CBCS SCHEME

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15ME63

Sixth Semester B.E. Degree Examination, Dec.2023/Jan.2024
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 and steam tables are permitted.

Module-1

1 a. State the laws governing three basic modes of heat transfer. **(06 Marks)**

b. Derive the general three-dimensional conduction equation in Cartesian coordinates and state the assumptions made. **(10 Marks)**

OR

2 a. Derive an expression for the temperature distribution through the plane wall with uniform thermal conductivity. **(06 Marks)**

b. A metal [K = 45 W/m°C] steam pipe of 5 cm inside diameter and 6.5 cm outside diameter is lagged with 2.75 cm thickness of high temperature high insulation having thermal conductivity 1.1 W/m°C. convective heat transfer coefficients on the inside and outside surfaces are 4650 W/m^2K and 11.5 W/m^2K respectively. If the steam temperature is 200°c and the ambient temperature is 25°C. Calculate:

i) Heat loss per metre length of pipe
ii) Temperature at the interfaces
iii) Overall heat transfer coefficient to inside and outside surfaces. **(10 Marks)**

Module-2

3 a. Derive the equation of temperature distribution for long fin with usual notations. **(08 Marks)**

b. Circumferential fins of constant thickness of 1 mm are fixed on a 50 mm pipe at a pitch of 9 mm. The fin length is 20 mm. The wall temperature is 130°C. The K = 210 W/mK. The convective coefficient is 50 W/m^2K. Determine heat flow and effectiveness. **(08 Marks)**

OR

4 a. Derive equation of temperature distribution using lumped parameter model. **(08 Marks)**

b. A concrete wall initially at 30°C is exposed to gases at 900°C with h = 85 W/m^2K. The thermal diffusivity is 4.92×10^{-7} m^2/s. the K of material is 1.28 W/mK. Determine the temperature of the surface and temperatures at 1 cm depth and also 5 cm depth after 1 hr. Also estimate the heat flow at the surface at the instant. **(08 Marks)**

Module-3

5 a. Explain formulation of differential equation 1-D steady heat conduction. **(06 Marks)**

b. Explain different solution method used in numerical analysis of heat conduction. **(06 Marks)**

c. Explain applications and computation error of numerical analysis heat conduction. **(04 Marks)**

OR

6 a. Define :
i) Blackbody
ii) Planks law
iii) Wein displacement law
iv) Lamberts law. **(06 Marks)**

b. Prove that emissive power of the black body in hemispherical enclosures in π terms of intensity of radiation. **(06 Marks)**

c. The temperature of black surface of 0.2 m^2 area is 540°C. calculate :
i) the total rate of energy emission
ii) ii) the intensity of normal radiation
iii) iii) the wavelength of maximum monochromatic emission power. **(04 Marks)**

Module-4

7 a. Explain the physical significance of:
(i) Prandtl number (ii) Reynolds number (iii) Nusselt number **(06 Marks)**

b. Air at 1 atm pressure and temperature 25°C flowing with a velocity 50 m/s crosses an industrial heater made of long solid rod of diameter 20 mm. The surface temperature of the heater is 457°C. Determine the allowable electrical power density (W/m^3) within the heater per meter length. **(10 Marks)**

OR

8 a. A circular plate of 25 cm diameter with both surfaces maintained at a uniform temperature of 100°C is suspended horizontally in atmospheric air at 20°C. Determine the heat transfer from the plate. **(10 Marks)**

b. Obtain the fundamental relationship between Nusselt, Prandtle and Reynolds number using Buckingham's π - theorem for forced convection heat transfer. **(06 Marks)**

Module-5

9 a. Sketch and explain regimes of pool boiling. **(08 Marks)**

b. Water at atmospheric pressure is boiling on a brass surface heated from below. If the surface is at 108°C, determine the heat flux and compare the same with critical heat flux. **(08 Marks)**

OR

10 a. Derive CMTD for parallel flow heat exchanger. **(08 Marks)**

b. In a shell and tube heat exchanger/condenser, the tube bank is 10 rows deep with ID of tube 20 mm and OD 25 mm. the tubes are arranged in square array of 50 mm pitch. Water flows across the tubes with V = 0.5 m/s. Sea water flows inside with 1 m/s. The water is cooled from 50°C to 30°C and sea water temperature changes from 15°C to 25°C. Assuming same properties for both side water, determine overall heat transfer coefficient. The tubes are of brass with K = 60.6 W/mK. Assume tube length of 4m. **(08 Marks)**

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