CBCS SCHEME

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21ME62

Sixth Semester B.E./B.Tech. Degree Examination, June/July 2025
Heat Transfer

Time: 3 hrs. Max. Marks: 100

Note:
1. Answer any FIVE full questions, selecting one Full question from each module.
2. Use of Heat transfer Data hand book, Thermodyamics Data hand Book, and steam tables are permitted.
3. Assume missing data suitably.

Module-1

1 a. What are three ways heat is transferred? In brief explain them. **(05 Marks)**

b. What are boundary conditions? Explain any one of the boundary conditions with a sketch. **(05Marks)**

c. Derive the general three – dimensional unsteady state heat condition equation with heat generation, in a Cartesian coordinate system for an isotropic material with assumptions made. **(10 Marks)**

OR

2 a. Find the heat flow rate through the composite wall as shown in Fig.Q2(a). Assume one – dimensional flow. $K_a = 150$ w/m°C, $K_b = 30$ w/ m°C, $K_c = 65$ w/ m°C, $K_d = 50$ w/ m°C.

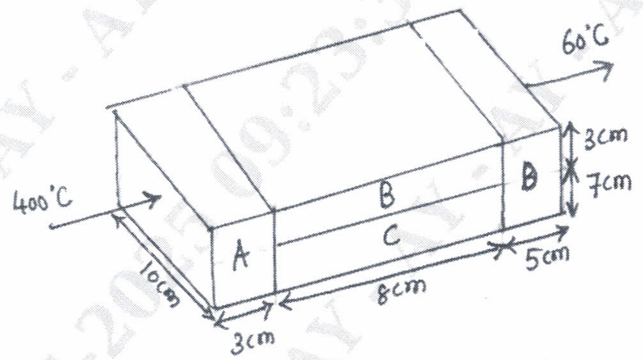

Fig. Q2(a)

(10 Marks)

b. Explain the experimental method of determining the thermal conductivity of a metal rod. **(10 Marks)**

Module-2

3 a. Define Fin, and list the common types of fin configurations. Write a note on any two types of fin with a neat sketch. **(05Marks)**

b. Define Efficiency of fin and Effectiveness of fin. In brief discuss on both. **(05 Marks)**

c. With assumptions, derive an expression for temperature distribution and rate of heat transfer for an infinitely long fin. **(10 Marks)**

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.

OR

4 a. Write a note on transient heat conduction. How to analyze transient heat flow? **(05 Marks)**

b. Write a note on Biot number and Fourier number with their significance on transient heat conduction. **(05 Marks)**

c. A steel ball of 5 cm diameter at 450°C is suddenly placed in a controlled environment of 100°C Considering the following data, find the time required for the ball to attain a temperature of 150°C. Take C_ρ= 450 J/kg–K, K = 35 w/mk, h = 10 w/m^2-k, ρ = 8000 kg/m^3. **(10 Marks)**

Module-3

5 a. Differentiate between the experimental, analytical and numerical methods of determining the solution of a heat transfer problem. **(10 Marks)**

b. Explain the finite difference formulation of the differential equation of one – dimensional steady heat conduction. **(10 Marks)**

OR

6 a. State :

i) Emissivity
ii) Stefan Boltzmann's law
iii) Kirchoff's law
iv) Plank's law
v) Wein displacement law **(10 Marks)**

b. Write a brief note on the Radiation shape factor ad Radiation shields. **(10 Marks)**

Module-4

7 a. With neat sketches, explain velocity boundary layer and thermal boundary layer over flat plate. **(10 Marks)**

b. With assumptions derive an expression for Nusselt's number in terms of Reynold's number and Prandtl's number for forced convection. **(10 Marks)**

OR

8 a. Define the following terms with their significance.

i) Reynolds number
ii) Nusselt number
iii) Prandtl number
iv) Laminar flow
v) Turbulent flow. **(10 Marks)**

b. Air at 20°C and at atmospheric pressure flows over a flat plate at a velocity of 1.8 m/s. If the length of the plate is 2.2 m and is maintained at 100°C, calculate the heat transfer rate per unit width using the properties of air at mean bulk temperature of $\left(\frac{100+20}{2}\right) = 60\,°C$ are ρ = 1.06 kg/m^3, $C\rho = 1.005\,\frac{KJ}{Kg}$, $K = 0.02894\,\frac{W}{m\,^\circ C}$, P_r = 0.696, $\nu = 18.97 \times 10^{-6}\,\frac{m^2}{S}$. **(10 Marks)**

Module-5

9 a. Discuss the regimes of pool boiling curve for water. **(10 Marks)**

b. Saturated steam at $t_{sat} = 90°C$ ($\rho = 70.14$ KPa) condenses on the outer surface of a 1.5 m long 2.5 m OD vertical tube maintained at a temperature $T_\infty = 70°C$. Assuming film condensation calculate :

1) The local transfer coefficient at the bottom of the tube.

2) The average heat transfer coefficient over the entire length of the tube.

Properties of water at 80°C are $\rho_l = 974$ kg/m^3, $K_t = 0.668$ w/mk, $\mu_l = 0.335 \times 10^3$ kg/ms, $h_{fg} = 2309$ kJ/kg, $\rho_v << \rho_l$. **(10 Marks)**

10 a. Define heat Exchanger and Logarithmic Mean Temperature difference. Differentiate between parallel and counter –flow heat exchangers. **(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 and mass flow rate of 0.9 kg/s. The oil is cooled from 230°C to 160°C. If the overall heat transfer coefficient is 420 w/m°C, calculate the following :

i) the rate of heat transfer

ii) the mass flow rate of water and

iii) the surface area of the heat Exchanger. **(10 Marks)**

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