketches the working of a four-stroke otto engine. 7