USN

18ME33

Third Semester B.E. Degree Examination, Jan./Feb. 2023
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 Thermodynamic handbook is permitted.*

Module-1

1 a. Distinguish between the following with an example for each
   i) Open system and closed system
   ii) Macroscopic and microscopic approach
   iii) Point function and path function
   iv) Diathermic walls and adiabatic walls
   v) Intensive and extensive property. **(10 Marks)**

b. The temperature 't' on a Celsius scale is defined in terms of property 'P' by the relation $P = e(t - B)/A$. Where A and B are constants. Experiments gives value of P is 1.86 and 6.81 at the ice and steam point respectively. Obtain relation for 't' and also find temperature 't' for the reading of $P = 2.5$. **(10 Marks)**

OR

2 a. Explain what do you understand by thermodynamic equilibrium. **(06 Marks)**

b. State Zeroth law of thermodynamics. Write its importance in thermodynamics. **(04 Marks)**

c. A platinum wire is used as a resistance thermometer. The wire resistance was found to be 10Ω and 16Ω at ice point and steam point respectively and 30Ω at sulphur boiling point of 444.6°C. Find the resistance of the wire at 750°C, it the resistance varies with temperature by the relation $R = R_0(1 + \alpha t + \beta t^2)$. **(10 Marks)**

Module-2

3 a. Distinguish between heat and work. **(04 Marks)**

b. A system undergoes a process in which the pressure and volume are related by an equation of the form P_v^n = constant. Derive an expression for displacement work during this process. **(06 Marks)**

c. A cylinder contains 1Kg of certain fluid at an initial pressure of 20 bar. The fluid is allowed to expand reversible behind a piston according to a law $Pv^2 = C$ until the volume is doubled the fluid is then cooled reversibly at constant pressure until the piston regains its original positions, heat is then supply reversibly with the piston firmly locked in position until the pressure rises to original value. Calculate the net work done by the fluid for an initial volume of $0.05 m^3$. **(10 Marks)**

OR

4 a. Starting from the first law of thermo-dynamics for a closed system undergoing a non cyclic process, derive the steady state, steady flow energy equation for a control volume. **(06 Marks)**

b. State the limitations of first law of thermodynamic. Illustrate with examples. **(04 Marks)**

c. The properties of system during a reversible constant pressure non-flow process at P = 1.6 bar change from $V_1 = 0.3\ m^3/Kg$, $T_1 = 20°C$ to $V_2 = 0.55\ m^3/Kg$, $T_2 = 260°C$. The specific heat of the fluid is given by

$$C_p = \left(1.5 + \frac{75}{T+45}\right) kJ/Kg°C.$$

Determine: i) Heat added/Kg ii) Work done/Kg iii) $\Delta V = ?$ iv) $\Delta H/Kg = ?$ **(10 Marks)**

Module-3

5 a. State and prove that Kelvin Plank and Clausius statements of second law of Thermodynamic are equivalent. **(10 Marks)**

b. A reversible heat engine operating between two thermal reservoirs at 800°C and 30°C respectively. If drives refrigerator operating between -15°C and 30°C. The heat input to the heat engine is 1900kJ and the network output from the combined plant is 290KJ. Calculate the heat absorbed by the refrigerant and the total heat transferred to 30°C reservoir. **(10 Marks)**

OR

6 a. State and prove principle of increase of entropy. **(06 Marks)**

b. A heat engine is supplied with 278kJ/sec of heat at a constant fixed temperature of 283°C and the heat rejection take place at 5°C. The following results were reported.

i) 208kJ/sec of heat rejected
ii) 139kJ/Sec of heat rejected
iii) 70 kJ/sec of heat rejected

Classify which of the result report reversible cycle irreversible cycle or impossible cycle. **(06 Marks)**

c. 2Kg of water at 80°C are mixed adiabatically with 3Kg of water at 30°C in a constant pressure process at 1 atmosphere. Determine the increase in entropy due to mixing process. Assume for water $C_p = 4.187$ kJ/Kg. **(08 Marks)**

Module-4

7 a. Explain briefly available and unavailable energies referred to a cyclic process. **(10 Marks)**

b. 5 Kg of air at 555K and 4 bar is enclosed in a system.

i) Determine the availability of the system if the surrounding temperature and pressure are 290K and 1 bar respectively.
ii) If the air is cooled at constant pressure to the atmospheric temperature and if $C_p = 1.005$kJ/Kg K and $C_v = 0.718$ kJ/Kg K for air, determine the availability and effectiveness. **(10 Marks)**

OR

8 a. Sketch and explain separating and throttling colorimeter to find out the dryness fraction of pure substance. **(10 Marks)**

b. A vessel of volume $0.04\ m^3$ contains a mixture of saturated water and saturated steam of a temperature of 240°C. The mass of liquid present is 8 kg. Find the pressure, mass, specific volume, enthalpy, entropy of the internal energy. **(10 Marks)**

Module-5

9 a. Define mass fraction and mole fraction. **(04 Marks)**

b. State Gibb's Dalton law of partial pressures and hence device an expression for the gas 'R' of a mixture of gases. **(06 Marks)**

c. A mixture of ideal gases consists of 3Kg of nitrogen and 5Kg of carbon dioxide at a pressure of 300 KPa and a temperature of 20°C find :

i) Mole fraction of each constituent
ii) The equivalent molecular weight of the mixture
iii) The equivalent gas constant of the mixture
iv) The partial pressure and partial volume
v) The volume and density of the mixture. **(10 Marks)**

OR

10 a. Explain the following :

i) Compressibility factor
ii) Law of corresponding states
iii) Compressibility chart **(10 Marks)**

b. Determine the specific volume of H_2 gas when its pressure is 60 bar and temperature is 100K

i) By using compressibility chart
ii) By using Vander Waal's equation

Take for H_2 $T_c = -239.76°C$

$P_c = 12.92$ bar

$a = 0.25105 \times 10^5\ Nm^2/Kg\ mole^4$

$b = 0.0262 m^3/Kg$ mole **(10 Marks)**

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