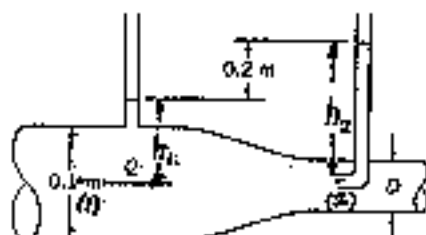
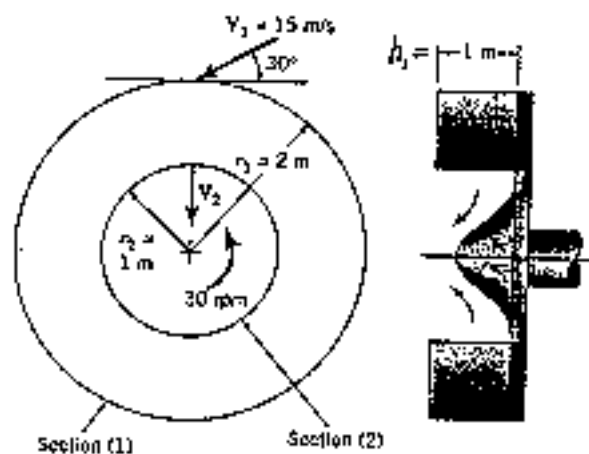


1. Water flows through the pipe contraction shown in Fig. 1. For the given 0.2m difference in manometer level, determine the flowrate as a function of the diameter of the small pipe, D . (10%)



2. A water turbine with radial flow has the dimensions shown in Fig. 2. The absolute entering velocity is 15 m/s, and it makes an angle of 30° with the tangent to the rotor. The absolute exit velocity is directed radially inward. The angular speed of the rotor is 30 rpm. Find the power delivered to the shaft of the turbine. (15%)



3. In a certain viscous, incompressible flow field with zero body forces the velocity components are

$$u = ay - b(cy - y^2)$$

$$v = w = 0$$

- where a , b , and c are constant. (a) Use the Navier-Stokes equation to determine an expression for the pressure gradient in the x direction. (b) For what combination of the constants a , b , and c (if any) will the shearing stress, τ_{xy} , be zero at $y=0$ where the velocity is zero? (10%)

4. Show that by writing the velocity in terms of the similarity variable η and the function $f(\eta)$ the momentum equation for boundary layer flow on a flat plate

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0, \quad u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} = \nu \left(\frac{\partial^2 u}{\partial y^2} \right)$$

can be written as the ordinary differential equation given by

$$2f''' - ff'' = 0.$$

(15%)

5. Plot the Moody's diagram and make a brief explanation. (10%)
6. Plot the drag coefficients for circular cylinders against the Reynolds numbers. (10%)
7. Explain the manner in which a valve controls the rate of flow through a conduit. When is it advantageous to use a gate valve instead of a globe valve? (10%)
8. Why do airplanes take off and land against the wind? (10%)
9. Sketch the successive changes in the cross section of a liquid jet issuing from an ellipsoidal opening. (10%)

