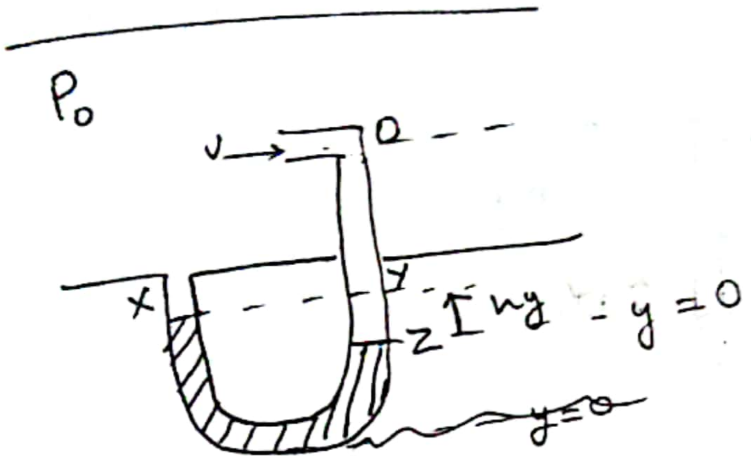
Tut 3

1.



$$P_x = P_o = P_y$$

(a) Applying Bernoulli's equation at Y and Z

$$g h_y + \frac{P_y}{\rho_a} + \frac{v^2}{2} = \overset{0}{\cancel{g h_z}} + \frac{P_z}{\rho_a} + 0$$

$$\Rightarrow \Delta P = \rho_a g h_y = \frac{\rho_a v^2}{2} \quad \left(\rho_a g h_y \to 0 \text{ as } \rho_a << \rho_w\right)$$

$$\therefore \Delta P = \frac{1.21 \times 225}{2}$$

$$\Delta P = \underline{136.12 \text{ Pa}} = \underline{1.39 \text{ cm water}}$$

(b) Applying Bernoulli's and ~~assuming~~ $\rho_a << \rho_o$, $\frac{V^2}{2g}$

$$\Rightarrow \Delta P = \left|\frac{(v^2 - 24^2)}{2} \times \rho_a\right|$$

$(\rho_o = 859.5 \text{ kg/m}^3)$

$$= \frac{15^2 - 24^2}{2} \times 1.21 = \underline{212.36 \text{ Pa}}$$

$$= 2.52 \text{ cm oil}$$

2] Apply ~~Apply~~ bernoulli... water surface level

① $\dot{V}_{outlet} = A V_{out}$

$$231 \times \frac{550}{60} = \pi \times \frac{5.95^2}{4} \times V$$

$V_{out} = 76.2$ inch/s $= 6.35$ ft/s

Applying Bernoulli's between outlet (O) and inlet (I)

$$\frac{P_O}{\rho_w} + \frac{V_{out}^2}{2} + g y_{out} = \frac{P_I}{\rho_w} + \frac{V_{in}^2}{2} + g y_{in}$$

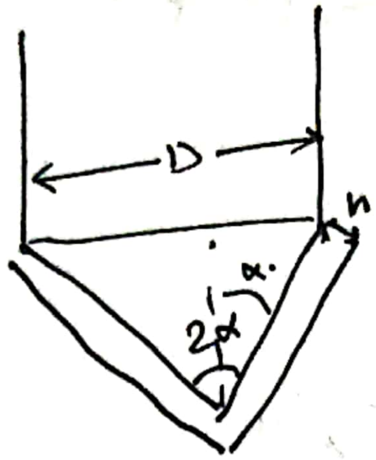
Assuming $v_{in} \rightarrow 0$ (as fluid is in bulk inside water)

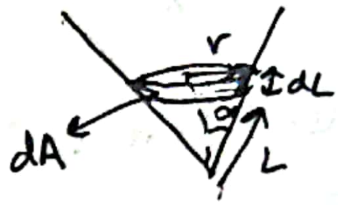
$$\therefore \frac{P_{atm} - P_I}{\rho_w} + \frac{6.35^2}{2} + g(10) = 0$$

$$(P_I)_{gauge} = 62.4\left(\frac{6.35^2}{2} + 10 \times 32.2\right)$$

$= 21350.86$ lbf/inch²

3]





Here,

$$L = \frac{r}{\sin\alpha}$$

$$\therefore dL = \frac{dr}{\sin\alpha}$$

$$\therefore dA = 2\pi r\, dL$$

$$\therefore dF = \tau\, dA$$

$$= \mu\left(\frac{r\omega}{h}\right) 2\pi r \frac{dr}{\sin\alpha} \qquad \left(\text{as } \frac{dv}{dy} = \frac{r\omega}{h}\right)$$

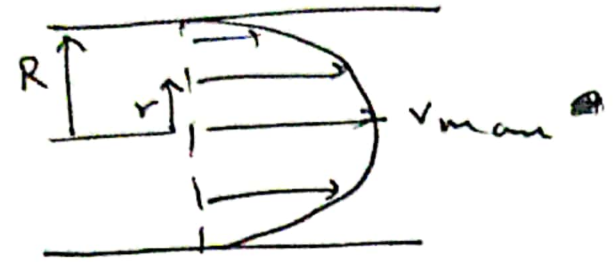
$$\therefore dM = r\, dF$$

$$\Rightarrow \int_0^M dM = \int_0^{R=D/2} \frac{2\pi\mu\omega}{h\sin\alpha} r^3\, dr$$

$$M = \frac{2\pi\mu\omega}{h\sin\alpha} \times \frac{D^4}{2^4} \times \frac{1}{4}$$

$$M = \frac{\pi\mu\omega D^4}{32h\sin\alpha}$$

4]



Now, $v_x = V_{max}\left[1 - \frac{r^2}{R^2}\right]$

where $v_{avg} = \frac{v_{max}}{2}$

$\therefore \frac{v_{max}}{2} = 2$

$\Rightarrow v_{max} = 4\ fps$

$\Rightarrow v_x = 4\left(1 - \frac{r^2}{R^2}\right)$

~~kinematic viscosity~~

$\tau_{wall} = \mu \left.\frac{dv_x}{dr}\right|_{r=R} = \cancel{0.738}\ 1.43\ lbs/ft^2 \times \left(-\frac{8r}{R^2}\right)_{r=R}$

$\tau_w = 0.738 \times \left(-\frac{1}{R}\right)$

$\tau_w = -\frac{0.738}{0.1} \times 12$

$$\boxed{\tau_{wall} = -88.56\ \cancel{lbs/ft^3}\ lbf/ft^2}$$