Sr. No. 013503

July 2025

B.Tech.- Vth SEMESTER

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

Time: 3 Hours | Max. Marks:75

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. *The use of the scientific calculator is allowed.*
5. *Use of heat and mass transfer data book is allowed.*

PART -A

Q1 (a) What do you understand by radiation heat transfer? (1.5)

(b) What is the importance of the critical radius of insulation in heat transfer? (1.5)

(c) What is the difference between natural and forced convection? (1.5)

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

(e) What is the phenomenon of condensation? (1.5)

(f) What is meant by a hydrodynamic boundary layer? (1.5)

(g) What is the significance of boundary conditions in solving heat transfer problems? (1.5)

(h) What is the importance of the Reynolds number in heat transfer analysis? (1.5)

(i) What are the two main dimensionless numbers used in the design of heat exchangers? (1.5)

(j) How do partial differential equations differ from ordinary differential equations? (1.5)

PART -B

Q2 A current of 250A is passed through a stainless-steel wire [k =19 W/mK] and 4 mm in diameter. The resistivity of the steel may be taken as 70 μΩ cm, and the length of the wire is 1 m. The wire is submerged in a liquid at 120°C and experiences a convection heat-transfer coefficient of 5 kW/m^2 K. Calculate the center temperature of the wire. (15)

Q3 What is heat? What are the three modes of heat transfer? Explain them using mathematical expressions and suitable examples. (15)

Q4 What is the Finite Difference Method (FDM)? How is it applied in heat transfer analysis? Why is the finite difference method preferred for solving certain heat transfer problems over analytical methods? What is the role of mesh size (Δx, Δt) in FDM simulations? How does it affect results? (15)

Q5 What are the primary industrial applications of heat exchangers? Please provide a comprehensive discussion, supported by relevant diagrams. Additionally, please detail the commonly utilised methods for the design of heat exchangers. A comparative analysis of these design methods should be included, outlining their respective advantages and limitations. (15)

Q6 Explain the construction and working of the heat pipe with a suitable diagram. Also, discuss the benefits and limitations of the heat pipe. (15)

Q7 Write a short note on the following: (5X3 =15)

a. Wien's Displacement Law
b. Stefan–Boltzmann's Law
c. Black and gray body radiation

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