Problem 250Z

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

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

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

Use approximate boundary layer methods to develop the differential equation for $\delta(x)$ (it involves $U(x)$).

If $U(x) = Cx^{\frac{1}{9}}$ the solution of this equation is of the form $\delta(x) = Ax^k$. Find A and k, in other words the solution to the problem, in terms of C and the kinematic viscosity, ν.

Postscript: In order to save time, it is not necessary for you to numerically evaluate the profile parameters, α, β and γ, provided you give complete and precise definitions of these quantities.