CBCS SCHEME

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ACHARYA INSTITUTE OF TECHNOLOGY MCA Library Date BANGALORE

Fifth Semester B.E./B.Tech. Degree Examination, June/July 2025
Heat and Mass Transfer

Time: 3 hrs. Max. Marks: 100

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

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 the different modes of heat transfer with examples. **(10 Marks)**

b. A plane wall is 150 mm thick and its wall area is 4.5 m^2. If its conductivity is 9.35 W/m°C and surface temperatures are steady at 150°C and 45°C, determine :
i) Heat flow across the plane wall
ii) Temperature gradient in the flow direction. **(10 Marks)**

OR

2 a. Derive the general three dimensional Heat conduction equation in Cartesian coordinates and state the assumption made. **(10 Marks)**

b. A wall of a furnace made up of inside layer of silica brick 120 mm thick covered with a layer of magnesite brick. The temperatures at the inside surface of silica brick wall and outside surface of magnesite brick wall are 725°C and 110°C respectively. The contact thermal resistance between the two walls at the interface is 0.0035°C/w per unit wall area. If the thermal conductivities of silica and magnesite bricks are 1.7 W/m°C and 5.8 W/m°C, calculate :
i) The rate of head loss per unit area of walls
ii) The temperature drop at the interface. **(10 Marks)**

Module-2

3 a. Derive an expression for the temperature distribution for a long fin of uniform cross section with insulated tip. **(10 Marks)**

b. A longitudinal copper fin (K = 280 W/m°C) 600 mm long and 5 mm diameter is exposed to air stream at 20°C. The convective heat transfer coefficient is 20 W/m^2 °C. If the fin base temperature is 150°C. determine :
i) The heat transferred
ii) The efficiency of the fin. **(10 Marks)**

OR

4 a. Derive the expression for the temperature distribution for the lumped heat analysis. **(10 Marks)**

b. An aluminum rod which is initially at a temperature of 200°C is exposed to air at 30°C. The diameter of the pipe is 10 cm. Find the time required for the rod to reach a temperature of 50°C. Assume that the surface convective heat transfer coefficient is 50 W/m^2K. **(10 Marks)**

Module-3

5 a. Explain the significance of any five dimensions numbers in forced and free convection. **(10 Marks)**

b. Find the rate of heat transfer from a vertical plate of height 4 m and width 10 m which is maintained at 333 K and exposed to atmospheric air at 283 K. **(10 Marks)**

OR

6 a. Derive an expression for the average temperature difference along the plate if constant heat flux is maintained in forced convection. **(10 Marks)**

b. Air at 373 K enters a tube of diameter 0.03 m and length 4 m at a mass flow ratio of 0.0047 kg/s. Find the exit temperature of air and the Nusselt number if 1 kw heat is supplied to the outer surface of the tube. **(10 Marks)**

Module-4

7 a. Derive the expression for effectiveness of parallel flow heat exchanger by NTU method. **(10 Marks)**

b. In a counter – flow double pipe heat exchanger, water is heated from 25°C to 65°C by an oil with a specific heat of 1.45 kJ/kg K and mass flow rate of 0.9kg/s, The oil is cooled from 230°C to 160°C. If the overall heat transfer coefficient is 420 W/m^2 °C, determine

i) The rate of heat transfer
ii) Mass flow rate of water
iii) Surface area of the heat exchanger. **(10 Marks)**

OR

8 a. Discuss the different regimes of pool boiling curve with a neat sketch. **(10 Marks)**

b. Vertical flat plate in the form of fin is 600 m in height and is exposed to steam at atmospheric pressure. If surface of the plate is maintained at 60°C, calculate the following :

i) The film thickness at the trailing edge of the film.
ii) The overall heat transfer coefficient
iii) Heat transfer rate. **(10 Marks)**

Module-5

9 a. State :

i) Stefan – Boltzmann Law
ii) Kirchoff's Law
iii) Planck Law
iv) Wein's displacement Law **(10 Marks)**

b. The effective temperature of a body having an area of 0.12 m^2 is 527°C. Calculate the following :

i) The total rate of energy emission
ii) Intensity of normal radiation
ii) Wavelength of maximum monochromatic emissive power. **(10 Marks)**

OR

10 a. Derive an expression for heat transfer between two infinite parallel planes. **(10 Marks)**

b. Determine the rate of heat loss by radiation from a steel tube of outside diameter 70 mm and 3 m long at a temperature of 227°c. If the tube is located within a square brick conduit of 0.3 m side and at 27°C. Take $\in_{steel} = 0.79$ and $\in_{brick} = 0.93$. **(10 Marks)**

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