Problem 270D

Using the hypothesis that the thickness of the laminar sublayer, δ_{LSL}, is defined by the distance from the wall at which the laminar viscous shear stress is equal to the Reynolds shear stress, find an expression for δ_{LSL}/R for the turbulent flow in a cylindrical pipe (of radius, R) in terms of the Reynolds number, $2RV/\nu$, and the friction factor, f. Here, V, is the volume-averaged velocity of flow in the pipe and ν is the kinematic viscosity of the fluid. Use Prandtl's mixing length hypothesis (the expression includes the universal constant, κ) but do not use the universal velocity profile or any experimental data. Compare your expression with that obtained using a laminar sub-layer thickness defined by $y^* = 5$.