Problem 5.1: The Kolmogorov microscale, the viscous sublayer, and the inertial sublayer

Consider a fully developed, turbulent flow in a smooth-walled, circular pipe of radius a.

(a) Suppose we define a nominal thickness δ_ν of the visous sublayer to be equivalent to $y_+=5$. On a log-log plot, show the ratio δ_ν/a of the viscous sublayer to the pipe radius for Reynolds number based on diameter from 2000 to 1,000,000. You may used Blasius's formula for friction factor.

(b) Suppose we say, somewhat arbitrarily, that the shear stress is approximately constant within a distance of the order of $0.1a$ from the wall (by what fraction of itself does the stress actually vary in this region?), and that the inertial (logarithmic) sublayer starts at $y_+=50$. Based on these considerations and the Blasius friction factor correlation, how high do you estimate that the Reynolds number $Re=u_{av}(2a)/\nu$ must be for there to be room for any inertial sublayer at all in the inner region of the flow? Comment.