CBCS SCHEME

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18MR61

Sixth Semester B.E. Degree Examination, Dec.2023/Jan.2024
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 and mass transfer data handbook is allowed.

Module-1

1 a. What is Heat transfer? Explain the modes of heat transfer. **(08 Marks)**

b. Define Heat, Energy and Work. **(06 Marks)**

c. Define and explain Fourier's law of heat conduction. **(06 Marks)**

OR

2 a. Derive three dimensional conduction equation in Cartesian coordinates. **(10 Marks)**

b. An exterior wall of a house may be approximated by a 0.1m layers of common brick (K = 0.7W/m°C) followed by a 0.04m layer of gypsum plaster (K = 0.48 W/m°C). What thickness of loosely packed rock wool insulation (K = 0.065 W/m°C), should be added to reduce the heat loss or (gain) through the wall by 80 percent. **(10 Marks)**

Module-2

3 a. Derive an equation for heat flow through rectangular fin. **(10 Marks)**

b. Two long rods of same diameter, one made of brass (K = 85W/m°C) and other made of copper (K = 375 W/m°C) have one of their ends inserted into the furnace. Both of the rods are exposed to the same environment. At a distance 105mm away from the furnace end, the temperature of the brass rod is 120°C. At what distance from the furnace end the same temperature would be reached in the copper rod? **(10 Marks)**

OR

4 a. Explain lumped parameter analysis in transient conduction. **(10 Marks)**

b. An aluminium alloy plate of 400mm × 400mm × 4mm size at 200°C is suddenly generated into liquid oxygen at 183°C. Starting from fundamentals or deriving the necessary expression determine the time required for the plate to reach a temperature of -76°C. Assume h = 20,000kJ/m^2 – n - °C, C_p = 0.8kJ/kg°C and e = 3000 kg/m^3. **(10 Marks)**

Module-3

5 a. Define the following:
i) Reynolds number
ii) Prandtl number
iii) Nusselt number
iv) Stanton number. **(10 Marks)**

b. A vertical cylinder 1.5m high and 180mm 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 e = 1.06kg/m^3, v = 18.97 × 10^{-6} m^2/s, c_p = 1.004kJ/kg°c and k = 0.1042 kJ/mh°c. **(10 Marks)**

OR

6 a. Derive an equation of motion or momentum equation for hydrodynamic boundary layer. **(10 Marks)**

b. Two vertical plates, each 120mm high and 85°C are placed in a tank of water at 15°C. Calculate the minimum spacing which will prevent interference of the free convection boundary layers. **(10 Marks)**

Module-4

7 a. What are heat exchangers? Classify and explain. **(10 Marks)**

b. In a certain double pipe heat exchanges hot water flows at a rate of 5000kg/hr and gets cooled from 95°C to 65°C. At the same time 50,000kg/h of cooling water at 30°C enters the heat exchanger. The flow conditions are such that overall heat transfer coefficient remains constant at 2270 W/m^2K. Determine the heat transfer area required and the effectiveness, assuming two streams are in parallel flow. Assume for the both the streams $c_p = 4.2kJ/kgk$. **(10 Marks)**

OR

8 a. Explain with neat sketch laminar film condensation on a vertical plate. **(10 Marks)**

b. A nickel wire of 1mm diameter and 400mm long, carrying current, is submerged in a water bath which is open to atmospheric pressure. Calculate the voltage at the burnout point if at this point the wire carries a current of 190A. **(10 Marks)**

Module-5

9 a. Define the following:
- i) Black body
- ii) Absorptivity
- iii) Intensity of radiation
- iv) Emissive power. **(08 Marks)**

b. Explain:
- i) Kirchoff law
- ii) Plank's law
- iii) Weins displacement law
- iv) Lambert's law. **(12 Marks)**

OR

10 a. Explain the concept of absorptivity, reflectivity and transmissivity. **(10 Marks)**

b. The effective temperature of a body having an area of $0.12m^2$ is 527°C. Calculate the following:
- i) The total rate of energy emission
- ii) The intensity of normal radiation
- iii) The wavelength of maximum monochromatic emission power. **(10 Marks)**

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