CBCS Scheme

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15MR33

Third Semester B.E. Degree Examination, June/July 2018
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing one full question from each module.

Module-1

1 a. Classify the following into intensive and extensive properties:
i) Molecular weight ii) Refractive index
iii) Roll strength of a class iv) Velocity of a bullet
v) Specific heat of a gas vi) Quality of a steam
vii) Concentration of sugar in the milk viii) Entropy **(08 Marks)**

b. Develop a linear temperature scale 'B' where in ice and normal human body temperature are assumed as two fixed points and assigned the values 0°B and 50°B respectively. If the temperature of human body on Celsius scale is 36.7°C, Obtain the relation between 'B; scale and Celsius scale. **(08 Marks)**

OR

2 a. Show that heat is a path function. **(04 Marks)**

b. Specify the most widely used sign convention for work and heat. **(04 Marks)**

c. A gas is contained in a cylinder fitted with piston loaded with a small number of weights, the initial pressure of the gas is 1.3 bar and the initial volume is 0.03 m^3. The gas is now heated until the volume of the gas increases to 0.1 m^3. Calculate the work done by the gas in the following processes.
i) Isobaric process
ii) Isothermal process
iii) $PV^{1.3} = C$ during the process.
Sketch the processes on P-V diagram. **(08 Marks)**

Module-2

3 a. Derive the steady flow energy equation for a single stream of fluid entering and single stream of fluid leaving the control volume. **(08 Marks)**

b. A nozzle is a device for increasing the velocity of a steadily flowing stream. At the inlet to a certain nozzle, the enthalpy of fluid passing is 3000 kJ/kg and the velocity is 60 m/s. At the discharge end, the enthalpy is 2762 kJ/kg. The nozzle is horizontal and there is negligible heat loss from it.
i) Find the velocity at the exit section of the nozzle.
ii) If the inlet area is 0.1 m^2 and the specific volume at inlet is 0.187 m^3/kg find the mass flow rate.
iii) If the specific volume at the exit of the nozzle is 0.498 m^3/kg find the diameter at the exit section of the nozzle. **(08 Marks)**

OR

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

b. A reversible heat engine operates between two thermal reservoirs at 800°C and 30°C respectively. It drives a reversible refrigerator operating between −15°C and 30°C. The heat input to the heat engine is 1900 kJ and the net work output from the combined plant (engine and refrigerator both) is 290 kJ. Calculate the heat absorbed by the refrigerant and the total heat transferred to 30°C reservoir. **(08 Marks)**

Module-3

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

b. 1 kg of air at 1 bar pressure and 15°C is heated in a cylinder under constant pressure conditions to 150°C. Find the final volume, the work done and the changes in internal energy, enthalpy and entropy. Take C_p for air = 0.992 kJ/kgK. **(08 Marks)**

OR

6 a. With a neat sketch brief the working of a throttling calorimeter to determine the quality of steam. **(08 Marks)**

b. A vessel of volume 0.04 m^3 contains a mixture of saturated water and saturated steam at a temperature of 250°C. The mass of the liquid present is 9 kg. Find the pressure, the mass, the specific volume, the enthalpy, the entropy and the internal energy. **(08 Marks)**

Module-4

7 a. Obtain four Maxwell's relation 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. 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 = constant. 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. Take C_V of air = 0.718 kJ/kgK. **(08 Marks)**

OR

8 a. Derive an expression for change in entropy of an ideal gas undergoing:
i) Isothermal process ii) Polytropic process **(08 Marks)**

b. Air expands reversibly in a cylinder behind piston till its volume is doubled at constant temperature of 200°C. The piston now moves in such that pressure remains constant, till volume reaches its initial volume. Determine the entropy change and net heat transfer if 2 kg of air were present in the cylinder. **(08 Marks)**

Module-5

9 a. Write short notes on:
i) Equation of states ii) Boyle's law
iii) Charles law iv) Vander Waal's equation of state **(08 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 compare the results obtained if CO_2 is treated as an ideal gas. Take a = 362.85 × 10^3, R = 8314.3, b = 0.0423. **(08 Marks)**

OR

10 a. State and explain:
i) Dalton's law of partial pressure
ii) Amagat low of additive volume. **(08 Marks)**

b. Explain: i) Beatie Bridgeman equation ii) compressibility factor. **(06 Marks)**

c. Write a note on compressibility chart. **(02 Marks)**

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