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CBCS SCHEME

USN

17AE53

Fifth Semester B.E. Degree Examination, Jan./Feb. 2023
Heat and Mass Transfer

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

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

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

OR

2 a. Explain the Fourier's law of conduction and Stefan Boltzmann law. **(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. Derive an expression for temperature distribution and heat flow through an infinity long fin with uniform cross section. **(10 Marks)**

OR

4 a. In a thermal conductivity measuring experiment, two identical long rods are used. One rod is mode of aluminium (K = 206W/mK). The other rod is a specimen. One end of both the rods are 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 the K for the specimen. Assume that the rod is insulated at the tip. **(10 Marks)**

b. Consider a flow of water at rate of 0.015kg/s through a square duct 2cm × 2cm whose walls are maintained at 100°C. Determine length of duct required to heat water from 30°C to 70°C. **(10 Marks)**

Module-3

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

b. Calculate the convection heat loss from a radiator 0.5m wide and 1m high maintained at a temperature of 84°C in a room at 20°C. Treat the radiator as a vertical plate. **(10 Marks)**

OR

6 a. Explain the following: i) Velocity boundary layer ii) Thermal boundary layer iii) Thermal entry. **(10 Marks)**

b. Air at 20°C and atmospheric pressure, is flowing with velocity of 3m/s along the length of a flat plate maintained at 60°C. Determine:

i) Boundary layer thickness at 20cm and 40cm from the leading edge.

ii) Mass entrainment rate between these two sections assuming a cubic velocity profile. **(10 Marks)**

Module-4

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

b. Consider two large parallel plates, one at 1000K with emissivity 0.8 and other is at 300K 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. Obtain an expression for the rate of heat transfer, when a radiation shield is introduced between two parallel plates. **(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 coil and water are 2.5kg/s and 1.2kg/s respectively. If the heat exchanger has $16m^2$ area available for heat transfer, determine the outlet temperature of coil and water for i) Parallel flow arrangement ii) Counter flow arrangement. **(10 Marks)**

Module-5

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

b. Explain heat transfer concept in

i) Rocket thrust chamber

ii) Gas turbine combustion chamber. **(10 Marks)**

OR

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

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

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