Cankaya University

Faculty of Engineering

Mechanical Engineering Dpartment

ME 613 Advanced Convective Heat Transfer

Fall 2017

HW# 2

1) Air flows at a velocity of 10 m/s over a flat plate. The plate length in the flow direction is 10 cm. Free stream temperature of air ahead of the plate is $15\,^{0}\mathrm{C}$ and the plate surface temperature is $85\,^{0}\mathrm{C}$. Using similarity solutions developed:

a) plot the variation of local heat transfer rate in $\mathrm{W/m^2}$ along the flow direction.
b) plot the velocity and temperature profiles in the boundary layer on the plate at a distance of $5\,\mathrm{cm}$ from the leading edge of the plate.
c) Calculate the average heat transfer rate from the plate

2) Air flows over a flat plate at a velocity of 10 m/s. The plate length in the flow direction 4 cm and plate width is 1 m. A uniform heat flux of $4\,\mathrm{kW/m^2}$ is applied to plate. Using the similarity solution results, plot the variation of local plate surface temperature along the plate. The free stream temperature ahead of the plate is $20\,^{0}\mathrm{C}$.

3) Air flows over a flat plate with a velocity of $10\,\mathrm{m/s}$ .The plate length in the flow direction is 20 cm and plate width is $1\,\mathrm{m}$. Free stream temperature of the air ahead of the plate is $10\,^{0}\mathrm{C}$ and plate surface temperature variation is

$$T_w(x) = 10 + 0.4\,x\ ^{0}\mathrm{C}$$

where x is the distance measured from the leading edge of the plate in m. Using the similarity solution results, plot the variation of local heat transfer rate in $\mathrm{W/m^2}$ along the plate.

4) Using the following velocity and temperature profiles for flow over a flat plate

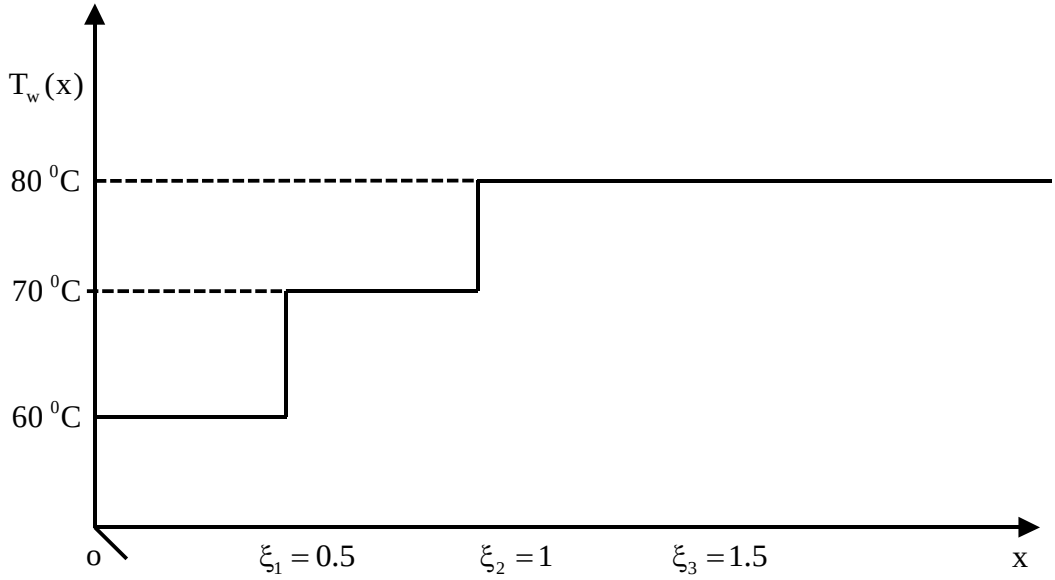
$$\frac{u}{U_\infty} = \cos\left(\frac{\pi}{2} - \pi\left(\frac{y}{\delta}\right)\right)$$

$$\frac{T - T_\infty}{T_\infty - T_w} = \frac{3}{2}\left(\frac{y}{\Delta}\right) - \frac{1}{2}\left(\frac{y}{\Delta}\right)^3$$

determine

a) Velocity boundary layer thickness
b) Displacement thickness
c) Momentum thickness
d) Skin friction coefficient
e) Thermal boundary layer thickness
f) Nusselt number

5) Air flows over a flat plate with a velocity of 6 m/s .Free stream temperature of the air ahead of the plate is $20\,^{0}\mathrm{C}$. Length of the plate in the flow direction is $2\,\mathrm{m}$ Surface temperature of a plate is given as



Determine the local heat flux at $x = 2$ m

6) Construct an approximate solution for laminar flow over a flat plate with constant free stream velocity and a simple step in surface temperature at some point ,determine the local Nusselt number for Pr=0.7 and with variable surface temperature as given $T_w(x) - T_\infty = x$. Use superposition theory.