CBCS SCHEME

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17ME33

Third Semester B.E. Degree Examination, Jan./Feb. 2023
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Distinguish between :
i) Macroscopic and microscopic approach of study
ii) Intensive and extensive properties
iii) Closed open and isolated systems. **(07 Marks)**

b. What do you mean by 'Thermodynamic equilibrium' of a system? **(05 Marks)**

c. The temperature T on a celcius scale is defined in terms of property P by the relationship $P = e^{(T-B)/A}$ where A and B are constants. Experiments give values of P as 1.86 and 6.81 at ice and steam points respectively. Obtain relation for T and also find the temperature T for the reading of P = 2.5. **(08 Marks)**

OR

2 a. Define thermodynamic work and heat. **(06 Marks)**

b. Derive an expression for displacement work for the polytrophic process. **(08 Marks)**

c. Specific heat capacity of the system during certain process is given by $C_p = [0.4 + 0.004T]$ kJ/kg°C. If the mass of the gas is 6kg and its temperature changes form 25°C to 125°C. Find the heat transferred. **(06 Marks)**

Module-2

3 a. State the first law of thermodynamics and show that internal energy is a property of a system. **(08 Marks)**

b. Derive an expression for steady flow energy equation for a single stream of fluid entering and single steam of fluid leaving the control volume. **(06 Marks)**

c. A long well insulated pipe consists of two pipes connected in series. The internal diameter of which are 7.5cm and 2.5cm respectively. A steady flow steam enters 7.5cm diameter at a pressure of 30 bar, specific volume of 0.0829 m^3/kg and an enthalpy of 3000 kJ/kg. A point in a downstream in 2.5cm pipe, pressure is 27 bar, specific volume 0.0838m^3/kg and enthalpy 2925 kJ/kg. Determine the velocity of steam at two points and mass flow rate of the steam. **(06 Marks)**

OR

4 a. Give Kelvin-Plank and Clausius statements of second law of thermodynamics and show that they are equivalent. **(10 Marks)**

b. A reversible heat engine operates between two reservoirs at constant temperature of 160° and 20°C. The work output from the engine is 15 kJ/s. Determine :
i) The efficiency of the cycle
ii) The heat transfer from the reservoir at 160°C
iii) Heat rejected to the reservoir at 20°C
If the engine is reversed and operates as a heat pump between same two reservoirs, determine COP of the heat pump and power required when the heat transfer from the reservoir at 20°C is 300 kJ per minute. **(10 Marks)**

Module-3

5 a. Define reversibility and irreversibility. What are the causes of irreversibility of a process? **(06 Marks)**

b. What do you understand by internal irreversibility and external irreversibility? **(06 Marks)**

c. Two Carnot engines A and B are connected in series by two reservoirs maintained at 1000 K and 100 K. Engine A receives 1680 kJ of heat from HTR and rejects heat to engine B. The engine B takes in heat rejected by engine A and rejects heat to LTR. If the efficiencies of A and B are same. Determine :

i) Heat rejected by engine B
ii) The temperature at which heat rejected by engine A
iii) Work-done during the process by A and B. **(08 Marks)**

OR

6 a. State and prove Clausius inequality. **(06 Marks)**

b. Explain the principle of increase of entropy of universe. **(06 Marks)**

c. One kg of ice at –5°C is exposed to the atmosphere which is at 20°C. The ice melts and comes into thermal equilibrium with the atmosphere. Determine the entropy increase of the universe. Take $C_{P\,ice}$ = 2.093 kJ/kg K and latent heat of fusion of ice is 333.3 kJ.kg. **(08 Marks)**

Module-4

7 a. Explain available, unavailable energies. When does the system becomes dead state. **(06 Marks)**

b. Derive expression for availability in a non flow process. **(06 Marks)**

c. Calculate the decrease in available energy when 25 kg of water at 95°C mix with 35kg of water at 35°C, the pressure being taken as constant and the temperature of the surroundings being 15°C. Take $C_{P\,water}$ = 4.2 kJ/kg K. **(08 Marks)**

OR

8 a. Sketch and explain the P – T diagram for a pure substance. **(06 Marks)**

b. Describe with neat sketch working of combined separating and throttling calorimeter. **(08 Marks)**

c. In a throttling calorimeter, the steam is admitted at a pressure of 10 bar. If it is discharged at 1 bar and 110°C after throttling, determine the dryness fraction of the steam. Assume specific heat of steam as 2.2 kJ/kg K. **(06 Marks)**

Module-5

9 a. Write a note on Dalton's law of partial pressures and Amagat's law of additive volumes. **(08 Marks)**

b. For an ideal gas prove PV^{γ} = constant, for a system undergoing a reversible adiabatic process. **(06 Marks)**

c. What are the law of corresponding state and compressibility chart? **(06 Marks)**

OR

10 a. Explain Van-der-Waals equation of state. **(06 Marks)**

b. With usual notations, write the Beattie – Bridgeman equation of state. **(04 Marks)**

c. A mass of 0.25 kg of an ideal gas has a pressure of 300 KPa, a temperature of 80°C and a volume of 0.07m^3. The gas undergoes an irreversible adiabatic process to a final pressure of 300 KPa and final volume of 0.10m^3, during which the work-done on the gas is 25 kJ. Evaluate the C_p and C_v of the gas and the increase in entropy of the gas. **(10 Marks)**

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