CBCS SCHEME

USN | | | | | | | | | | |

15ME33

Third Semester B.E. Degree Examination, July/August 2022
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 80

Note : 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use of Thermodynamic data handbook is allowed.***

Module-1

1 a. Distinguish between :
i) Open system and Closed system ii) Macroscopic and Microscopic approaches
iii) Intensive and Extensive properties iv) Diathermic and Adiabatic walls. **(08 Marks)**

b. A platinum wire is used as resistance thermometer. The wire resistance were found to be 10Ω and 16Ω at ice point and steam point on Celsius scale and 30Ω at sulphur boiling point of 444.6°C. Find the constants 'a' and 'b' in the equation. $R = R_0(1 + at + bt^2)$, where 't' is in °C. Also find the resistance of the wire at 500°C. **(08 Marks)**

OR

2 a. Show that work is a path function. **(04 Marks)**

b. Derive an expression for the workdone by a system, undergoing a polytropic process $PV^n = C$. **(04 Marks)**

c. To a closed system 150 kJ of work is done on it. If the initial volume is $0.6m^3$ and pressure of system varies as follows : $P = (8 - 4V)$, where P is pressure in bar and V is volume in m^3. Determine the final volume and pressure of the system. **(08 Marks)**

Module-2

3 a. State the 1st law of Thermodynamics for cyclic process and show that internal energy is a property of a system. **(06 Marks)**

b. A perfect gas flows through a Nozzle where it expands in a reversible adiabatic manner. The inlet conditions are 22bar, 500°C and 38m/s. At exit the pressure is 2 bar. Determine the exit velocity and exit area. If the flow rate is 4kg/S. Take R = 0.190 kJ/kg K and $\gamma = 1.35$. **(10 Marks)**

OR

4 a. State the Kelvin – Planck and Clausius statements of the Second law of Thermodynamics and prove their equivalence. **(08 Marks)**

b. A reversible heat engine operates between two reservoirs at temperature of 600° C and 40°C. The engine drives a reversible refrigerator which operates between at temperature of 40°C and -20°C. The heat transfer to the heat engine is 2000 kJ and the net work output of the combined engine refrigerator plant is 360 kJ.
i) Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40°C.
ii) Reconsider (i) given that the efficiency of the heat engine and the Cop of the refrigerator are each 40% of their maximum possible values. **(08 Marks)**

Module-3

5 a. Explain the various causes of Irreversibility. **(04 Marks)**

b. Write any four remarks on Carnot's engine. **(04 Marks)**

c. Two Carnot refrigerators A and B operate in series. The refrigerator A absorbs energy at the rate of 1kJ/S from a body at temperature 300K and rejects energy as heat to a body at a temperature T. The refrigerator B absorbs the same quantity of energy which is rejected by the refrigerator A from the body at temperature T and rejects energy as heat to a body at temperature 1000K. If both the refrigerators have the same C.O.P, calculate
i) The temperature T of the body ii) The C.O.P of the refrigerators and
iii) The rate at which energy is rejected as heat to the body at temperature 1000K. **(08 Marks)**

OR

6 a. State and prove Clausius in equality. **(08 Marks)**

b. Air at 20°C and 1.05 bar occupies $0.025m^3$. The air is heated at constant volume until the pressure is 4.5bar and then cooled at constant pressure back to original temperature. Calculate i) The net heat flow from the air ii) The net entropy change. Sketch the process on T – S diagram. **(08 Marks)**

Module-4

7 a. Explain "Useful Work", Maximum useful work and Irreversibility. **(06 Marks)**

b. Two kg of air at 500KPa, 80°C expands adiabatically in a closed system until its volume is doubled and its temperature becomes equal to that of the surroundings which is at 100KPa and 5°C. For this process determine i) The maximum work ii) the change in availability and iii) The irreversibility. For air take C_V = 0.718kJ/kg K and R = 0.287kJ/kg K. **(10 Marks)**

OR

8 a. With a neat sketch, explain Combined Separating and Throttling Calorimeter. **(08 Marks)**

b. A vessel of volume $0.05m^3$ contains a mixture of saturated water and saturated steam at a temperature of 250°C. The mass of water present is 9kg. Find the pressure , the mass , specific volume, the enthalpy, entropy and internal energy. **(08 Marks)**

Module-5

9 a. Explain i) Dalton's law of partial pressure ii) Amagat's law of additive volume. **(04 Marks)**

b. Derive an expression for specific humidity of moist air. **(04 Marks)**

c. Define the following : i) Dry bulb temperature ii) Wet bulb temperature
iii) Relative humidity iv) Specific humidity. **(08 Marks)**

OR

10 a. Derive Vander Waal's constants interms of Critical properties. **(08 Marks)**

b. Explain the following :
i) Compressibility factor ii) Law of Corresponding States
iii) Generalized compressibility chart iv) Reducing properties. **(08 Marks)**

* * * * *