Problem 250C

A laminar boundary layer subjected to a favorable pressure gradient is to be approximated by a profile of the form :

$$\frac{u}{U} = 3\left(\frac{y}{\delta}\right) - 3\left(\frac{y}{\delta}\right)^2 + \left(\frac{y}{\delta}\right)^3 \quad \text{for} \quad 0 < y < \delta$$

$$\frac{u}{U} = 1 \quad \text{for} \quad y > \delta$$

Find the profile parameters α, β and γ for this profile. Substitute into the Karman momentum integral equation to find the differential equation involving $U(x)$ which must be satisfied by $\delta(x)$. If $U(x) = Cx^{\frac{1}{9}}$ the solution of this equation is of the form $\delta(x) = Ax^{\frac{4}{9}}$. Show that this is so and find A (in other words the solution to the problem) in terms of C and the kinematic viscosity, ν.

Compare this answer for $\delta(x)$ with the value of $\delta_{0.99}$ from the Faulkner-Skan solution: