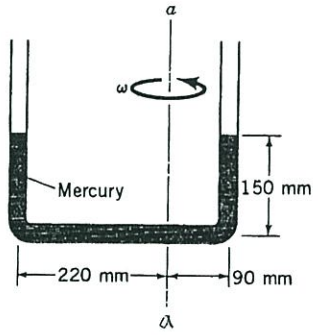
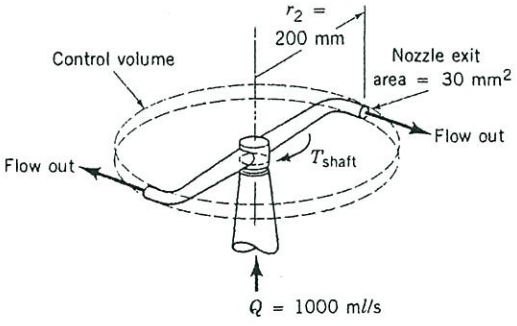
Fluid Mechanics Part I

1. (a) What is the so-called Newtonian fluid? (5%)
   (b) What is the Bernoulli's equation and under what conditions can this equation be applied? (12%)

2. The U-tube in the following figure contains mercury and rotates about the off-center axis a-a. At rest, the depth of mercury in each leg is 150 mm as illustrated. Determine the angular velocity for which the difference in heights between the two legs is 75 mm. (15%)



3. Water enters a rotating lawn sprinkler through its base at the steady rate of 1000 ml/s as sketched in the figure. The exit area of each of the two nozzles is 30 mm^2 and the flow leaving each nozzle is in the tangential direction. The radius from the axis of rotation to the centerline of each nozzle is 200 mm. (6%)
   (a) Determine the resisting torque required to hold the sprinkler head stationary.
   (b) Determine the resisting torque associated with the sprinkler rotating with a constant speed of 500 rev/min. (6%)
   (c) Determine the speed of the sprinkler if no resisting torque is applied. (6%)



Graduate School of Mechanical Engineering (PH. D. Qualify Exam)
2008/4
Fluid Mechanics (Part II)

1. The velocity in a certain flow field is given by the equation

$$\mathrm{V} = yz\hat{\mathrm{i}} + x^2 z\hat{\mathrm{j}} + x\hat{\mathrm{k}}$$

Determine the expressions for the three rectangular components of acceleration. (15 %)

2. The velocity components in an ideal, two-dimensional velocity field are given by the equations

$$u = 3(x^2 - y^2)$$
$$v = -6xy$$

All body forces are negligible. (**a**) Does this velocity field satisfy the continuity equation? (**b**) Determine the equation for the pressure gradient in the y direction at any point in the field. (20%)

3. The streamlines in a particular two-dimensional flow field are all concentric circles, as shown in Fig. 1. The velocity is given by the equation $v_\theta = \omega r$ where ω is the angular velocity of the rotating mass of fluid. Determine the circulation around the path *ABCD*. (15 %)

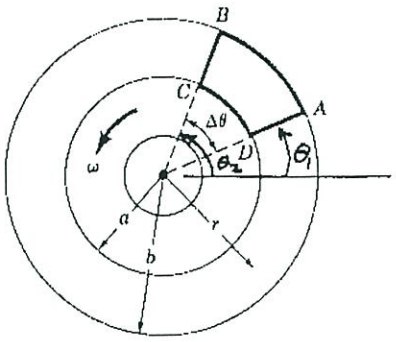


Figure 1