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

15ME33

Third Semester B.E Degree Examination, Feb./Mar.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 thermodynamics data hand book is permitted.*

Module-1

1 a. Distinguish between:
(i) Diathermic and adiabatic walls.
(ii) Thermal equilibrium and mechanical equilibrium.
(iii) Homogenous and Heterogenous system.
(iv) Microscopic and Macroscopic point of view. **(08 Marks)**

b. Two thermometers, one centigrade and other Fahrenheit, are immersed in a fluid. After the thermometers reach equilibrium with the fluid, it is noted that both the thermometers indicate the same numerical value. Find that identical numerical value shown by the thermometers. What would be the corresponding temperature of the fluid expressed in degrees Kelvin and degree Rankine? **(08 Marks)**

OR

2 a. Starting from a common stage point, draw the following process on the PV-plane and derive an expression for the work done in each case:
(i) Isobaric process (ii) Hyperbolic process. (iii) Polytropic process. **(08 Marks)**

b. A cylinder with a frictionless piston contains 0.1 m^3 of gas at 200 KPa pressure. The piston is connected to a coil spring which exerts a force proportional to the displacement from its equilibrium position. The gas is heated until the volume is doubled at which pressure is 500 KPa. Determine the workdone by the gas. Take atmospheric pressure equal to 100 KPa. **(08 Marks)**

Module-2

3 a. State and explain the first law of thermodynamics. Give its equation with reference to a cyclic and non-cyclic process. **(05 Marks)**

b. Define specific heat at constant volume and constant pressure. **(03 Marks)**

c. A cylinder fitted with a movable piston contains 0.04 m^3 of air at 10 bar pressure and 400 K temperature. The air expands according to the law $P = \left[\frac{A}{V^2} - \frac{B}{V}\right]$ to a final pressure of 1 bar and 0.2 m^3. Determine work done, change in internal energy and heat absorbed Rejected during the expansion process. [Take C_V = 0.718 KJ/kgK]. **(08 Marks)**

OR

4 a. Explain the establishment of a thermodynamic temperature scale. **(08 Marks)**

b. A reversible heat engine working between two thermal reservoirs at 875 K and 315 K drives a reversible refrigerator which operates between the same 315 K reservoir and a reservoir at 260 K. The engine is supplied 2000 KJ of heat and the net work output from the combined system is 350 KJ. Make calculations for the heat transfer to the refrigerator and the net heat interaction with the reservoir at 315 K temperatre. **(08 Marks)**

Module-3

5 a. List any four factors that make a process irreversible. Explain any two factors. **(08 Marks)**

b. Three Carnot heat engines are arranged in series. The first engine takes 4000 KJ of heat. From a source at 2000 K and delivers 1800 KJ of work, the second and third engines delivers 1200 KJ and 500 KJ of work respectively. Make calculations for the exhaust temperature of the second and third Carnot engines. **(08 Marks)**

OR

6 a. With usual notations, explain Clausis theorem. **(08 Marks)**

b. 1.5 kg of air initially at 25˚C is heated reversibly at constant pressure until volume is doubled and heated reversibly until pressure is doubled at constant volume. For total path, determine

(i) The Work transfer (ii) The Heat transfer. (iii) The change in entropy. **(08 Marks)**

Module-4

7 a. Define the following:

(i) Effectiveness (ii) Irreversibility **(04 Marks)**

b. Write a short notes on Gibbs and Helmholtz functions. **(04 Marks)**

c. 20 kg of water at 90˚C is mixed with 30 kg of water at 30˚C and the pressure remains constant during the mixing operation. Calculate the decrease in available energy. It may be pressumed that the surroundings are at 10˚C temperature and for water C_P = 4.18 KJ/kg.K. **(08 Marks)**

OR

8 a. Sketch and explain combined separating and throttling calorimeter. **(08 Marks)**

b. A sample of steam at 5 bar is stated to have an enthalpy of 2350 KJ/kg. Make calculations for the specific volume, internal energy and entropy of this sample of steam. **(08 Marks)**

Module-5

9 a. Define the following terms as applied to ideal gas and phychrometric process:

(i) Amagat's law of additives.
(ii) Dalton's law of partial pressure
(iii) Dry Bulb Temperature.
(iv) Specific humidity. **(08 Marks)**

b. A vessel contains 10 kg of oxygen, 8 kg of nitrogen and 25 kg of carbon dioxide at 375 K temperature and 250 KPa pressure. Make calculation for the capacity of vessel the partial pressure of each gas present in the vessel and the total pressure in the vessel when the temperature is raised to 450 K. **(08 Marks)**

OR

10 a. Explain the following :

(i) Compressibility factor. (ii) Vander Waals equation of state.
(iii) Law of corresponding states. (iv) Compressibility chart. **(08 Marks)**

b. Give its equation with reference to a real gas :

(i) Redlich-Kwong equation (ii) Berthelot equation **(02 Marks)**

c. 1 kg of propane (C_3H_8) is at a pressure of 7 MPa and a temperature of 150˚C. The critical properties of propane are P_C = 4.36 MPa, T_C = 370 K and V_C = 0.00454 m^3/kg and compressibility factor is 0.54.

Calculate

(i) The reduced pressure, volume and temperature.
(ii) Specific volume of propane. **(06 Marks)**

* * * * *