Advanced Transport Phenomena 1

ChE 862 **March 1, 2019** **Spring 2019**

Due March 8, 2019

Application of Prandtl's equation for the laminar boundary layer to the free jet. Please see section 4.5 in the textbook.

The similarity transformation can be applied to a variety of flow phenomena, including the free jet. Consider a laminar jet issuing from a narrow rectangular slot located on a vertical wall. The jet flows into an extensive reservoir containing a viscous fluid at rest. Momentum is transferred from the jet toward its periphery and the jet expands (vertically) as the central core energy decays. Let the x-coordinate correspond to the axis of the jet and the y-axis be coincident with the vertical wall. As we saw in class, the similarity transformation is successful in this case resulting in eq. (4.29), a third-order, nonlinear, ordinary differential equation:

$$f''' + ff'' + f'^2 = 0\,.$$

Although the analytic solution for this problem is known, *we will find the velocity distribution for this case by numerical solution of (4.29).* Make special note of the point of inflection present in the profile; this will be important to us later. Take the kinematic viscosity of the fluid (ν) be 0.15 cm^2/s and let us *require* that the centerline velocity at x=1 cm be v_x=2 cm/s. Use the results of your computations to prepare a graph illustrating $v_x(x,y)$ for x=1 and x=10 cm. What is the *maximum positive* value of v_y at x=1 cm, and exactly where is that maximum located?