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10ME/AU/TL33

Third Semester B.E. Degree Examination, June/July 2013
Basic Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: *1. Answer FIVE full questions, selecting at least TWO questions from each part.*
2. Use of thermodynamic tables permitted.

PART – A

1 a. Classify the following as open/closed/isolated systems:
i) Tree; ii) Printer; iii) Baking of bread in an oven; iv) Fan. **(04 Marks)**

b. Define the following with examples:
i) Property; ii) Cycle; iii) Path function; iv) Reference temperature; v) Quasistatic process; vi) Thermodynamic equilibrium; vii) Macroscopic approach; viii) State point. **(08 Marks)**

c. Develop a linear temperature scale '°B' where in ice and normal human body temperature are assumed as two fixed points and assigned the values 0°B and 50°B respectively. If the temperature of human body on Celsius scale is 36.7°C, obtain the relation between 'B' scale and Celsius scale and find out water boiling temperature in 'B' scale. **(08 Marks)**

2 a. Define 'work' from thermodynamic point of view and derive an expression for flow work. **(06 Marks)**

b. Define 'heat' and bring out dissimilarities between heat and work. **(06 Marks)**

c. A gas contained in a cylinder fitted with a piston loaded with a small number of weights is at 1.3 bar pressure and 0.03m^3 volume. The gas is heated until the volume increases to 0.1m^3. Calculate the work done by the gas in the following processes: i) Pressure remains constant; ii) Temperature remains constant; iii) $PV^{1.3} = C$ during the process. Show the processes on P-V diagram. **(08 Marks)**

3 a. With a neat sketch, explain the famous 'Joules experiment' to show that energy transfer to an adiabatic system is a function of end states only. **(04 Marks)**

b. For isotherming nonflow and steady flow processes show that $\int_1^2 pdv = -\int_1^2 vdp$. **(06 Marks)**

c. Simplify SFEE equation for a case of throttle value. **(02 Marks)**

d. An ideal gas (γ = 1.4) expands reversibly in a turbine from 10 bar to 1 bar. Assume that process law is P = 12-5V, where 'P' is in bar and 'V' is in m^3/kg. If the heat loss from the turbine is 200 kJ/kg, calculate the shaft work done. **(08 Marks)**

4 a. Define Kelvin-Plank statement, Clausius statement of IInd law of thermodynamics and show that they are equivalent. **(08 Marks)**

b. Using Kelvin-Plank statement show that free expansion process is irreversible. **(04 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 heat engine operating with in the higher and lower temperatures of 1077°C and 77°C. For every 100 kJ/kg of energy supplied to reservoir at 77°C, estimate the energy taken from the reservoir at 1077°C. **(08 Marks)**

PART – B

5 a. Derive Clausius inequality for a cycle. **(08 Marks)**

b. Using entropy principle show that mixing of two fluids is an irreversible process. **(06 Marks)**

c. One kg of water at 273K is heated to 373K by first bringing it in contact with reservoir at 323K and then reservoir at 373K. What is the change in entropy of universe? **(06 Marks)**

6 a. With neat sketches indicate various parameters on typical T-S and H-S diagrams. **(06 Marks)**

b. With a neat sketch, explain how throttling calorimeter can be used to measure the dryness fraction of wet vapour. **(06 Marks)**

c. Stream at 1MPa and 250°C enters a nozzle with a velocity of 60m/s and leaves the nozzle at 10kPa. Assuming the flow process to be isentropic and the mass flow rate to be 1kg/s determine: i) The exit velocity; ii) The exit diameter of nozzle. **(08 Marks)**

7 a. Obtain four max well relations for a simple compressible system in the form $\left(\frac{\partial M}{\partial y}\right)_x = \left(\frac{\partial N}{\partial x}\right)_y$. **(08 Marks)**

b. Obtain Clausius clapeyron relation involving the saturation temperature and pressure. **(06 Marks)**

c. Determine the enthalpy of vapourization of water at 200°C using Clapeyron equation. **(06 Marks)**

8 a. State and explain Amagat's law. **(06 Marks)**

b. State and explain law of corresponding states. **(06 Marks)**

c. A mixture of methane with, just enough oxygen to permit combustion, is burned. The temperature and pressure of the final mixture are 27°C and 101.3 kPa respectively. Calculate:

i) Mass traction of reactants.

ii) The volume traction of products.

iii) The partial pressure of water vapour in the products of combustion and

iv) Volume of products. **(08 Marks)**

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