AE 3003 Home Work Set #2
Fall 1998
Due on Monday, November 2, 1998

These problems are based Bernoulli equation and the definition of streamlines

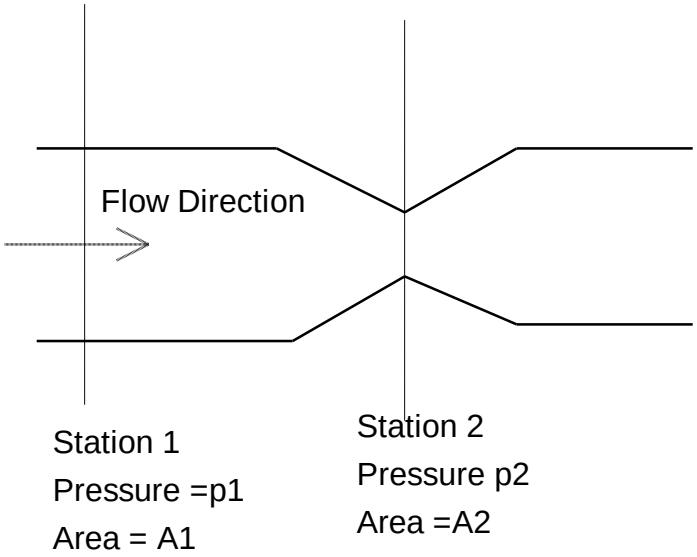
1. In a low speed experiment, the velocity field was measured and curve-fitted as

$$\vec{V} = \frac{3y}{x^2 + y^2}\vec{i} - \frac{3x}{x^2 + y^2}\vec{j}$$

Determine the streamline shapes that these velocity vectors represent.

Hint: Use the relationship udy=vdx ; Group all the terms involving y to the left, others to the right. Integrate. You will find that these relations represent circular streamlines.

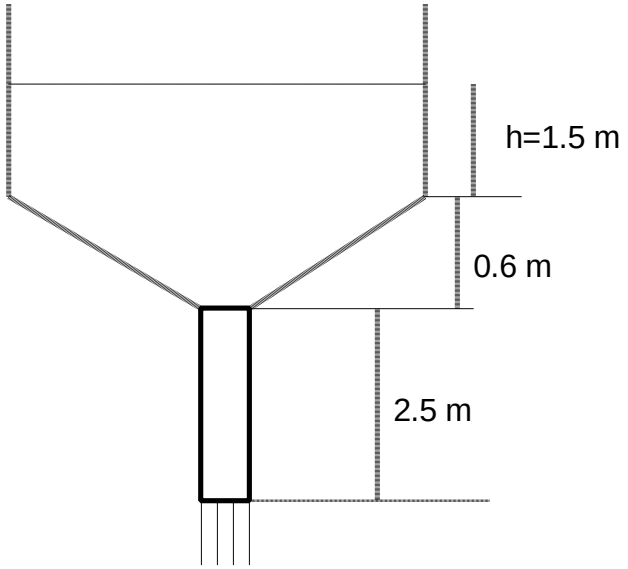
2. A venturi meter is a device or constriction inserted into a pipeline to measure incompressible flow rates. It basically measures pressure at two points in the flow, where the cross-sectional areas are changing rapidly. The pipe is horizontal. The flow may be assumed to be one-dimensional.



Show that the volume flow rate is given by

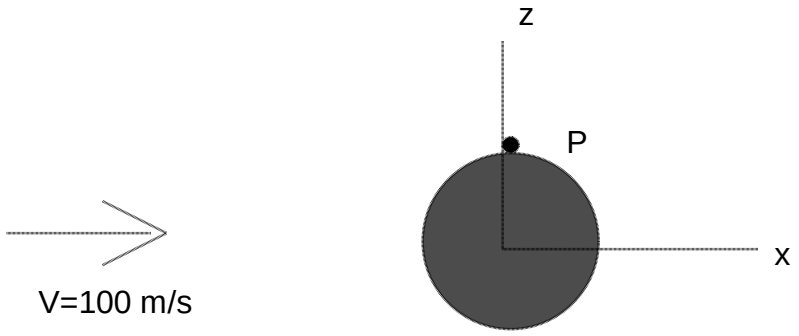
$$q = \frac{A_2}{\sqrt{1 - \left(\frac{A_2}{A}\right)^2}} \sqrt{2\frac{(p_1 - p_2)}{r}}$$

3. If friction is neglected, what is the velocity of the jet issuing from the water tank as a free jet? The pipe diameter is 150 mm.



Ans: V=9.5 m/s

4. Consider air flow over a circular cylinder. The cylinder has a 60 cm radius. At the upstream location the flow velocity was measured to be 10 m/s, the density was atmospheric (1.23 kg/m^3), and the pressure was atmospheric (101,000 N/m^2). At the point P just outside the boundary layer (z_P approximately equals cylinder radius), the velocity was 20 m/s. Assume that the fluid particles passing through P originated at z=0 far upstream. Compute the pressure at this point with and without the inclusion of gravity. Use g= 9.8 m/s^2. Comment on whether gravity effects may be neglected.



V at P = 190 m/s

Gravity acts downwards, along -z