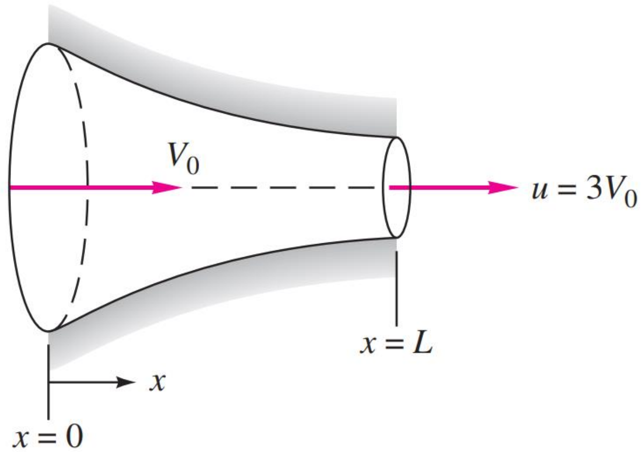
Dr Karimi
due date:
1402/08/22

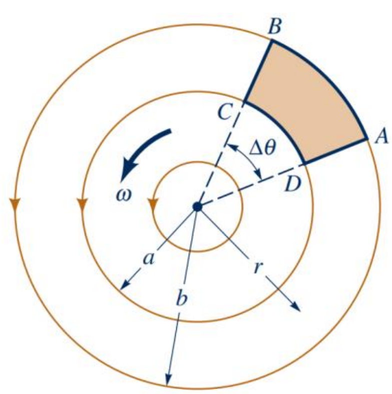
In the name of Allah
Fluid Mechanics 2
Assignment 3: Fluid element kinematics

1- Flow through the converging nozzle in Figure can be approximated by the one-dimensional velocity distribution $u = V_0\left(1+\frac{2x}{L}\right), v = 0, w = 0$
(*a*) Find a general expression for the fluid acceleration in the nozzle.
(*b*) For the specific case $V_0 = 10\ ft/s$ and $L = 6\ in$, compute the acceleration, in g's, at the entrance and at the exit.



2- Velocity field for a certain two-dimensional flow is $\vec{V} = (x^2 - 3xy + z^3)\hat{\imath} + (5xy + z - 2)\hat{\jmath} + (x + y^2)\hat{k}$. find the following values in general and at (2,1,-1):
(a) linear strain rate
(b) angular deformation rate
(c) volume dilution rate
(d) vorticity in z direction

3- The streamlines in a particular two-dimensional flow field are all concentric circles, as shown in Figure. 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 $ABCD$.



4- The streamlines in a certain incompressible, two-dimensional flow field are all concentric circles so that $v_r = 0$. Determine the stream function for

(a) $v_\theta = Ar$

(b) $v_\theta = Ar^{-1}$

where *A* is a constant.

5- Liquid drains from a small hole in a tank, as shown in the Figure, such that the velocity field set up is given by $v_r = 0,\ v_z = 0, v_\theta = KR^2/r$, where $z = H$ is the depth of the water far from the hole. Is this flow pattern rotational or irrotational? Find the depth z_C of the water at the radius $r = R$. (Note: $\omega_z = \frac{1}{r}\frac{\partial}{\partial r}(rv_\theta) - \frac{1}{r}\frac{\partial}{\partial \theta}(v_\theta) = 0$)