CBCS SCHEME

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18ME33

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. Explain microscopic and macroscopic approaches to thermodynamics. **(06 Marks)**

b. State and explain Zeroth law of thermodynamics. What is diathermal and adiabatic wall? **(06 Marks)**

c. The temperature t on a Celsius thermometer scale is defined in terms of property P by the relation $P = e^{\frac{(t-B)}{A}}$ where A and B are constants. At ice point and steam points the value of P is 1.86 and 6.81 respectively. Find the value of 't' for P = 2.5. **(08 Marks)**

OR

2 a. With examples distinguish between:
(i) Intensive and extensive property
(ii) Point and path function
(iii) Thermodynamic equilibrium **(10 Marks)**

b. In 1709m Newton proposed a linear temperature scale where ice point and normal human body temperature are maintained as two fixed points of 0°N ad 12°N respectively. The temperature of human body on the Celsius scale is 36°C. Obtain relation between Newton scale and Celsius scale. **(10 Marks)**

Module-2

3 a. Obtain the expression for displacement adiabatic work. **(06 Marks)**

b. Define heat and work with reference to thermodynamic point of view and also the sign convention of heat and work. **(06 Marks)**

c. A cylinder contains 1 kg of certain fluid at an initial pressure of 20 bar. The fluid is allowed to expand reversibly behind a piston according to law PV^2 = constant until the volume is doubled. The fluid is then cooled reversibly at constant pressure until the piston regains its original position. Heat is then supplied reversibly with the piston firmly locked in position until the pressure rises to its original value of 20 bar. Calculate the net work done by the fluid for an initial volume of 0.05 m^3. **(08 Marks)**

OR

4 a. Apply steady flow energy equation to each of the following:
(i) Boiler (ii) Nozzle (iii) Centrifugal pump
(iv) Throttling device (v) Turbine **(10 Marks)**

b. The working fluid in a steady flow process flows at the rate of 220 kg/min. the fluid rejects 100 kJ/s of heat passing through the system. The fluid enters at a velocity of 320 m/s, pressure of 6 bar, internal energy 2000 kJ/kg, specific volume of 0.36 m^3/kg and leaves the system at a velocity of 140 m/s, pressure of 1.2 bar, internal energy 1400 kJ/kg, specific volume of 1.3 m^3/kg. Determine the power output in MW. The change in potential energy is neglected. **(10 Marks)**

Module-3

5 a. Prove that Kelvin-Planck statement and clausius statements of second law of thermodynamic are equivalent. **(10 Marks)**

b. A reversible heat engine operates between two reservoirs at temperature of 600°C and 40°C. The engine drives a reversible refrigerator which operates between reservoirs at temperature of 40°C and –20°C. The heat transfer to the heat engine is 2000 kJ and net work output of combined engine refrigerator plant is 360 kJ. Evaluate the heat transfer to the refrigerant and net heat transfer to the reservoir at 40°C. **(10 Marks)**

OR

6 a. Show that entropy is a property of the system. **(04 Marks)**

b. Derive the maximum work attainable from a finite body and a thermal energy reservoir. **(10 Marks)**

c. A lump of steel of mass 10 kg at 627°C is dropped in 100 kg of oil at 30°C. The specific heats of steel and oil are 0.5 kJ/kgK and 3.5 kJ/kgK respectively. Calculate the entropy change of steel, the oil and the universe. **(06 Marks)**

Module-4

7 a. Explain the concept of available and unavailable energy. **(04 Marks)**

b. Write Maxell relations and explain the terms involved. **(06 Marks)**

c. A vessel of volume 0.04 m^3 contains a mixture of saturated water and saturated steam of a temperature of 250°C. The mass of liquid present is 9 kg. Find the pressure, mass, specific volume, enthalpy and internal energy. **(10 Marks)**

OR

8 a. With a neat sketch, explain the working of combined separating and throttling calorimeter. **(10 Marks)**

b. Steam at 10 bar and dry state is cooled under constant pressure until it becomes 0.85 dry. Using steam tables, find the work done, change in enthalpy, heat transferred and change in entropy. **(10 Marks)**

Module-5

9 a. Determine the Vander Waal's constant in terms of critical properties. **(08 Marks)**

b. Explain the following:
(i) Generalized compressibility chart
(ii) Law of corresponding state
(iii) Compressibility factor **(04 Marks)**

c. Determine the pressure exerted by carbon dioxide in a container of 1.5 m^3 capacity when it contains 5 kg at 27°C using (i) Ideal gas equation (iii) Vander Waal's equation. Take Vander Waal's constant for CO_2 as a = 364.3 $kNm^4/kgmol^2$, b = 0.0427 $m^3/kgmol$. **(08 Marks)**

OR

10 a. Explain Dalton's law if partial pressure and Amagat's law of additive volumes with reference to ideal gas mixture. **(08 Marks)**

b. Derive an expression for internal energy and enthalpy of gaseous mixtures. **(04 Marks)**

c. A mixture of gases contains 1 kg of CO_2 and 1.5 kg and N_2. The pressure and temperature of the mixture are 3.5 bar and 27°C. Determine for the mixture :
(i) The mass and mole fraction of each constituent gas
(ii) Average molecular weight
(iii) The partial pressure **(08 Marks)**

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