CBCS SCHEME

USN | | | | | | | | | | 18ME33

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

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of Thermodynamics data hand book permitted.

Module-1

1 a. Define Thermodynamic system, differentiate between open, closed and isolated system. **(08 Marks)**

b. Explain the following: i) State ii) Process iii) Cyclic process. **(06 Marks)**

c. A temperature scale of a certain thermometer is given by the relation $t = a\ ln\ p + b$, where a and b are constants and p is Thermometric property. If at ice point and steam point the properties are found to be 2.5 and 9.5 respectively, what will be the temperature corresponding to the thermometric property of 4.5 on Celsius scale. **(06 Marks)**

OR

2 a. Explain briefly Zeroth law of Thermo dynamics. **(06 Marks)**

b. Explain the following:
i) Quasistatic process
ii) Adiabatic and dia thermal wall
iii) Reversible process. **(06 Marks)**

c. Estimate the % variation in temperature from a thermocouple from a thermocouple having its test junction in gas and other reference junction at ice point. The temperature of gas using gas thermometer is found to be 50°C. Thermocouple is calibrated with emf varying linearly between ice point and steam point. When thermocouple's test junction is kept in gas t°C and reference junction at ice point, the emf produced in millivolts is $e = 0.18t - 5.2 \times 10^{-4}t^2$. **(08 Marks)**

Module-2

3 a. Compare heat and work. **(06 Marks)**

b. Derive an expression for work in a polytropic process. **(06 Marks)**

c. A fluid at a pressure of 3 bar, and with specific volume of $0.18 m^3/kg$ contained in a cylinder behind a piston expands reversibly to a pressure of 0.6bar, according to a Law $P = \frac{c}{v^2}$ where c is a constant. Calculate the workdone by the fluid on the piston. Show the process on p-v diagram. **(08 Marks)**

OR

4 a. State first law of thermodynamics and show that internal energy is property of a system. **(08 Marks)**

b. What do you mean by "Perpetual Motion Machine of first kind, PMM-1"? **(04 Marks)**

c. A stream of gases at 7.5 bar, 750°C and 140m/s is passed through a turbine of a jet engine. The gases comes out of the turbine at 2 bar, 550°C and 280m/s. The process may be assumed adiabatic. The enthalpies of gas at the entry and exit of the turbine are 950kJ/kg and 650kJ/kg of gas respectively. Determine the capacity of the turbine in KW if the gas flow rate is 5kg/s. **(08 Marks)**

Module-3

5 a. Give the following statements of second law of thermodynamics:
i) Clausius statement ii) Kelvin Plank statement. **(06 Marks)**

b. Show that the efficiency of a Reversible heat engine is more than a Irreversible heat engine, both heat engines working between the same temperature limits. **(06 Marks)**

c. A heat pump working on a reversed carnot cycle takes in energy from a reservoir, maintained at 5°C and delivers it to another reservoir where temperature is 77°C. The heat pump derives power for its operation from a reversible engine operating with in the higher and lower temperature of 1077°C and 77°C. For 100kJ/kg of energy supplied to reservoir at 77°C, estimate the energy taken from the reservoir at 1077°C. **(08 Marks)**

OR

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

b. Prove that entropy is a property of a system. **(06 Marks)**

c. In an air turbine the air expands from 7 bar 460°C to 1.012 bar and 160°C. The heat loss from the turbine can be assumed to be negligible. Estimate the change in entropy. **(06 Marks)**

Module-4

7 a. Explain the concept of available and unavailable energy. When does the system becomes dead? **(06 Marks)**

b. Explain the concept of second law efficiency. **(06 Marks)**

c. A heat engine is working between 700°C and 30°C. The temperature of surroundings is 17°C. Engine receives heat at the rate of 2×10^4kJ/min and the measured output of engine is 0.13MW. Determine the availability, rate of irreversibility and second law efficiency of engine. **(08 Marks)**

OR

8 a. Define the following: i) Triple point ii) Critical point iii) Enthalpy of wet steam iv) Dryness fraction. **(08 Marks)**

b. Draw a neat sketch of throttling calorimeter and explain how dryness fraction is determined. **(06 Marks)**

c. A throttling calorimeter is attached to the steam pipe carrying steam at 11 bar. The pressure and temperature of steam after throttling are 1.2 bar and 120°C. Find the dryness fraction of steam. Take $C_P = 2.1$ for super heated steam. What is the maximum dryness fraction that can be measured under above condition? **(06 Marks)**

Module-5

9 a. Define the terms partial pressure, massfraction and mole fraction. **(06 Marks)**

b. Develop an expression to determine the gas constant and molecular weight of a mixture of ideal gases. **(06 Marks)**

c. A mixture of gases has the following volumetric composition.
$CO_2 = 12\%$, $O_2 = 4\%$, $N_2 = 82\%$, $CO = 2\%$.
Calculate: i) The gravimetric composition ii) Molecular weight of mixture iii) R for mixture. **(08 Marks)**

OR

10 a. Explain the following: i) Compressibility factor ii) Reduced properties iii) Law of corresponding states. **(06 Marks)**

b. Write a note on compressibility chart. **(06 Marks)**

c. Determine the pressure of Nitrogen in a steel vessel having a volume of 15 litres and containing 3.4kg at 400°C by using i) Ideal gas equation ii) Vander Walls equation. **(08 Marks)**