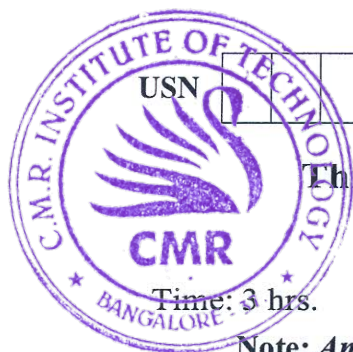


# CBCS SCHEME



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 :
- Macroscopic and microscopic approach of study
  - Intensive and extensive properties
  - 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<sup>3</sup>/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<sup>3</sup>/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 :
- The efficiency of the cycle
  - The heat transfer from the reservoir at 160°C
  - 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 :
- Heat rejected by engine B
  - The temperature at which heat rejected by engine A
  - 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  $-5^{\circ}\text{C}$  is exposed to the atmosphere which is at  $20^{\circ}\text{C}$ . The ice melts and comes into thermal equilibrium with the atmosphere. Determine the entropy increase of the universe. Take  $C_{p\text{ice}} = 2.093 \text{ kJ/kg K}$  and latent heat of fusion of ice is  $333.3 \text{ kJ.kg}$ . (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  $95^{\circ}\text{C}$  mix with 35kg of water at  $35^{\circ}\text{C}$ , the pressure being taken as constant and the temperature of the surroundings being  $15^{\circ}\text{C}$ . Take  $C_{p\text{water}} = 4.2 \text{ kJ/kg K}$ . (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  $110^{\circ}\text{C}$  after throttling, determine the dryness fraction of the steam. Assume specific heat of steam as  $2.2 \text{ kJ/kg K}$ . (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  $PV^{\gamma} = \text{constant}$ , 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  $80^{\circ}\text{C}$  and a volume of  $0.07\text{m}^3$ . The gas undergoes an irreversible adiabatic process to a final pressure of 300 KPa and final volume of  $0.10\text{m}^3$ , 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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