CBCS SCHEME

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15AE53

Fifth Semester B.E. Degree Examination, June/July 2023
Heat and Mass 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 handbook is permitted.*

Module-1

1 a. Explain the type of mass transfer with examples. **(06 Marks)**

b. Derive an equation for radiation exchange between two bodies. **(06 Marks)**

c. Briefly explain Fick's law of diffusion. **(04 Marks)**

OR

2 a. State Fourier's Law of conduction and formulate an equation of heat transfer through conduction. **(06 Marks)**

b. Explain combined heat transfer mechanism. **(06 Marks)**

c. Derive an equation for radiation heat transfer coefficient. **(04 Marks)**

Module-2

3 a. Derive the three dimensional general heat conduction equation in cylindrical coordinate system. **(08 Marks)**

b. Explain the effect of variable thermal conductivity on heat transfer in solids. **(08 Marks)**

OR

4 a. Explain the types of fins with applications. **(08 Marks)**

b. Derive an equation for an infinitely long fin of uniform cross section along the length. **(08 Marks)**

Module-3

5 a. Derive an equation in term of dimensionless numbers for heat transfer coefficient in the case of forced convection heat transfer. **(08 Marks)**

b. A flat plate is kept in an air stream at a temperature of 20°C. The velocity of air is 3m/s. The plate measures 50cm × 20cm and is maintained at a uniform temperature of 100°C. Compare the heat loss from the plate, when the air flour parallel to 50cm side and parallel to 20cm side. Also determine the percentage increase in heat loss. **(08 Marks)**

OR

6 a. In a thermal conductivity measuring experiment, 2 identical long rods are used. One rod is made up of aluminium with K = 200w/m-k. The other rod is a specimen. One end of both the rod is fixed to a wall at 100°C, while the other end is suspended in air at 25°C. The steady temperature at the same distance along the rods were measured and found to be 75°C on aluminium and 60°C on the specimen rod. Find the thermal conductivity for the specimen. Assume that the fin is insulated at the tip. **(08 Marks)**

b. Three 10mm diameter rods A, B and C protrude from a steam bath at 100°C to a length of 25cm into the atmosphere at 20°C. The temperature at the other ends are found to be 26.27°C for A, 32°C for B and 36.96°C for C. Neglecting the effect of radiation and assuming a surface heat transfer coefficient as 23w/m^{2}K, evaluate their thermal conductivity. **(08 Marks)**

Module-4

7 a. With assumptions, derive an expression for LMTD for a parallel flow heat exchanger. **(08 Marks)**

b. What is fouling factor in heat exchanger and what is the effect of it on heat exchanger? **(02 Marks)**

c. An oil cooler consists of straight tube of 2 cm outer diameter and 1.5 cm inner diameter, enclosed within a pipe and concentric with it. The external pipe is well insulated. The oil flows through the tube at 0.05 kg/s (C_p = 2 kJ/kg.K) and cooling fluid flows in the annulus in the opposite direction at the rate of 0.1 kg/s (C_p = 4.2 kJ/kg.K). The oil enters the cooler at 180°C and leaves at 80°C, while cooling liquid enter the cooler at 30°C. Calculate the length of the pipe required if heat transfer coefficient from oil to the surface is 1720 W/m^{2}K and from metal surface to coolant is 3450 W/m^{2}K. Neglect the resistance of the tube wall. **(06 Marks)**

OR

8 a. Explain : i) Stefan Boltzman law, ii) Black body. **(04 Marks)**

b. Obtain an expression for the rate of heat transfer when radiation shield is introduced between two parallel plates. **(06 Marks)**

c. Consider two large parallel plates, one at 1000 K with emissivity 0.8 and other is at 300 K having emissivity 0.6. A radiation shield is placed between them. The shield has emissivity 0.1 on the side facing hot plate and 0.3 on the side facing cold plate. Calculate percentage reduction in radiation heat transfer as a result of radiation shield. **(06 Marks)**

Module-5

9 a. Write a short note on Aerodynamic heating. **(08 Marks)**

b. The flow rate of hot and cold fluids running through a parallel flow heat exchanger are 0.2 and 0.5 kg/s respectively. The inlet temperature on the hot and cold sides are 75°C and 20°C respectively. The exit temperature of hot water is 45°C. If the individual heat transfer coefficient on both sides are 650 W/m^{2}K, calculate the area of heat transfer (for hot and cold fluid, C_p = 4.2 kJ/kg.K) **(08 Marks)**

OR

10 a. Explain diffusive mass transfer with neat diagram. **(08 Marks)**

b. Write a short note on Ablative heat transfer. **(08 Marks)**

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