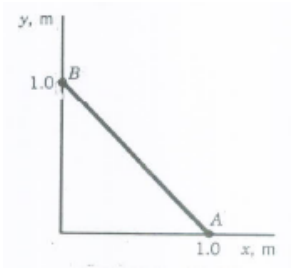
ME322: Homework #1 ~~Due January 20~~

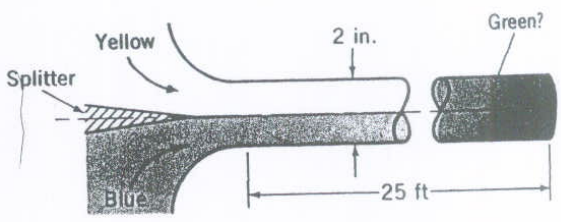
1. Determine the vorticity field for the following velocity vector:
   $V = (x^2 - y^2)\, i - 2xy\, j$

2. The stream function for an incompressible, two-dimensional flow field is
   $\Psi = ay^2 - bx$
   where a and b are constants. Is this an irrotational flow? Explain.

3. The stream function for an incompressible flow is given the by the equation
   $\Psi = 3x^2y - y^3$
   where the stream function has the units of m2/s with x and y in meters.
   a. Sketch the streamline(s) passing through the origin.
   b. Determine the rate of flow across the straight path AB shown in the figure below.



4. Blue and yellow streams of paint at 60°F (each with a density of 1.6 slugs/ft^3 and a viscosity 1000 greater than water) enter a pipe with an average velocity of 4 ft/s as shown in the figure below. Would you expect the paint to exit the pipe as green paint or separate streams of blue and yellow paint? Explain. Repeat the same problem if the paint were "thinned" so that it is only 10 times more viscous than water. Assume the density remains the same.



5. Air at 200°F flows at standard atmospheric pressure in a pipe at a rate of 0.08 lb/s. Determine the minimum diameter allowed if the flow is to be laminar.

6. The pressure drop needed to force water through a horizontal 1-in.-diameter pipe is 0.60 psi for every 12-ft length of pipe. Determine the shear stress on the pipe wall. Determine the shear stress at distances 0.3 and 0.5 in away from the pipe wall.