CBCS Scheme

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15ME33

Third Semester B.E. Degree Examination, Dec.2016/Jan.2017
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 80

Note: 1. Answer FIVE full questions, choosing ONE full question from each module.
2. Use of thermodynamic data hand book and steam tables is permitted.

Module-1

1 a. Define thermodynamics. Differentiate between open system, closed system and isolated system. **(04 Marks)**

b. State Zeroth Law of thermodynamics. What is diathermal wall and adiabatic wall? **(04 Marks)**

c. Estimate the % variation in temperature reading from a thermocouple having its test junction in gas and other reference junction at ice point. The temperature of gas using gas thermometer is found to be 50°C. Thermocouple is calibrated with e.m.f varying linearly between ice point and steam point when thermocouples test junction is kept in gas at t°C and reference junction at ice point, the e.m.f produced in milli volts is $e = 0.18t - 5.2 \times 10^{-4}t^2$. **(08 Marks)**

OR

2 a. Define heat and work in thermodynamics. Show that work is path function. **(08 Marks)**

b. A cylinder contains 1 kg of a certain fluid at an initial pressure of 20 bar. The fluid is allowed to expand reversibly behind a piston according to law PV^2= constant until the volume is doubled. The fluid is then cooled reversibly at constant pressure until the piston regains its original position. Heat is then supplied reversibly with the piston firmly locked in position until the pressure rises to the original value of 20 bar. Calculate the net work done by the fluid for an initial volume of $0.05m^3$. **(08 Marks)**

Module-2

3 a. State the first law of thermodynamics applied to cyclic process and non-cyclic process. **(05 Marks)**

b. Write the steady flow energy equation indicating all the terms in the equation. **(03 Marks)**

c. The working fluid in a steady flow process flows at the rate of 220 kg/min. The fluid rejects 100 kJ/s of heat passing through the system. The fluid enters at a velocity of 320 m/s, pressure of 6 bar, internal energy 2000 kJ/kg, specific volume of 0.36 m^3/kg and leaves the system at a velocity of 140 m/s, pressure of 1.2 bar, internal energy 1400 kJ/kg, specific volume 1.3 m^3/kg. Determine the power output in MW. The change in potential energy is neglected. **(08 Marks)**

OR

4 a. Show that Kelvin plank statement and Clausius statement are equivalent. **(08 Marks)**

b. A heat pump working on a reversible cycle takes in heat from a reservoir at 5°C and delivers heat to low temperature reservoir at 60°C. The heat pump is driven by a heat engine taking heat from source at 840°C and rejects heat to low temperature reservoir at 60°C. The engine also drives a machine of 30 KW capacity. If the heat pump extracts 17 kJ/s from high temperature reservoir at 5°C. Determine : i) rate of heat flow from reservoir at 840°C ii) rate of heat rejected to sink at 60°C. **(08 Marks)**

Module-3

5 a. Mention the factors which render a process irreversible. **(05 Marks)**

b. Explain reversible and irreversible process. **(03 Marks)**

c. A reversible engine operates between T_1 and T. The energy rejected by this engine is received by second reversible engine and heat is rejected to sink at T_2. Show that :
i) For same work T is arithmetic mean of T_1 and T_2
ii) for same efficiency T is geometric mean of T_1 and T_2. **(08 Marks)**

OR

6 a. State and prove Clausius inequality. **(08 Marks)**

b. 5 kg of copper block at 200°C is dropped to an insulated tank with 100 kg of oil at 30°C. Find the increase in entropy of the universe. Take $C_{P_{cu}} = 0.4 kJ/kg\,K$ and $C_{P_{oil}} = 2.1 kJ/kg\,K$. **(08 Marks)**

Module-4

7 a. What is available energy, unavailable energy and second law efficiency? **(04 Marks)**

b. Write Maxwell relations and explain the terms involved. **(04 Marks)**

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

OR

8 a. Define : i) Sub cooled liquid ii) triple point iii) critical point. **(03 Marks)**

b. With a neat sketch explain the working of a throttling calorimeter. **(05 Marks)**

c. In a test to find the quality of the steam in a pipe using a combined separating and throttling calorimeter, the following data was obtained pressure of steam in the steam mains = 14 bar pressure of steam after throttling = 1.19 bar temperature after throttling = 120°C water collected in the separator = 0.45 kg steam condensed after throttling = 6.75 kg. Determine the condition of the steam in the mains. Take C_P for superheated steam $C_{P_S} = 2.1 kJ/kg\,k$. **(08 Marks)**

Module-5

9 a. Explain the reasons for deviations of Vander Walls equation from ideal gas equations. **(05 Marks)**

b. Write a note on compressibility chart. **(03 Marks)**

c. Determine the pressure exerted by carbon dioxide in a container of 1.5 m^3 capacity when it contains 5 kg at 27°C, using : i) Ideal gas equation ii) Vander Walls equation.
Take Vander Walls constants for CO_2 as a = 364.3 kN m^4/kg mol^2; b = 0.0427 m^3/kg mol. **(08 Marks)**

OR

10 a. Define :
i) Dry bulb temperature
ii) Wet bulb temperature
iii) Dew point temperature. **(03 Marks)**

b. Develop an expression to determine the gas constant of a mixture of ideal gases. **(05 Marks)**

c. A mixture of gases has the following volumetric composition : CO_2 = 12%, O_2 = 4%, N_2 = 82% and CO = 2%. Determine : i) the gravimetric composition ii) molecular weight of mixture iii) gas constant R for mixture. **(08 Marks)**

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