Supplementary Homework Problem (HW Set 21)

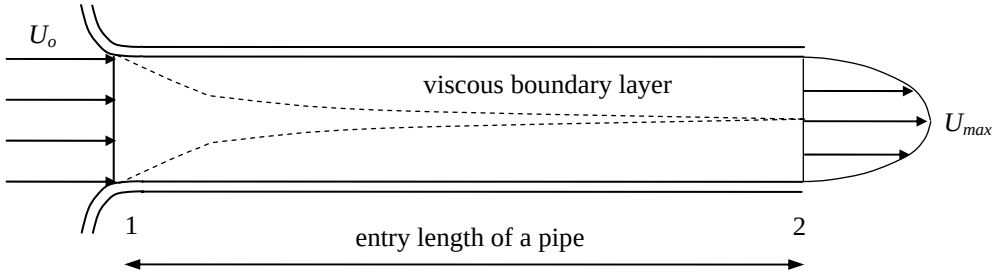
Due at the beginning of Lecture 23

Drag analysis over the entry length of a circular pipe

At the entrance of a circular pipe, a flow develops from a uniform velocity profile, U_o, at (1), the pipe entrance, to a fully-developed parabolic profile

$$u(r) = U_{\max}\left(1 - \frac{r^2}{R^2}\right)$$ at (2), the end of entry length section.

where R is the inside radius of the circular pipe. In this problem, your goal is to determine the total drag force on the pipe over this entry length section. The solution strategy will follow a 3-step guided approach.



a) Apply conservation of mass to express $U_{\max}$ in terms of U_o.

b) Apply Bernoulli's equation to determine the pressure drop from Station 1 to Station 2, *i.e.* $P_1 - P_2$.

c) Apply conservation of linear momentum to determine the total drag force on the pipe over the entry length section.