



CBCS SCHEME

21AE734

Seventh Semester B.E./B.Tech. Degree Examination, June/July 2026 Heat and Mass Transfer

Time: 3 hrs.

Max. Marks: 100

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

Module-1

- 1 a. Explain the modes of heat transfer with their examples. (08 Marks)
b. Define the term thermal diffusivity. (06 Marks)
c. Explain combined heat transfer mechanism. (06 Marks)

OR

- 2 a. Explain mass transfer and modes of mass transfer with examples. (10 Marks)
b. Define the following terms:
i) Mass concentration
ii) Molar concentration
iii) Mass fraction
iv) Mole fraction
v) Mass diffusion velocity (10 Marks)

Module-2

- 3 a. Derive the three dimensional general heat conduction equation in Cartesian coordinates. (10 Marks)
b. A furnace wall consists of 25 cm of fire brick, 15 cm of steel, 55 mm layer of brick and a 3 mm thick magnesia on the outside. If the inside surface temperature of the furnace is 1600°C and outside surface temperature is to be 80°C. Calculate the temperature between the layers and heat loss per unit area of furnace wall. K for fire brick = 1.28 W/m°C. For steel = 69.77 W/m°C, brick = 0.814 W/m°C and magnesia = 0.0698 W/m°C. (10 Marks)

OR

- 4 a. Obtain temperature distribution equation for lumped heat system and hence obtain expression for total heat transfer in such system. (10 Marks)
b. A 50 cm × 50 cm copper slab 6.25 mm thick has a uniform temperature of 300°C. Its temperature is suddenly lowered to 36°C. Calculate the time required for the plate to reach the temperature of 108°C. Assume $\rho = 9000 \text{ kg/m}^3$, $c = 0.38 \text{ kJ/kg}^\circ\text{C}$. Take $k = 370 \text{ W/m}^\circ\text{C}$, $h = 90 \text{ W/m}^2^\circ\text{C}$. (10 Marks)

Module-3

- 5 a. Obtain an empirical expression in terms of dimensionless number for heat transfer co-efficient in the case of forced convection heat transfer. (10 Marks)
b. Dry air at atmospheric pressure and 20°C is flowing with a velocity of 3 m/s along the length of a long flat plate 0.3 m wide maintained at 100°C. Calculate the following quantities at $x = 0.3 \text{ m}$.
i) Boundary layer thickness
ii) Average friction coefficient
iii) Thickness of thermal boundary layer
iv) Rate of heat transfer from the plate between $x = 0$ and $x = x$ by convection. (10 Marks)

OR

- 6 a. Explain the following :
 i) Velocity boundary layer
 ii) Thermal boundary layer (08 Marks)
 b. Calculate the convection heat loss from a radiator 0.5 m wide and 1 m high maintained at a temperature of 84°C in a room at 20°C. Treat radiator as a vertical plate. (12 Marks)

Module-4

- 7 a. Explain the following:
 i) Stefan Boltzmann law
 ii) Black body (08 Marks)
 b. Consider two large parallel plates, one at 1000 K with emissivity 0.8 and other is at 300 K having emissivity 0.6. A radiation shield is placed between them. The shield has emissivity 0.1 on the side facing hot plate and 0.3 on the side facing cold plate. Calculate percentage reduction in radiation heat transfer as a result of radiation shield. (12 Marks)

OR

- 8 a. With assumptions, derive an expression for LMTD for a parallel flow heat exchanger. (10 Marks)
 b. Exhaust gases ($C_p = 1.12$ kJ/kg K) flowing through a tubular heat exchanger at the rate of 1200 kg/hr is cooled from 400°C to 120°C. The cooling is affected by water ($C_p = 4.2$ kJ/kg K) that enters the system at 10°C at the rate of 1500 kg/hr. If the overall heat transfer co-efficient is 500 kJ/m² hr°C, what heat exchange area is required to handle the load for parallel flow and counter flow arrangement. (10 Marks)

Module-5

- 9 a. Explain heat distribution in rocket thrust chamber. (08 Marks)
 b. Explain Ablative heat transfer. (06 Marks)
 c. Explain aerodynamic heating in aerospace engineering. (06 Marks)

OR

- 10 a. Explain briefly the combustion process in gas turbine and types of combustion chamber. (08 Marks)
 b. The flow rate of hot and cold fluids running through a parallel flow heat exchanger are 0.2 and 0.5 kg/s. The inlet temperature on the hot and cold sides are 75°C and 20°C respectively. The exit temperature of hot water is 45°C. If the individual heat transfer coefficient on both sides are 650 W/m²K. Calculate the area of heat transfer (for hot and cold fluid, $C_p = 4.2$ kJ/kg K). (12 Marks)
