

Birzeit University
Mechanical & Mechatronics Engineering Department
Heat Transfer ME 431

Homework # 5 Convection chapter 6

Instructor: Dr. Afif Hasan

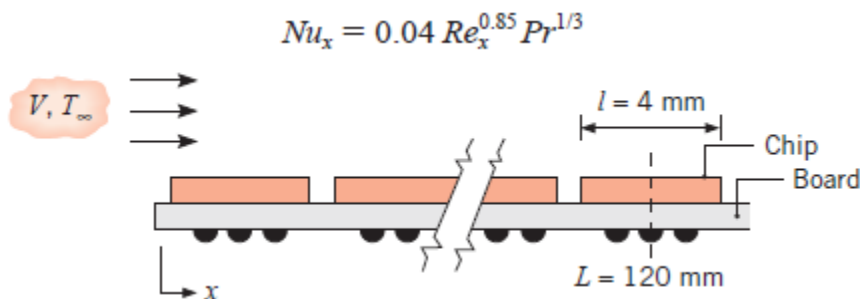
6.4 Water at a temperature of $T_\infty = 25^\circ\text{C}$ flows over one of the surfaces of a steel wall (AISI 1010) whose temperature is $T_{s,1} = 40^\circ\text{C}$. The wall is 0.35 m thick, and its other surface temperature is $T_{s,2} = 100^\circ\text{C}$. For steady state conditions what is the convection coefficient associated with the water flow? What is the temperature gradient in the wall and in the water that is in contact with the wall? Sketch the temperature distribution in the wall and in the adjoining water.

6.32 Experimental results for heat transfer over a flat plate with an extremely rough surface were found to be correlated by an expression of the form

$$Nu_x = 0.04 Re_x^{0.9} Pr^{1/3}$$

where Nu_x is the local value of the Nusselt number at a position x measured from the leading edge of the plate. Obtain an expression for the ratio of the average heat transfer coefficient to the local coefficient h_x .

6.39 Forced air at $T_\infty = 25^\circ\text{C}$ and $V = 10 \text{ m/s}$ is used to cool electronic elements on a circuit board. One such element is a chip, 4 mm = 4 mm, located 120 mm from the leading edge of the board. Experiments have revealed that flow over the board is disturbed by the elements and that convection heat transfer is correlated by an expression of the form



Estimate the surface temperature of the chip if it is dissipating 30 mW.

6.45 A thin, flat plate that is 0.2 m x 0.2 m on a side is oriented parallel to an atmospheric airstream having a velocity of 40 m/s. The air is at a temperature of $T_\infty = 20^\circ\text{C}$, while the plate is maintained at $T_s = 120^\circ\text{C}$. The airflows over the top and bottom surfaces of the plate, and measurement of the drag force reveals a value of 0.075 N. What is the rate of heat transfer from both sides of the plate to the air?