CBCS SCHEME

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15MR33

Third Semester B.E. Degree Examination, Dec.2018/Jan.2019
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 80

Note: ***1. Answer any FIVE full questions, choosing one full question from each module.***
2. Use of thermodynamic data book is allowed.

Module-1

1 a. Distinguish between:
i) Point function and path function
ii) Intensive and extensive properties
iii) Macroscopic and microscopic study in thermodynamics
iv) Open and closed system **(08 Marks)**

b. Two Celsius thermometers 'A' and 'B' agree at ice point and steam point and the related equation is $t_A = L + M.t_B + N.t_B^2$, where L, M and N are constants. When both thermometer are immersed in fluid, 'A' registers 26°C while 'B' registers 25°C. Determine the leading of 'A', when 'B' reads 37.4°C. **(08 Marks)**

OR

2 a. Starting from a common state point, draw following process on PV-plane and derive an expression for work done in each case:
i) Isobasic process
ii) Isothermal process
iii) Polytropic process **(08 Marks)**

b. An automobile vehicle of 1500 kg is running at a speed of 60 km/hr. The brakes are suddenly applied and vehicle is brought to rest. Calculate the rise in temperature of brake shoes, if their mass is 15 kg. Take specific heat of brake shoe material as 0.46 kJ/kgK. **(08 Marks)**

Module-2

3 a. Derive the SFEE for a single stream of fluid entering and leaving the control volume. State clearly assumptions made. **(08 Marks)**

b. 10 kg of gas undergoes a process for which $P = \frac{1500}{V} - V^2$ where P is the pressure in kPa and V is volume in m^3. Initial volume is 5 m^3 and temperature is 200°C. The final volume is 10 m^3 and temperature is (−100°C). If $u = (8T + 2)\frac{kJ}{kgK}$. Find: (i) Work done (ii) Change in internal energy (iii) Heat transfer. **(08 Marks)**

OR

4 a. Describe the working of carnot cycle, showing the cycle on P-V diagram and show $\eta_{th} = 1 - \frac{T_2}{T_1}$. **(08 Marks)**

b. A series combination of two carnot engines operate between the temperature of 180°C and 20°C. Calculate intermediate temperature if the engines produce equal amount of work. **(08 Marks)**

Module-3

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

b. One kg of ice at −5°C is exposed to the atmosphere at 20°C. The ice melts and comes in thermal equilibrium with atmosphere.

i) Determine entropy increase of universe and

ii) What is the minimum amount of work necessary to convert the water back into ice at −5°C?

Take C = 2.093 kJ/kg°C and latent heat of fusion of ice = 333.3 kJ/kg. **(08 Marks)**

OR

6 a. Explain the working of separating and throttling calorimeter. **(08 Marks)**

b. A pressure cooker contains 1.5 kg of saturated steam at 5 bar. Find the quantity of heat which must be rejected so as to reduce the quality to 60% dry. Determine the pressure and temperature of steam in the new state. **(08 Marks)**

Module-4

7 a. Obtain four Maxwell 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. One kg of air with an initial volume of 0.25 m^3 is heated at constant pressure of 0.4 MPa until its volume is doubled. Calculate:

i) Initial and final temperature air ii) Heat transferred

iii) External work done iv) Change in entropy. **(08 Marks)**

OR

8 a. Derive an expression for change in entropy of an ideal gas undergoing:

i) An Isobasic process

ii) Polytropic process **(08 Marks)**

b. One kg of ideal gas is heated from 50°C to 150°C. Determine:

i) Change in internal energy ii) Change in enthalpy

iii) Change in flow energy iv) $\overline{C_V}$ and $\overline{C_P}$

Take R = 280 J/kg-K, γ = 1.32 for gas. **(08 Marks)**

Module-5

9 a. Explain the following:

i) Generalized compressibility chart ii) Compressibility factor

iii) Law of corresponding states iv) Beatie-Bridgeman equation **(08 Marks)**

b. A gaseous mixture has the following volumetric analysis O_2 = 30%, CO_2 = 40%, N_2 = 30%. Determine:

i) The analysis on man basis

ii) Molecular weight of mixture

iii) Partial pressure of each component if total pressure is 100 kPa and temperature is 32°C. **(08 Marks)**

OR

10 a. Derive Vander Waal's constants in terms of critical properties. **(08 Marks)**

b. Determine the pressure in a steel vessel having a volume of 15 liters and containing 3.4 kg Nitrogen at 400°C by using (i) ideal gas equation (ii) Vander Waal's equation. Also calculate the compressibility factor by using the answer obtained from Vander Waal's equation. Take a = 136.4 $kNm^4/(kg\ mol)^2$ and b = 0.0386 m^3/kg mol. **(08 Marks)**

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