J C Bose University of Science and Technology, YMCA, Faridabad

Mechanical Engineering Department

Heat Transfer (PCC-ME-501/21)

Sessional 1st (September 2025)

Maximum Marks: 30 Maximum Time: 90 Minutes

Note: Attempt any three questions.

Q1. Steam at a temperature of 350 °C flows in a pipe of thermal conductivity k = 80 W/m°C, having an internal diameter of 5.0 cm and an external diameter of 5.6 cm. The convective heat transfer coefficient from inside the pipe is $h_i = 60$ W/m^2°C. It is covered with a 3 cm thick insulation which has a thermal conductivity of 0.05 W/m°C. Surrounding temperature is 5 °C. Heat is lost to the surroundings by natural convection and radiation with a combined heat transfer coefficient $h = 60$ W/m^2°C. Calculate:

(i) The rate of heat loss from the pipe per unit length

(ii) The temperature drop across the pipe and the insulation

(10)

Q2. What is the significance of lumped system analysis? Discuss how it simplifies the analysis of transient heat conduction problems. Provide mathematical expressions to illustrate the concept, such as the lumped capacitance model and its application to determine temperature changes over time for a solid body subject to heating or cooling. (10)

Q3. Discuss the criteria for selecting fins. What is the difference between fin effectiveness and fin efficiency? Additionally, derive the mathematical expression used to measure the thermal performance of a fin. (10)

Q4. Write a short note on the following: (2X5 = 10)

(i) Thermal Diffusivity

(ii) Steady state and equilibrium

(iii) Isotropic Solid

(iv) Biot number

(v) Critical radius of insulation