

JK Lakshmipat University Jaipur
INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination, April, 2019

Heat Transfer

B. Tech. in Mechanical Engineering, Semester IV

Roll No.

Course Code : ME408

Time: 3 hours

Max. Marks: 60

Instructions to students:

Do not write anything other than your roll number on question paper.

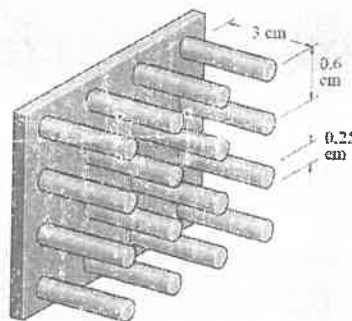
Assume suitable data wherever required and mention it clearly.

Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.

- Q.1 a) You are making tea at home. Explain different heat transfer phenomena you observe. Draw the heat/temperature profile up to burnout. 05
LO1
b) You burnt your finger while helping your mother making chapati. What are different possible modes of cooling, and what are different modes of heat transfer you will observe.
- Q.2 Two very large parallel plates are maintained at uniform temperatures $T_1 = 800$ K and $T_2 = 500$ K and have emissivities 0.2 and 0.7, respectively. Determine the net rate of radiation heat transfer between the two surfaces per unit surface area of the plates. 05
LO6
- Q.3a Consider a 0.8-m-high and 1.5-m-wide double-pane window consisting of two 4-mm-thick layers of glass ($k = 0.78$ W/m $\cdot$ $^{\circ}$ C) separated by a 10-mm-wide stagnant air space ($k = 0.026$ W/m $\cdot$ $^{\circ}$ C). Determine the steady rate of heat transfer through this double-pane window and the temperature of its inner surface for a day during which the room is maintained at 20° C while the temperature of the outdoors is -10° C. Take the convection heat transfer coefficients on the inner and outer surfaces of the window to be $h_1 = 10$ W/m² $\cdot$ $^{\circ}$ C and $h_2 = 40$ W/m² $\cdot$ $^{\circ}$ C, which includes the effects of radiation. 10
LO2

OR

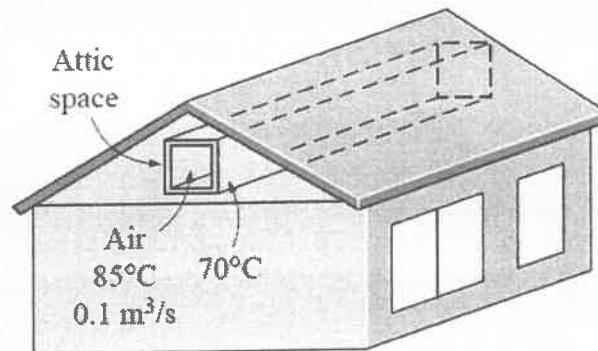
- Q.3b A hot surface at 100° C is to be cooled by attaching 3-cm-long, 0.25-cm-diameter aluminum pin fins ($k = 237$ W/m $\cdot$ $^{\circ}$ C) to it, with a center-to-center distance of 0.6 cm. The temperature of the surrounding medium is 30° C, and the heat transfer coefficient on the surfaces is 35 W/m² $\cdot$ $^{\circ}$ C. Determine the rate of heat transfer from the surface for a 1-m $\times$ 1-m section of the plate. Also determine the overall effectiveness of the fins.



- Q.4 During a picnic on a hot summer day, all the cold drinks disappeared quickly, and the only available drinks were those at the ambient temperature of 25° C. In an effort to cool a 375 ml drink in a can, which is 12 cm high and has a diameter of 60 mm, a person grabs the can and starts shaking it in the iced water at 0° C. 10
LO2

The temperature of the drink can be assumed to be uniform at all times, and the heat transfer coefficient between the iced water and the aluminum can is $150 \text{ W/m}^2 \text{ } ^\circ\text{C}$. Using the properties of water for the drink, estimate how long it will take for the canned drink to cool to 7°C .

- Q.5 During a cold winter day, wind at 55 km/h is blowing parallel to a 4-m -high and 10-m -long wall of a house. If the air outside is at 5°C and the surface temperature of the wall is 12°C , determine the rate of heat loss from that wall by convection. What would your answer be if the wind velocity was doubled? 10
LO3,4
- Q.6 Hot air at atmospheric pressure and 85°C enters a 10-m -long un-insulated square duct of cross section $0.15 \text{ m} \times 0.15 \text{ m}$ that passes through the attic of a house at a rate of $0.10 \text{ m}^3/\text{s}$. The duct is observed to be nearly isothermal at 70°C . Determine the exit temperature of the air and the rate of heat loss from the duct to the air space in the attic. 10
LO3,4



- Q.7a A counter-flow double-pipe heat exchanger is to heat water from 20°C to 80°C at a rate of 1.2 kg/s . The heating is to be accomplished by geothermal water available at 160°C at a mass flow rate of 2 kg/s . The inner tube is thin-walled and has a diameter of 1.5 cm . If the overall heat transfer coefficient of the heat exchanger is $640 \text{ W/m}^2 \text{ } ^\circ\text{C}$, determine the length of the heat exchanger required to achieve the desired heating. 10
LO3

OR

- Q.7b The bottom of a copper pan, 150 mm in diameter, is maintained at 115°C by the heating element of an electric range. Estimate the power required to boil the water in this pan. Determine the evaporation rate. What is the ratio of the surface heat flux to the critical heat flux? What pan temperature is required to achieve the critical heat flux? 10
LO4,5