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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.

- 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 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 $200^\circ C$ is dipped to an insulated tank with 100kg of oil at $30^\circ C$. 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)



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- 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) Trippl 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 $a = 228.5 \text{ KPa (m}^3/\text{K-mol)}^2$.
 $b = 0.0427 \text{ m}^3/\text{K-mol}$. (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. $\text{O}_2 = 30\%$, $\text{CO}_2 = 40\%$, $\text{N}_2 = 30\%$. 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°C . (12 Marks)

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