December 2022

B.Tech. (ME) – Vth SEMESTER

Heat and Mass Transfer (PCC-ME-501-21)

[Max. Marks : 75

Time : 3 Hours]

Instructions :

1. *It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.*
2. *Answer any four questions from Part-B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*
4. *Use of scientific calculator is allowed.*
5. *Use of heat and mass transfer data book is allowed.*

PART–A

1. (a) What is thermal diffusivity? (1.5)

   (b) What do you understand from the term boundary condition? (1.5)

   (c) Define fin efficiency. (1.5)

   (d) Define the Biot and Fourier numbers. (1.5)

   (e) What is meant by a hydrodynamic boundary level? (1.5)

   (f) What is the physical mechanism of viscous action? (1.5)

   (g) How does thermal radiation differ from other types of electromagnetic radiation? (1.5)

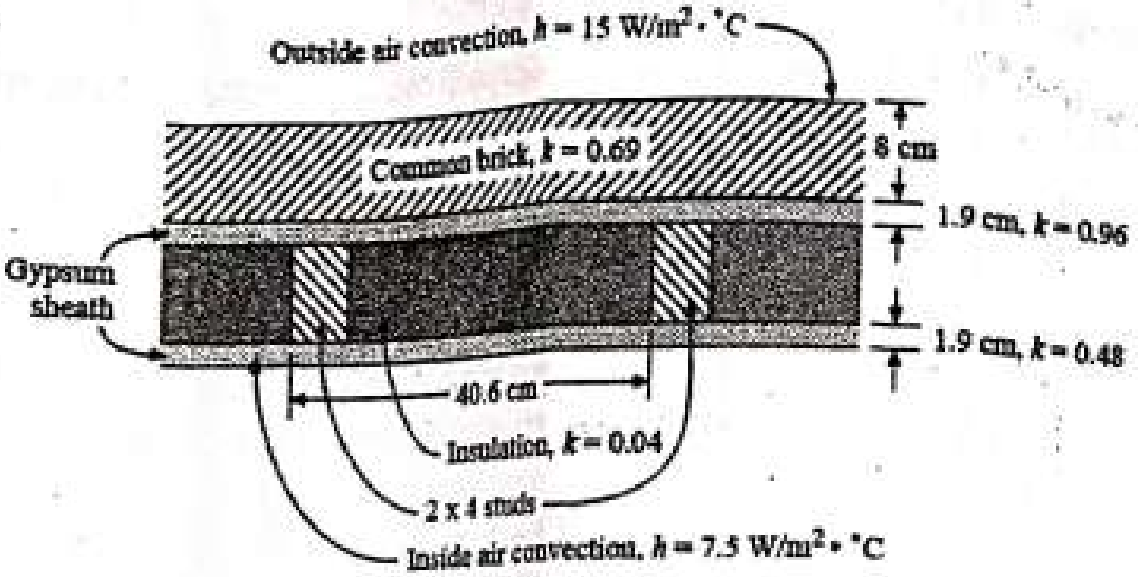
   (h) What advantage does the effectiveness-NTU method have over the LMTD method? (1.5)

(i) What is meant by subcooled and saturated boiling? (1.5)

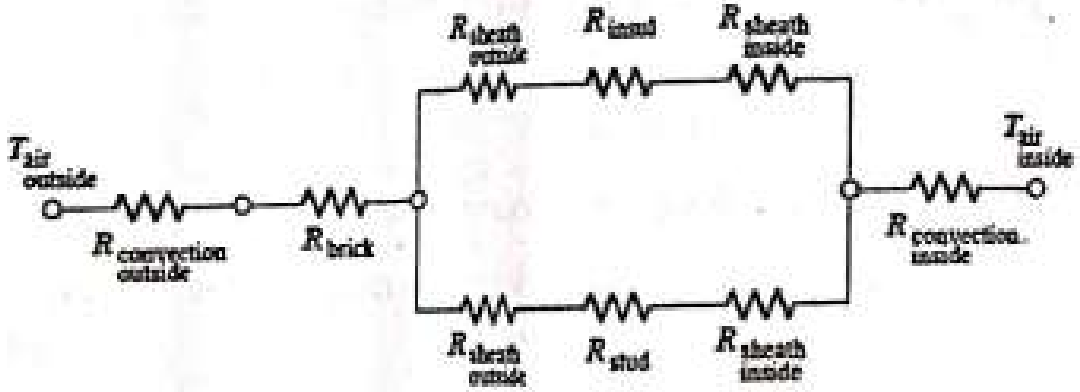
(j) How is the diffusion coefficient defined? (1.5)

PART–B

2. A typical wall for a house is constructed as shown in the following Figure. (15)



(a) Construction of a dwelling wall



(b) Thermal resistance model

"Two-by-four" wood studs have actual dimensions of 4.13 cm × 9.21 cm and thermal conductivity of 0.1 W/m.°C. Calculate the overall heat-transfer coefficient and R value of the wall.

3. (a) What is meant by a lumped capacity? What are the physical assumptions necessary for a lumped-capacity unsteady-state analysis to apply? (5)

(b) Air at 27°C and 1 atm flow over a flat plate at a speed of 2 m/s. Calculate the boundary-layer thickness at distances of 20 cm and 40 cm from the leading edge of the plate. Calculate the mass flow that enters the boundary layer between x = 20 cm and x = 40 cm. The viscosity of air at 27°C is 1.85×10^{-5} kg/m.s. Assume unit depth in the z direction. (10)

4. (a) What is the use of the numerical method in heat transfer analysis? How complex geometry is solved with the help of numerical methods? What is the use of computer programming tools in solving heat transfer problems? (10)

(b) Why are higher heat-transfer rates experienced in dropwise condensation than in film condensation? (5)

5. (a) Explain the greenhouse effect. (5)

(b) Two concentric cylinders having diameters of 10 and 20 cm have a length of 20 cm. Calculate the shape factor between the open ends of the cylinders. (10)

6. (a) Explain the construction and working of a heat pipe with suitable diagrams. What are its benefits and limitations? (10)

(b) Why is a counterflow exchanger more effective than a parallel-flow exchanger? Discuss with suitable data and diagrams. (5)

7. What is boiling? Distinguish between nucleate and film boiling. Discuss the heat transfer phenomena in different types of heat exchangers with suitable data and diagrams. (15)
