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A – 6328

Reg. No. : ....

Name : ....

Third Semester B.Tech. Degree Examination, September 2016
(2008 Scheme)
08.305 : THERMODYNAMICS (MS)

Time : 3 Hours Max. Marks : 100

Instructions *: 1) Answer **all** questions from Part – **A** and **any one** question from **each** Module in Part – **B**.*

*2) **Use** of thermodynamic tables and charts is **permitted**.*

PART – A

1. Explain the concept of ideal gas thermometer.

2. Show the steady flow energy equation applied to a throttling device.

3. Prove that entropy is a property.

4. Distinguish between system approach and control volume approach in the analysis of flow process of an open system.

5. Sketch P-V diagram of a pure substance and show isotherms and constant quality lines on it.

6. Explain about virial expansions.

7. Estimate density of nitrogen at 25°C and 170 kPa, if compressibility factor is 0.85.

8. Define Gibbs function and explain its significance.

9. Discuss Kelvin Planck statement and Clausius statement of second law of thermodynamics.

10. Define Joule-Kelvin coefficient and discuss its significance. **(10×4=40 Marks)**

P.T.O.

PART – B

Module – I

11. a) Show the energy balance for the gas undergoing bottle filling process from a pipeline with all assumptions. **5**

b) A fluid is contained in a cylinder by a spring-loaded, frictionless piston so that the pressure in the fluid is a linear function of the volume (p = a+bV). The internal energy of the fluid is given by the following equation :
$U = 34 + 3.15pV$
where U is in kJ, p in kPa, and V in cubic metre. If the fluid changes from an initial state of 170 kPa, 0.03 m^3 to a final state of 400 kPa, 0.06m^3, with no work other than that done on the piston, find the direction and magnitude of the work and heat transfer. **9**

c) A gas is taken in a piston and cylinder arrangement at an initial pressure of 25 bar. It undergoes a cyclic process as follows.

a) The gas is expanded reversibly according to the relation $PV^{2.5} = C$ until the volume is doubled.

b) Then, the gas is cooled reversibly at a constant pressure until the piston reaches the initial position.

c) Now the piston is kept stationary and heat is added until the pressure rises to the original value of 25 bar. Calculate the net work done by the fluid. Take initial volume as 0.05m^3 and mass as 1 kg. **6**

OR

12. a) Derive the expression of the law of corresponding states. **6**

b) Air enters an adiabatic nozzle steadily at 300 kPa, 200°C and 30 m/s and leaves at 100 kPa and 180 m/s. The inlet area of the nozzle is 80 cm^2. Determine the following :

a) Mass flow rate through the nozzle.

b) Exit temperature of the air.

c) Exit area of the nozzle. **9**

c) The e.m.f. in a thermocouple with the test junction at t°C on gas thermometer scale and reference junction at ice point is given by :
$\epsilon = 0.20\,t - 5 \times 10^{-4}\,t^2$ mV
The millivoltmeter is calibrated at ice and steam points. What will this thermometer will read in a place where the gas thermometer reads 50°C ? **5**

Module – II

13. a) A fluid undergoes a reversible adiabatic compression from 0.5 MPa, 0.2 m^3 to 0.05 m^3 according to the law, $pv^{1.3}$ = constant. Determine the change in enthalpy, internal energy and entropy and the heat transfer and work transfer during the process. **10**

    b) Derive an expression for maximum work obtainable from 2 bodies of finite heat capacities at temperatures T_1 and T_2 respectively. **10**

OR

14. a) State and prove the Clausius inequality. **10**

    b) Calculate the decrease in available energy when 25kg of water at 95°C mix with 35 kg of water at 35°C, the pressure being taken as constant and the temperature of the surroundings being 15°C (Cp of water = 4.2 kJ/kg-K). **10**

Module – III

15. a) Derive the T.ds equations. **10**

    b) A certain gas has Cp = 1.968 and Cv = 1.507 kJ/kg-K. Find its molecular weight and the gas constant. A constant volume chamber of 0.3 m^3 capacity contains 2 kg of this gas at 5°C. Heat is transferred to the gas until the temperature is 100°C. Find the work done, heat transferred, and the changes in internal energy, enthalpy and entropy. **10**

OR

16. A mixture of ideal gases consists of 3 kg of nitrogen and 5 kg of carbon-dioxide at a pressure of 300 kPa and a temperature of 20°C. Find

    a) The mole fraction of each constituent.

    b) The equivalent molecular weight of the mixture.

    c) The equivalent gas constant of the mixture.

    d) The partial pressures and the partial volumes.

    e) The volume and density of the mixture, and

    f) The Cp and Cv of the mixture.

    Also determine the changes in internal energy, enthalpy and entropy of the mixture when the mixture is heated to a temperature of 40°C.

    a) At constant volume and

    b) At constant pressure

    Take γ for CO_2 and N_2 to be 1.286 and 1.4 respectively. **20**
