Solution to Problem 241A

For a wedge flow, the relation between the velocity outside the boundary layer, U, and the distance from the vertex, x, is

$$U = Cx^m$$

where C is a constant and m is related to the half-angle of the wedge, θ, by

$$\theta = \frac{\pi m}{m+1}$$

so that

$$m = \frac{\theta}{\pi - \theta}$$

Thus for the wedge angles $\pi/10$, $\pi/4$ and $\pi/2$ it follows that $m_1 = 1/9$, $m_2 = 1/3$ and $m_3 = 1$ respectively. To determine the laminar boundary layer thickness, $\delta_{0.99}$, we seek the values of $(2(m+1))^{1/2}\eta_{0.99}$ from the graph at which $u/U = 0.99$. Then the value of $\delta_{0.99}$ can be calculated from:

$$\eta_{0.99} = \delta_{0.99}\left(\frac{U}{4\nu x}\right)^{1/2} = \frac{1}{2}\delta_{0.99}\left(\frac{c}{\nu}\right)^{1/2} x^{\frac{m-1}{2}}$$

and $\delta_{0.99}$ is given by:

$$\delta_{0.99} = 2\eta_{0.99}\left(\frac{v}{c}\right)^{1/2} x^{\frac{1-m}{2}}$$

α	m	$(2(m+1))^{1/2}\eta_{0.99}$	$\eta_{0.99}$	$\delta_{0.99}$
$\pi/10$	1/9	3.2	2.15	$4.3\left(\frac{v}{c}\right)^{1/2} x^{4/9}$
$\pi/4$	1/3	2.9	1.78	$3.6\left(\frac{v}{c}\right)^{1/2} x^{1/3}$
$\pi/2$	1	2.4	1.2	$2.4\left(\frac{v}{c}\right)^{1/2}$