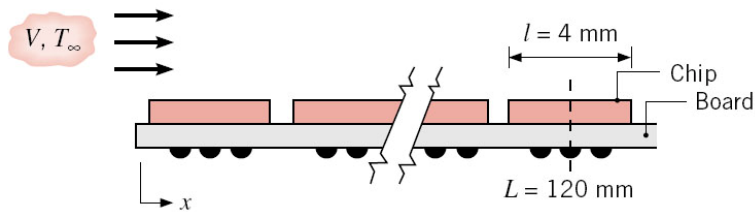


MAE 3314: Heat Transfer

Homework #6 (Due date – 11/1/07) Key Assignment

1. [10 pts] 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, 4mm by 4mm, located 120mm from the leading edge of the board. A chip is dissipating 30 mW. Experiments have revealed that flow over the board is distributed by the elements and that convection heat transfer is correlated by the elements and that convection heat transfer is correlated by an expression of the form $Nu_x = 0.04 Re_x^{0.85} Pr^{1/3}$.

The cooling condition listed above was designed at atmospheric pressure (= 1 atm).



- (a) Estimate the surface temperature of the chip located 120 mm from the leading edge of the board when the board is operated at 76.5 kPa.

- (b) It is desirable for the chip operating temperature to be independent of the location. What air velocity is required for operation at 76.5 kPa if the chip temperature is to be the same as at 1 atm?

* At 1 atm, 35°C ($= T_f = (45^\circ\text{C} + 25^\circ\text{C})/2$), air has values of: $k = 0.0269 \text{ W/m}\cdot\text{K}$, $\nu = 16.69 \times 10^{-6} \text{ m}^2/\text{s}$, $Pr = 0.706$ (From Table A.4)

* Assume that the average heat transfer coefficient for the chip surface is equivalent to the local value at $x=L$.

* Assume that air has ideal gas behavior.

2. [10 pts] Nitrogen at 100°F and 1 atm flows at a velocity of 10fps. A flat plate 6 in wide, at a temperature of 200°F , is aligned parallel to the direction of flow. At a position 4 ft from the leading edge, determine the following:

(a) δ

(b) δ_t

(c) $C_{f,x}$

(d) $\bar{C}_{f,L}$

(e) h_x

(f) \bar{h}_L

(g) total drag force

(h) total heat transfer