CBCS SCHEME

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17AE53

Fifth Semester B.E. Degree Examination, Jan./Feb. 2021
Heat and Mass 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 handbook is permitted.***

Module-1

1 a. What are the different modes of heat transfer? Explain each of them with an example. **(10 Marks)**

b. Explain Newton's law of cooling and derive the governing equation for convective heat transfer. **(10 Marks)**

OR

2 a. Explain Fick's First law of diffusion and types of mass transfer with examples. **(10 Marks)**

b. Derive an equation for heat transfer through radiation. **(10 Marks)**

Module-2

3 a. Derive the three dimensional general heat conduction equation in Cartesian coordinates. **(10 Marks)**

b. In a thermal conductivity measuring experiment, two identical long rods are used. One rod is made of aluminium (K = 200 W/m.K). The other rod is a specimen. One end of both the rods 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° on specimen rod. Find K for the specimen. Assume that the rod is insulated at the tip. **(10 Marks)**

OR

4 a. Derive an expression for temperature distribution and heat flow through an infinity long fin with uniform cross section. **(10 Marks)**

b. A rod (K = 200 W/m°K), 5 mm in diameter and 5 cm long has its one end maintained at 100°C. The surface of the rod is exposed to ambient air at 25°C with convection heat transfer coefficient of 100 W/m^2K. Assuming other end is insulated, determine :

(i) The temperature of rod at 20 mm distance from the end at 100°C
(ii) Heat dissipation rate from the surface of the rod
(iii) Effectiveness. **(10 Marks)**

Module-3

5 a. Explain the physical significance of following non-dimensional numbers-Reynolds number, Nusselt number, Prandtl number, Stanton number, Pec let number. **(10 Marks)**

b. A flat plate is kept in an air stream at a temperature of 20°C. the velocity of air is 3 m/s. The plate measures 50 cm × 20 cm and is maintained at a uniform temperature of 100°C. Determine the heat loss from the plate when the air flows parallel to 50 cm side and parallel to 20 cm side. Also calculate the percentage increase in heat loss. **(10 Marks)**

OR

6 a. Explain the following:
(i) Velocity boundary Layer
(ii) Thermal Boundary Layer **(10 Marks)**

b. Air at 20°C and atmospheric pressure, is flowing with a velocity of 3 m/s along the length of a flat plate maintained at 60°C. Determine:
(i) Boundary layer thickness at 20 cm and 40 cm from the leading edge.
(ii) Mass entrainment rate between these two sections assuming a cubic velocity profile. **(10 Marks)**

Module-4

7 a. Obtain an expression for the rate of heat transfer, when a radiation shield is introduced between two parallel plates. **(10 Marks)**

b. 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. Determine the percentage reduction in radiation heat transfer as a result of radiation shield. **(10 Marks)**

OR

8 a. With assumptions, derive an expression for LMTD for a counter flow heat exchanger. **(10 Marks)**

b. A heat exchanger is used for cooling oil at 180°C using water available at 25°C. The mass flow rate of oil and water are 2.5 kg/s and 1.2 kg/s respectively. If the heat exchanger has 16 m^2 area available for heat transfer, determine the outlet temperature of oil and water for (i) Parallel flow arrangement (ii) Counter flow arrangement **(10 Marks)**

Module-5

9 a. Explain ablative heat transfer. **(10 Marks)**

b. 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)**

OR

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

b. Write a short note on Aerodynamic heating. **(10 Marks)**

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