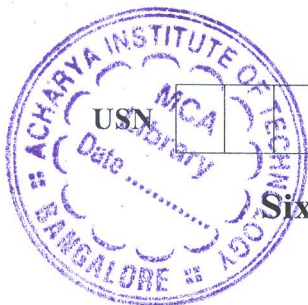


CBCS SCHEME

15ME63



Sixth Semester B.E. Degree Examination, Jan./Feb. 2023

Heat Transfer

Time: 3 hrs.

Max. Marks: 80

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.

2. Use of Heat transfer data hand book is permitted.

Module-1

- 1 a. Explain briefly the mechanism of conduction, convection and radiation heat transfer. (09 Marks)
- b. An exterior wall of a house may be approximated by a 10cm layer of brick ($K = 0.7\text{W/m}^\circ\text{C}$), followed by 4cm layer of gypsum plaster ($K = 0.48\text{W/m}^\circ\text{C}$). What thickness of rock wool insulation ($K = 0.06\text{W/m}^\circ\text{C}$) should be added to reduce the heat loss through the wall by 80%. (07 Marks)

OR

- 2 a. Derive general three dimensional heat conduction equation in Cartesian coordinate system. (08 Marks)
- b. A square plate heater of size (15×15)cm is inserted between two slabs. Slab 'A' is 2cm thick ($K = 50\text{W/mK}$) and slab 'B' is 1cm thick ($K = 0.2\text{W/mK}$). The outside heat transfer co-efficient on both sides of A and B are 200 and $50\text{W/m}^2\text{-K}$ respectively. Temperature of surrounding air is 25°C . If the rating of heater is 1kW, find:
- Maximum temperature in the system.
 - Outer surface temperature of two slabs. (08 Marks)

Module-2

- 3 a. Derive an expression for critical radius, of insulation for a sphere, hence define the critical thickness of insulation. (08 Marks)
- b. A steel rod of ($12\text{mm} \times 12\text{mm}$) with a length of 159mm protrudes into air at 35°C from a furnace wall at 200°C . The thermal conductivity of the material is 51.9W/mK and the convective heat transfer coefficient is $22\text{W/m}^2\text{K}$. Determine:
- The end temperature assuming the end to be insulated.
 - Temperature at 80mm distance from the wall.
 - The end temperature, if the fin were to be 80m long with end not insulated. (08 Marks)

OR

- 4 a. Show that the temperature distribution in a body during Newtonian heating or cooling is given by
- $$\frac{T - T_\infty}{T_i - T_\infty} = \text{EXP} \left[\frac{-hAt}{\rho v c p} \right] \quad (08 \text{ Marks})$$
- b. A 6cm potato initially at a uniform temperature of 20°C , is suddenly dropped into boiling water at 100°C . The heat transfer co-efficient between water and the surface is $6000\text{W/m}^2\text{K}$. The thermo physical properties of potato can be taken same as those of water [$\alpha = 1.6 \times 10^{-7}\text{m}^2/\text{sec}$ and $K = 0.68\text{W/m-K}$]. Determine the time required for the centre of potato to reach 95°C and energy transferred to the potato during this time. (08 Marks)

Module-3

- 5 a. Briefly describe the boundary conditions related to numerical analysis of heat conduction. (08 Marks)
- b. Explain the energy balance procedure to obtain the finite difference formulation of 1-D heat conduction problem in Cartesian coordinates. (08 Marks)

OR

- 6 a. Define: i) Black body ii) Planck's law iii) Wein's displacement law iv) Lambertz law. (08 Marks)
- b. Two parallel plates at $T_1 = 900\text{K}$ and $T_2 = 500\text{K}$ have emissivities $\epsilon_1 = 0.6$ and $\epsilon_2 = 0.9$ respectively. A radiation shield having an emissivity $\epsilon_{31} = 0.15$ on one side and emissivity $\epsilon_{32} = 0.06$. On the other side is placed between the plates. Calculate the percentage reduction in heat transfer, when radiation shield placed between the plates. (08 Marks)

Module-4

- 7 a. Explain the concept of thermal boundary layer on a flat plate. (08 Marks)
- b. Air at 30°C is flowing across a tube with a velocity of 25m/sec . The tube could be either a square with a side of 5cm or a circular cylinder of diameter 5cm . Compare the rate of heat transfer in each case if the tube surface temperature is 124°C . (08 Marks)

OR

- 8 a. Explain the concept of velocity boundary layer on a flat plate. (08 Marks)
- b. A circular plate of 25cm diameter with both the surfaces are maintained at a uniform temperature of 100°C is suspended in a horizontal position in atmospheric air at 20°C . Determine the heat transfer from plate. (08 Marks)

Module-5

- 9 a. Derive an expression of LMTD for counter flow heat exchanger. (08 Marks)
- b. A cross flow heat exchanger with both fluids unmixed is used to heat water flowing at a rate of 20kg/sec from 25°C to 75°C , using gases available at 300°C to be cooled to 180°C . The overall heat transfer coefficient has a value of $95\text{W/m}^2\text{-K}$. If C_p for gas is 1.005kJ/kg-K . Determine the area of heat transfer required. (08 Marks)

OR

- 10 a. Explain the regimes of pool boiling with a neat sketch. (08 Marks)
- b. Dry steam at 100°C condenses on outside surface of a horizontal pipe of outside diameter = 2.5cm . The pipe surface is maintained at 84°C by circulating water through it. Determine the rate of formation of condensate per meter length of the pipe. (08 Marks)
