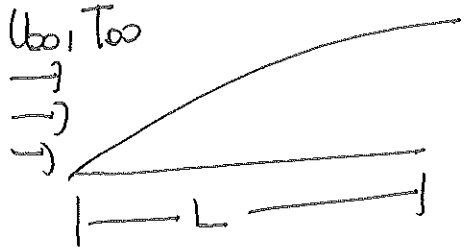
Cankaya University
Faculty of Engineering
Mechanical Engineering department
ME 313 Heat transfer

Quiz 7
Fall 2017

Atmosheric air at 20 ^{0}C flows with a velocity of 2 m/s over the 3 m by 3 m surface of a wall which absorbs solar energy flux at a rate of 800 W/m^2 and dissipates heat only by convection into air stream. Assuming that the sides an the back of the wall are insulated, determine the average temperature of the wall under equilibrium conditions.



$T_\infty = 20^\circ C$
$U_\infty = 2\ m/s$
$L = W = 3\ m$
$q'' = 800\ W/m^2$

$\nu = 1.581 \times 10^{-5}\ m^2/s$
$k = 0.02568\ W/m^\circ C$
$Pr = 0.71$

$Re_L = \frac{U_\infty L}{\nu} = \frac{(2)(3)}{1.581 \times 10^{-5}} = 3.8 \times 10^5 < 500\,000$ laminar flow

$\overline{Nu}_L = \frac{\bar{h} L}{k} = 0.664 \sqrt{Re_L}\, Pr^{1/3}$

$= 0.664 (3.8 \times 10^5)^{1/2} (0.71)^{1/3} = 365$

$\bar{h} = \frac{k}{L} \overline{Nu}_L = \frac{0.02568}{3} (365) = 3.13\ W/m^2{}^\circ C$

$\therefore G'' = q_c = \bar{h} A_s (T_w - T_\infty)$

$800 = 3.13 (T_w - 20) \Rightarrow T_w = 275^\circ C$