CANKAYA UNIVERSITY
FACULTY OF ENGINEERING
MECHANICAL ENGINEERING DEPARTMENT

ME 313 HEAT TRANSFER

FALL 2016

QUIZ ON CHAPTER 7

Engine oil (unused) at 27 ^{0}C is forced to flow over 30 cm by 20 cm plate at a velocity of 1.5 m/s. The flow is parallel to the 30 cm side of the plate and the plate is heated to a uniform temperature of 67 ^{0}C. Calculate the heat transfer from the plate oil.

$T_f = \frac{T_w + T_\infty}{2} = \frac{27+67}{2} = 47^\circ C = 320 K$

$\rho = 871.8\ kg/m^3 \quad c_p = 1.993\ J/kg\,K$

$\mu = 14.1 \times 10^{-2}\ N.s/m^2 \quad k = 0.143\ W/mK$

$Pr = 1965$

Pr is high so Let us use

$$\overline{Nu}_L = \frac{0.6774\sqrt{Re_L}\,Pr^{-1/3}}{\left[1+\left(\frac{0.0468}{Pr}\right)^{2/3}\right]^{1/4}}$$

$Re_L = \frac{\rho V_\infty L}{\mu} = \frac{(871.8)(1.5)(0.3)}{14.1\times10^{-2}} = 2782 < 500\,000$ laminar flow

$$\overline{Nu}_L = \frac{(0.6774)\sqrt{2782}\,(1965)^{1/3}}{\left[1+\left(\frac{0.0468}{1965}\right)^{2/3}\right]^{1/4}} = 48.74$$

$\bar{h} = \frac{k}{L}\overline{Nu}_L = (0.143/0.3)(48.74) = 23\ W/m^2K$

$q = \bar{h}A(T_w - T_\infty) = (23)(0.3)(0.2)(67-27)$

$= 55\ W$