B. Tech. 3rd Semester (ME) F-Scheme Examination,

Decembeber–2014

THERMODYNAMICS

Paper–ME-201-F

Time allowed : 3 hours] *[Maximum marks : 100*

Note : **Section–A** ***is compulsory.*** *Attempt* ***five*** *questions in all including compulsory question. Select at least* ***one*** *question from each section. Provide steam tables. Assume suitable values for missing parameters (if any).*

Section–A

1. (a) Discuss the concept of temperature.

(b) Distinguish between heat and work from thermodynamic point of view.

(c) Define Joule Thomson coefficient.

(d) Distinguish between characteristic and universal gas constant.

(e) Define Helmholtz and Gibb's function. 4×5

Section–B

2. (a) Define reversible process. 5

(b) The turbine operating on a steady flow of N_2 is to produce 0.81 kJ/s of power by expanding N_2 from 301 kPa, 351 K (inlet specific volume of 0.35

m^3/kg), to 121 kPa. For preliminary design, the inlet velocity is assumed to be 30 m/s, the exit velocity is assumed to be 50m/s, and expansion will be considered by the relation $PV^{1.4}$ = constant. Determine flow rate. 15

3. (a) What is quasi-static process ? Illustrate with suitable examples. How you will execute a quasi-static process from an initial pressure P_{in} to the final pressure P_{out} on a P-V diagram. 5

(b) A rigid tank have volume of 0.45 m^3 and initially contained saturated vapour at 350 kN/m^2. The valve is then opened and steam from the line at 1.4 MPa, 300°C flows into the tank until the pressure is 1.4 MPa. Calculate the mass of steam that flows into the tank. 15

Section–C

4. (a) Discuss the limitations of 1st law of thermodynamics. 5

(b) An insulated rigid tank contains 0.9 kg of air at 151 kN/m^2 and 294K. A paddle wheel inside the tank is rotated by external source until the temperature in the tank rises to 328K, if the surrounding air is at T_0=293K, determine maximum possible work. 15

5. (a) Describe combined separating and throttling calorimeter. 5

(b) Steam enters in a turbine steadily at 3 MPa and 450°C at a rate of 8 kg/s and exists at 0.2 MPa and 150°C. The steam is losing heat to the surrounding air at 100 kPa and 25°C at a rate of 300 kW. Determine (a) the actual power output, (b) the maximum possible power output, (c) the second law efficiency, (d) the exergy destroyed. 15

Section–D

6. (a) Define the triple and critical point of pure substance. 5

(b) Wet steam from a steam header (1.51MPa) is throttled to 110 kPa before it is charged to a throttling calorimeter. After throttling, the steam temperature rises to 1250°C. Determine the quality of the steam in the steam header. Determine maximum moisture load that can be determined by this set-up which requires at least 4°C of superheat for an accurate measurement. 15

7. (a) What is the expected temperature and pressure range when ideal gas equation agrees ? 5

(b) A volumetric analysis of gas mixture yields the following results :

$CO_2 = 12\%$, $O_2 = 4\%$, $N_2 = 82\%$, $CO = 2\%$.

Determine the characteristic gas constant. Write the expression for entropy change due to mixing of these gas components. 15

Section–E

8. (a) What do you understand by Joule Thomson Coefficient ? Discuss. 5

(b) Using Clapeyron equation, estimate value of enthalpy of vaporization of R-134a at 20.5°C. Take $v_{fg} = 0.03515\ m^3/kg$ at 20.5°C. P_{sat} at 24.5°C and 16.5°C are 646.25 kPa and 504.6 kPa. 15

9. (a) Discuss the Stirling and Ericsson cycle with practical applications. 8

(b) Prove the relation

$$c_p - c_v = -T\left(\frac{\partial V}{\partial T}\right)_P^2\left(\frac{\partial P}{\partial V}\right)_T .$$ 12