CBCS SCHEME

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21AE734

Seventh Semester B.E. Degree Examination, Dec.2025/Jan.2026
Heat and Mass Transfer

Time: 3 hrs. Max. Marks: 100

Note: 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. Use of Heat and Mass Transfer data handbook is permitted.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Explain types of mass transfer with examples. **(08 Marks)**
b. Briefly explain Ficks law of diffusion. **(04 Marks)**
c. State the laws governing three basic modes of heat transfer. **(08 Marks)**

OR

2 a. Briefly explain Stefan Boltzmann Law. **(06 Marks)**
b. Explain the basic modes of heat transfer. **(06 Marks)**
c. Define the following : i) Mass Flux ii) Molar flux iii) Molar concentration iv) Diffusion coefficient. **(08 Marks)**

Module-2

3 a. A 40cm × 40cm copper slab 5 mm thick has a uniform temperature of 250 °C suddenly has its surface temperature lowered to 30 °C. Find the time which the slab temperature becomes 90 °C. $\rho = 900$ kg/m^3, specific heat C = 0.38 kJ/kg - K, K = 370 W/m-K and convection heat transfer coefficient h = 90 W/m^2- K. **(10 Marks)**
b. Derive the general three dimensional conduction equations in Cartesian coordinates and state the assumption made. **(10 Marks)**

OR

4 a. A stainless steel rod of outer diameter 1 cm originally at a temperature of 320°C is suddenly immersed in a liquid at 120°C for which the convective heat transfer co-efficient is 100W/m^2-K. Determine the time required for the rod to reach a temperature of 200°C **(08 Marks)**
b. Derive an expression for instantaneous heat transfer and total heat transfer, for lumped heat analysis treatment of heat conduction problem. **(12 Marks)**

Module-3

5 a. Dry Air at a atmospheric pressure and 20 °C is flowing with a velocity of 3 m/s along the length of a long flat plate, 0.3m wide , maintained at 100 °C. Calculate the following quantities at x = 0.3 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 convention. **(12 Marks)**
b. Explain the following with its expression :
i) Reynold's number ii) Prandtl number
iii) Nusselt number iv) Stanton number. **(08 Marks)**

OR

6 a. Obtain an empirical expression in terms of dimensionless numbers for heat transfer co-efficient in the case of forced convection heat transfer. **(12 Marks)**

b. Explain the following :
i) Velocity boundary layer
ii) Thermal boundary layer
iii) Thermal Entry length **(08 Marks)**

Module-4

7 a. With assumption, derive an expression for LMTD for a parallel flow heat exchanger. **(10 Marks)**

b. An oil cooler consists of straight tube of 2 cm outer diameter and 1.5 cm inner diameter enclosed within a pipe and concentric with it. The external pipe is well insulated. The oil flow through the tube at 0.05 kg/s (Cp = 2 kJ/kg – K) and cooling fluid flows in the annulus in the opposite direction at the rate of 0.1 kg/s (Cp = 4.2 kJ/kg – K). The oil enters the cooler at 180 °C and leaves at 80 °C, while cooling liquid enter the cooler at 30°C. Calculate the length of the pipe required if heat transfer co-efficient from oil to the surface is 1720 W/m^2 – K and from metal surface to coolant is 3450 W/m^2 - K. Neglect the resistance of the tube wall. **(10 Marks)**

OR

8 a. Obtain an expression for the rate of heat transfer when radiation shield is introduced between two parallel plates. **(10 Marks)**

b. Consider two large parallel plates, one at 1000K with emissivity 0.8 and other is at 300K having emissivity 0.6. A radiation shield is placed between them. The shield has emissivity 0.1 on the facing hot plate and 0.3 on the side facing cold plate. Calculate percentage reduction in radiation heat transfer an a result of radiation shield **(10 Marks)**

Module-5

9 a. Write short notes on Aerodynamic heating. **(08 Marks)**

b. The flow rate of hot and cold fluids running through a parallel flow heat exchanger are 0.2 kg /s and 0.5 kg/s respectively. 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 co-efficient on both sides are 650 w/m^2K. Calculate the area of heat transfer (For hot and cold fluid, C_p = 4.2 KJ/kg-K). **(12 Marks)**

OR

10 a. Explain the heat transfer concept for the following :
i) Rocket thrust chamber
ii) Gas turbine combustion chamber. **(10 Marks)**

b. Explain the concept of ablative heat transfer with its application. **(10 Marks)**

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