Problem 250F

A laminar boundary layer in a planar, incompressible flow experiences a velocity, U, external to the boundary layer which increases with distance, x, measured along the surface as follows:

$$U = Ax^{\frac{1}{2}}$$

where A is a known constant.

Approximate boundary layer methods (the Karman momentum integral equation) are to be used to find the boundary layer thickness, δ. An approximate velocity profile is assumed and the profile parameters, α, β, and γ, are calculated. Assume that this has been done and that α, β, and γ are known.

The answer is that the boundary layer thickness is given by

$$\delta = Cx^m$$

where C and m are constants. Determine the index m. Find the constant C as a function of A, α, β, γ, and the kinematic viscosity, ν, of the fluid.