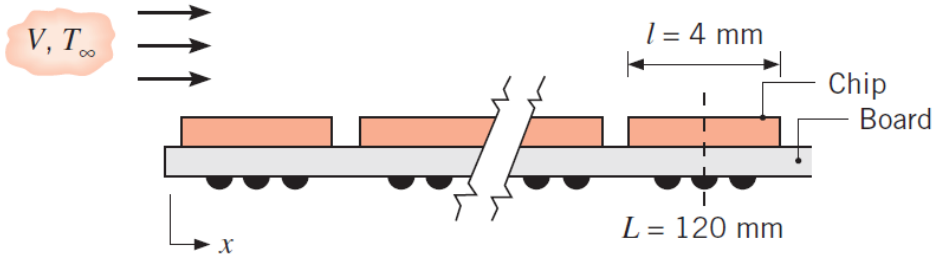
ME 331 Homework Assignment #4
Due Friday April 28, by 5 pm in MEB main office

1. Hot electronic elements on a circuit board can be cooled by blowing air on them. Consider forced air at a temperature $T_\infty = 20^o C$ flowing at a speed $V = 10\ m/s$ over a circuit board. Consider a board with chips, with area 4x4 mm^2, located 120 mm from the leading edge of the board. Experimentally you can find that the chips disturb the flow over the board and that the heat transfer is correlated by an expression of the form:

$$Nu_x = 0.04\, Re_x^{0.85} Pr^{1/3}$$



Estimate the chip's surface temperature if it is dissipating 40 mW.

2. Consider the circuit boards in the previous problem. The system was designed and tested in Seattle (at sea level, $p \approx 1\ atm$) but you want to ship it to costumers in La Paz, Bolivia, which is at an average elevation of 3650 m above sea level ($p \approx 0.64\ atm$)
(a) Estimate the surface temperature of the chip located 120 mm from the leading edge of the board when the board is operated in La Paz. Note that thermo-physical properties depend on pressure
(b) It is desirable for the chip operating temperature to be independent of the location of the customer. What air velocity is required for operation in La Paz if the chip temperature is to be the same as at sea level?

3. Air at 20°C is flowing over a flat plate with a surface temperature of 100°C. At a specific location, the air temperature is measured as a function of distance normal to the surface of the plate. The experimental results are plotted in the figure below. From these data, determine the local heat transfer coefficient at this location at the plate surface. What is the heat flux q'' at this location and the thermal boundary layer thickness δ_t?