CBCS SCHEME

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18ME33

Third Semester B.E. Degree Examination, July/August 2021
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note : 1. ***Answer any FIVE full questions.***
2. ***Use of thermodynamic data handbook and steam table is permitted.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

1 a. Explain Mechanical , Chemical and Thermal equilibrium. **(06 Marks)**

b. With suitable examples, distinguish between : i) Open and closed system
ii) Point and path function iii) Intensive and Extensive property. **(06 Marks)**

c. A constant volume gas thermometer, contain helium gives a reading of gas pressure 'P' of 1000 and 1366 mm of Hg at ice and steam point respectively. Assuming a linear relationship of form T = a + bP. Express the gas thermometer celicious temperature 'T' in terms of gas pressure 'P'. What is temperature recorded when thermometer reads 1074 mm of Hg. **(08 Marks)**

2 a. What do you understand by Microscopic and Macroscopic approach? **(06 Marks)**

b. Define i) State ii) Process iii) System iv) Quasistatic process. **(08 Marks)**

c. Define Zeroth law of thermodynamics and briefly explain its significance. **(06 Marks)**

3 a. Define Heat and Work in thermodynamics. Show that work is path function. **(08 Marks)**

b. Derive an expression for work done during an adiabatic process. **(06 Marks)**

c. A quasistatic process occurs such that $P = V^2 + \frac{8}{V}$, where 'P' is pressure in bar and V is volume in m^3. Find the work done when volume changes from $1m^3$ to $3m^3$. **(06 Marks)**

4 a. State the First law of thermodynamics applied to cyclic and non cyclic process. **(04 Marks)**

b. Derive Steady flow energy equation with Assumptions. **(06 Marks)**

c. Steam enters a turbine with a velocity of 320 m/s , Pressure 6 bar, Internal energy 2000 kJ/kg Specific volume of 0.36 m^3/kg and leaves at a velocity of 140 m/s , Pressure of 1.2 bar , Internal energy 1400 kJ/kg , Specific volume $1.3m^3$/kg. If the flow rate of fluid is 220kg/min and fluid rejects 100 kJ/s of heat. Determine the power developed in MW. The change in potential energy is neglected. **(10 Marks)**

5 a. Write two statements of Second law of thermodynamics and show their equivalence. **(10 Marks)**

b. A reversible engine 'A' operates between temperature limits T_1 and T_2 [$T_1 > T_2$]. The heat rejected by engine 'A' is received by another reversible engine 'B'. Engine 'B' rejects the heat to reservoir at temperature 'T_3' [$T_2 > T_3$].

Prove that i) $T_2 = \frac{T_1 + T_3}{2}$ for same work output ii) $T_2 = \sqrt{T_1 T_3}$ for same efficiency. **(10 Marks)**

6 a. Show that the entropy is a property of a system. **(06 Marks)**

b. State and prove Clausius inequality. **(06 Marks)**

c. 5 kg copper block at 200^0C is dipped to an insulated tank with 100kg of oil at 30^0C. Find the increase in entropy of the universe.
Take C_p [copper] = 0.4kJ/kg – K , C_p [oil] = 2.1 kJ/kg-K. **(08 Marks)**

7 a. What is Available and Unavailable energy? **(06 Marks)**

b. Write Maxwell relations and explain the terms involved. **(06 Marks)**

c. Derive Clausius Clayperon equation for evaporation of liquid and explain the significance. **(08 Marks)**

8 a. Define the following terms with reference to the pure substance : i) Latent heat ii) Sensible heat iii) Tripple point iv) Wet steam v) Dryness fraction. **(10 Marks)**

b. With neat sketch, explain the working of Separating Throttling Calorimeter. **(10 Marks)**

9 a. Explain the following :

i) Compressibility factor.

ii) Compressibility chart.

iii) Vander Waals equation of state.

iv) Law of corresponding states.

v) Gibbs Dalton's law. **(10 Marks)**

b. One K – mol of methane is stored in a $0.4m^3$ tank at 300K. Estimate the pressure of the gas using i) Ideal gas equation ii) Vander Waal's equation.
Vander Waal's constant $a = 228.5$ KPa $(m^3/K\text{-mol})^2$.
$b = 0.0427\ m^3/K\text{-mol}$. **(10 Marks)**

10 a. Derive Vander Waal's constants in terms of critical properties. **(08 Marks)**

b. A gaseous mixture has the following volumetric analysis. $O_2 = 30\%$, $CO_2 = 40\%$, $N_2 = 30\%$. Determine i) Analysis on mass basis.

ii) Molecular weight of mixture.

iii) Partial pressure of each component if total pressure is 100KPa and temperature is 32^0C. **(12 Marks)**

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