Assignment #3

Determine the below mentioned velocity profile using appropriate boundary conditions. Then, calculate the boundary layer thickness and drag coefficient for each velocity profile.

a) Third order polynomial velocity profile
b) Quartic function velocity profile
c) Sinusoidal velocity profile

We have four conditions that a proposed velocity profile should satisfy:

$$\begin{aligned} u &= 0 && \text{at} \quad y = 0 \\ u &= U_\infty && \text{at} \quad y = \delta \\ \frac{\partial u}{\partial y} &= 0 && \text{at} \quad y = \delta \\ \frac{\partial^2 u}{\partial y^2} &= 0 && \text{at} \quad y = 0 \end{aligned} \tag{8.6.9}$$

The first three of these conditions are obvious from a sketch of a velocity profile; the fourth condition comes from the x-component Navier–Stokes equation (5.3.14) since $u = v = 0$ at the wall, $\partial^2 u/\partial x^2 = 0$ on the wall, and $dp/dx = 0$ for the steady flow on the flat plate under consideration.