## Problem 271A

The velocity profile in a turbulent boundary layer of incompressible fluid on a flat plate ($U$ = constant) is to be approximated by the form:

$$u/U = (y/\delta)^{\frac{1}{7}}$$

[Disregard the fact that this does not exactly satisfy one of the constraints usually imposed on laminar boundary layer profiles namely that $du/dy$ should tend to zero as $y$ tends to $\delta$]. Find the profile parameter $\alpha$ for this profile. If the wall shear stress, $\tau_w$, for this turbulent profile is assumed to be given by the empirical formula

$$\tau_w = 0.023\rho U^2(\nu/\delta U)^{\frac{1}{4}}$$

where $\rho$ and $\nu$ are the fluid density and kinematic viscosity, then solve the resulting Karman momentum integral equation to obtain an expression for the thickness of the boundary layer, $\delta$, as a function of distance, $x$, along the plate. Assume that the layer first becomes turbulent at $x = x_0$ where the thickness is $\delta_0$.

[Do not use $\tau_w = \mu(du/dy)_{y=0}$ which is inappropriate in turbulent boundary layer calculations.]