CBCS SCHEME

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18MR61

Sixth Semester B.E. Degree Examination, Jan./Feb. 2023
Heat 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 transfer data book is permitted.

Module-1

1 a. State the laws governing three basic modes of heat transfer. **(09 Marks)**

b. A square plate of size 15 cm × 15 cm is inserted between two slabs. Slab 'A' is 2 cm thick (K = 50 W/m°C) and slab B is 1 cm thick (K = 0.2 W/mK). The outside heat transfer coefficient on both sides of 'A' and 'B' are 200 and 50 W/m^2K respectively. Temperature of surrounding air is 25°C. If the rating of heater is 1 KW. Find:
(i) Maximum temperature in the system
(ii) Outer surface temperature of two slabs
Draw equivalent circuit for the system. **(11 Marks)**

OR

2 a. What is critical thickness of insulation and derive an expression for critical thickness of insulation for a cylinder. **(10 Marks)**

b. Calculate the critical radius of insulation for asbestos (K = 0.172 W/mK) surrounding a pipe and exposed to room air at 300°K with h = 2.8 W/m^2K. Calculate the heat loss from a 475 K, 60 mm diameter pipe when covered with the critical radius of insulation and without insulation. Also calculate percentage increase in heat dissipation. **(10 Marks)**

Module-2

3 a. Derive an expression for rate of heat transfer and temperature distribution for infinite long fin. **(10 Marks)**

b. A motor body is 360 mm in diameter and 240 mm long. Its surface temperature should not exceed 55°C when dissipating 340 W. Longitudinal fins of 15 mm thickness and 40 mm height are proposed. The convective coefficient is 40 $W/m^2°C$. Determine the number of fins required. Atmospheric temperature is 30°C thermal conductivity 40 W/m°C. **(10 Marks)**

OR

4 a. Derive an expression for instantaneous and total heat flow in terms of Biot and Fourier number in one dimensional heat conduction. **(08 Marks)**

b. What are Biot and Fourier numbers? Explain their significance. **(06 Marks)**

c. A 50 cm × 50 cm copper slab 6.25 mm thick has a uniform temperature of 300°C. The temperature is suddenly lowered to 36°C. Calculate the time required for the plate to reach the temperature of 108°C. Take ρ = 9000 kg/m^3; C = 0.38 kJ/kg°C; K = 370 W/m°C; h = 90 $W/m^2°C$. **(06 Marks)**

Module-3

5 a. Using dimensional analysis obtain dimensionless parameter in forced convection heat transfer. **(10 Marks)**

b. When 0.5 kg of water per minute is passed through a tube of 20 mm diameter, it is found to be heated from 20°C to 50°C. The heating is accomplished by condensing steam on the surface of the tube and subsequently the surface temperature of the tube is maintained at 85°C. Determine the length of the tube required for fully developed flow. Take thermo-physical properties, ρ = 983.2 kg/m^3; C_p = 4.178 kJ/kgK; K = 0.659 W/mK, $\gamma = 0.478 \times 10^{-6}$ m^2/s. **(10 Marks)**

OR

6 a. Explain briefly the following for flow over flat plate:
(i) Velocity boundary layer (ii) Thermal boundary layer **(12 Marks)**

b. A vertical cylinder 1.5 m high and 180 mm in diameter is maintained at 100°C in an atmosphere environment of 20°C. Calculate heat loss by free convection from the surface of the cylinder. Assume properties of air at mean temperature as ρ = 1.06 kg/m^3, $\gamma = 18.97 \times 10^{-6}$ m^2/s, C_p = 1.004 kJ/kg°C and K = 0.1042 kJ/mh°C (W/m°K). **(08 Marks)**

Module-4

7 a. Derive an expression for LMTD for parallel flow heat exchanger and state the assumptions. **(10 Marks)**

b. Water to water heat exchanger of a counter flow arrangement has heating surface area of 2 m^2. Mass flow rates of hot and cold fluids are 2000 kg/hr and 1500 kg/hr respectively. Temperature of hot and cold fluids at inlet are 85°C and 25°C respectively. Determine the amount of heat transferred from hot to cold water and their temperature at the exit if the overall heat transfer coefficient is U = 1400 W/m^{2}K. **(10 Marks)**

OR

8 a. Explain the following: (i) Film boiling (ii) Forced boiling (iii) Subcooled boiling
(iv) Saturated boiling **(08 Marks)**

b. A steam condenser consisting a square array of 625 horizontal tubes, each 6 mm in diameter, is installed at the exhaust hood of steam turbine. The tubes are exposed to saturated steam at a pressure of 15 kPa. If the surface temperature is maintained at 25°C, calculate:
(i) The heat transfer coefficient
(ii) The rate at which steam is condensed per unit length of the tubes.
Take T_{sat} = 54°C at 15 kPa. **(12 Marks)**

Module-5

9 a. State and explain the following:
(i) Stefan Boltzman law (ii) Kirchoff law (iii) Plank's law
(iv) Wein's displacement law (v) Lambert's cosine law **(10 Marks)**

b. Two large parallel plates with $\in$ = 0.5 each are maintained at different temperature and are exchanging heat by radiation. Two equally large radiation shields with surface emissivity 0.05 are introduced in parallel to the plates. Find the percentage reduction in net radiative heat transfer. **(10 Marks)**

OR

10 a. Explain the following: (i) Concept of black body (ii) Radiation shield
(iii) View or shape factor in radiation **(12 Marks)**

b. Two parallel rectangular surface 1m × 2m are opposite to each other at a distance 4m. The surfaces are black and at 100°C and 200°C. Calculate the heat exchange by radiation between two surfaces. **(08 Marks)**

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