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06ME33

Third Semester B.E. Degree Examination, January 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 datahand book and steam tables permitted.***

PART – A

1 a. Explain the following terms:
i) Thermodynamic equilibrium ii) Zeroth law of thermodynamics. **(06 Marks)**

b. Explain any three practical applications of engineering thermodynamics. **(06 Marks)**

c. A platinum wire is used as a resistance thermometer. The wire resistance is found to be 10 Ω and 16 Ω at ice point and steam point respectively, and 30 Ω at sulphur boiling point of 444.6°C. Find the resistance of the wire at 500°C, if the resistance varies with temperature by the relation, $R = R_0(1 + \alpha T + \beta T^2)$ **(08 Marks)**

2 a. With appropriate illustration obtain the expressions for, i) Electrical work ii) Shaft work. **(06 Marks)**

b. Obtain the expressions for displacement work in, i) Isothermal process ii) Polytropic process. **(06 Marks)**

c. A gas is contained in a cylinder fitted with a piston loaded with a small number of weights. The initial pressure of the gas is 1.3 bar, and the initial volume is 0.03 m^3. The gas is now heated until the volume of the gas increases to 0.1 m^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.
Sketch the processes on P-V diagram. **(08 Marks)**

3 a. With appropriate illustration, explain the equivalence of heat and work. **(06 Marks)**

b. A system is composed of stone having a mass of 10 kg and a bucket containing 100 kg of water. Initially the stone is 42.7 meters above the water. The stone and water are at the same temperature. The stone then falls into the water. Determine ΔU, ΔKE, ΔPE, ΔQ and ΔW for the following cases:
i) At the instant the stone is about to enter the water.
ii) Just after the stone comes to rest in the bucket.
Assume no heat transfer to the surrounding during this period. **(08 Marks)**

c. Starting from first law for a closed system, obtain the SFEE equation and reduce the same for the case of heat exchanger. **(06 Marks)**

4 a. Define the following: i) Heat engine ii) Thermal energy reservoir iii) Heat pump. **(06 Marks)**

b. State and prove Carnot theorem. **(06 Marks)**

c. A heat pump is to be used to heat a house in the winter and the reversed to cool the house in the summer. The interior temperature is to be maintained at 20°C in the winter and 25°C in the summer. Heat transfer through the walls and roof is estimated to be 2400 KJ per hour per degree temperature difference between the inside and outsides.
i) If the outside temperature in the winter is 0°C, what is the minimum power required to drive the pump?
ii) If the power output is the same as that of part (i), what is the maximum outside summer temperature for which the inside of the house can be maintained at 25°C? **(08 Marks)**

PART – B

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

b. Explain briefly available energy unavailable energy and Tds relations. **(06 Marks)**

c. A 10 kg metal piece with constant specific heat of 0.9 KJ/kgK at 200°C is dropped into an insulated tank which contains 100 kg of water at 20°C. Determine the final equilibrium temperature and the total change in entropy for this process. **(08 Marks)**

6 a. Explain second law efficiency with respect to heat engines and compressors. **(06 Marks)**

b. Explain "useful work" "maximum useful work" and irreversibility. **(06 Marks)**

c. A rigid tank of volume 2.5 m^3 contains air at 200 KPa and 300 K. The air is heated by supplying heat from a reservoir at 600 K, until the temperature reaches 500 K. The surrounding atmosphere is at 100 KPa and 300 K. Determine the maximum useful work and irreversibility associated with process. **(08 Marks)**

7 a. With neat sketches, explain phase equilibrium diagram on T-S and h-S coordinates. **(06 Marks)**

b. Define i) Subcooled liquid ii) Triple point iii) Critical point iv) Saturated vapour v) Super heated vapour vi) Compressed liquid **(06 Marks)**

c. A vessel of volume 0.05 m^3 contains wet steam at 250°C. The mass of liquid water present is 10 kg. Find the total mass, specific volume, specific enthalpy and specific entropy of wet vapour. **(08 Marks)**

8 a. State and explain i) Dalton's law of additive pressures and ii) Amagat's law of additive volumes. **(06 Marks)**

b. Write a note on comparison between ideal gas equation and Vander Waal's equation of state. **(06 Marks)**

c. One kg of propane (C_3H_8) is at a pressure of 7 MPa and temperature of 150°C. The critical properties of propane are P_C = 4.26 MPa, T_C= 370 K and V_C = 0.00454 m^3/kg. Compressibility factor Z = 0.54, calculate

i) Reduced pressure, volume and temperature.

ii) Specific volume of propane using ideal gas equation. **(08 Marks)**

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