CBCS SCHEME

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17MR33

Third Semester B.E. Degree Examination, Jan./Feb. 2021
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: 1. *Answer any FIVE full questions, choosing ONE full question from each module.*
2. *Use of thermodynamic data handbook is permitted.*

Module-1

1 a. With the suitable sketches/examples, distinguish between:
(i) Closed system and open system
(ii) Point function and path function
(iii) Intensive and extensive properties
(iv) Thermal and mechanical equilibrium **(08 Marks)**

b. State the Zeroth law of thermodynamics. **(04 Marks)**

c. A new scale N of temperature is deviled in which the ice point is assigned 100 N and the steam point is assigned 400 N establish the relationship between the N scale and the Celsius Scale. At what temperature will both the Celsius and the New Scale thermometer readings would be identical Newly? **(08 Marks)**

OR

2 a. Define work, from the thermodynamic point of view. Compare heat and work. **(08 Marks)**

b. A fluid at 0.7 bar occupying 0.09 m^3 is compressed reversible to a pressure of 3.5 bar according to a law $PV^n = C$ the fluid is then heated reversible at constant volume until the pressure is 4 bar, the specific volume is then 0.5 m^3/kg. A reversible expansion according to a law $PV^2 = C$, restores the fluid to its initial state. Sketch the cycle on a PV diagram and calculate:
(i) The mass of fluid present
(ii) The value of n in the first process
(iii) Net work of the cycle **(12 Marks)**

Module-2

3 a. Starting from the first law of thermodynamics for a closed system undergoing a non-cyclic process derive the steady state, SFEE for a control volume (open system). **(08 Marks)**

b. A small turbine runs an aircraft refrigeration system. Air enters the turbine at 4 bar and 40°C with a velocity of 40 ms^{-1}. At the exit the air is at 1 bar, 2.5°C and having a velocity of 200 m/s. If the work output of the turbine is 52 kJ/kg of air, calculate the heat transferred per kg of air. **(06 Marks)**

c. The properties of a certain fluid are related by u = 196 + 0.718t ad $p_v = 0.287(t + 273)$ where u → kJ/kg, t → °C, p → kPa and v → m^3/kg. Find C_p, C_v and R and γ for the fluid. **(06 Marks)**

OR

4 a. State and prove that Kelvin Planck and Clausius statement of 2[nd] law of thermodynamics are equivalent. **(10 Marks)**

b. Two Carnot engines connected in series operates between the temperature of 180°C and 20°C. Calculate the intermediate temperature, engine produces: (i) equal amount of work produced (ii) same efficiency **(10 Marks)**

Module-3

5 a. Show that for an irreversible process $\Delta S \geq \int_1^2 \frac{\delta Q}{T}$ and write Tds relations. **(12 Marks)**

b. A volume of 0.05 m^3 of a perfect gas for which R = 0.297 kJ/kgK is compressed reversibly in a cylinder according to the law $PV^n = C$ and then cooled at constant pressure. The initial temperature is 27°C and the final pressure is 8.5 times the initial pressure, the final volume is 0.007 m^3. Determine the following:
(i) The final temperature after compression
(ii) The final temperature
(iii) The net heat transfer per kg
(iv) The net change in specific entropy. **(08 Marks)**

OR

6 a. With a neat sketch, explain the measurement of dryness fraction by using throttling calorimeter. **(10 Marks)**

b. Steam at 1 MPa and 250°C enters a nozzle with a velocity of 60 m/s and leaves the nozzle at 10 kPa. Assuming the flow process to be isentropic and the mass flow rate to be 1 kg/s, determine: (i) the exit velocity (ii) the exit diameter **(10 Marks)**

Module-4

7 a. Write notes on: (i) Maxwell's Relations (ii) Clapeyton equation **(10 Marks)**

b. 0.5 kg of air is compressed reversibly and adiabatically from 80 kPa, 60°C to 0.4 MPa and is then expanded at constant pressure to the original volume. Sketch these processes on the PV and T-S planes. Compute the heat transfer and work transfer for the whole path. **(10 Marks)**

OR

8 a. Derive an expression for change in entropy of an ideal gas. **(08 Marks)**

b. A quantity of air at a pressure of 100 kPa 27°C occupying a volume of 0.5 m^3 is compressed to a pressure of 500 kPa and volume of 0.12 m^3 according to the law $PV^n = C$. Find:
(i) The value of index 'n' (ii) The mass of air (iii) Work transfer
(iv) Heat transferred during the process (v) Change in entropy **(12 Marks)**

Module-5

9 a. Write notes on: (i) Ideal and Real gas mixture (ii) Vander Waal's equation of state. **(12 Marks)**

b. Compute from the Vander Waal's equation the pressure exerted by 1 kg of CO_2 at 100°C if the specific volume is 3 m^3/kg. Also compute the results obtained if CO_2 is treated as an ideal gas. Take $a = 362.85 \times 10^3$, R = 8314.3 and b = 0.0423. **(08 Marks)**

OR

10 a. State : (i) Dalton's law of partial pressures (ii) Amagat's law of additive volumes **(10 Marks)**

b. A gaseous mixture consists of 1 kg of oxygen and 2 kg of nitrogen at a pressure of 150 kPa and a temperature of 20°C. Determine:
(i) The gas constant of the mixture
(ii) The molecular weight of the mixture
(iii) Specific heats C_p and C_v of the mixture
(iv) The change in entropy of the mixture if the mixture is heated at constant volume to a temperature of 100°C. **(10 Marks)**

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