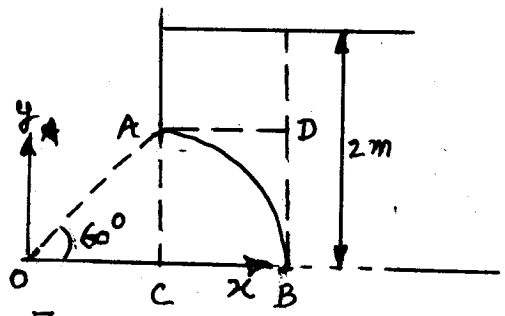
Q2



$AC = OA\sin 60^\circ = \sqrt{3}/4$

$F_H =$

$F_H = -\left[\rho g\left(2 - \frac{AC}{2}\right)\right](AC \times 2)\,\hat{i}$

$= -15.152\,\hat{i}\ (KN)$ or $15.152\ KN \leftarrow$

$AD = CB = 0.5 - 0.5\cos 60^\circ = \frac{1}{4}$

Vol of fluid above AB =

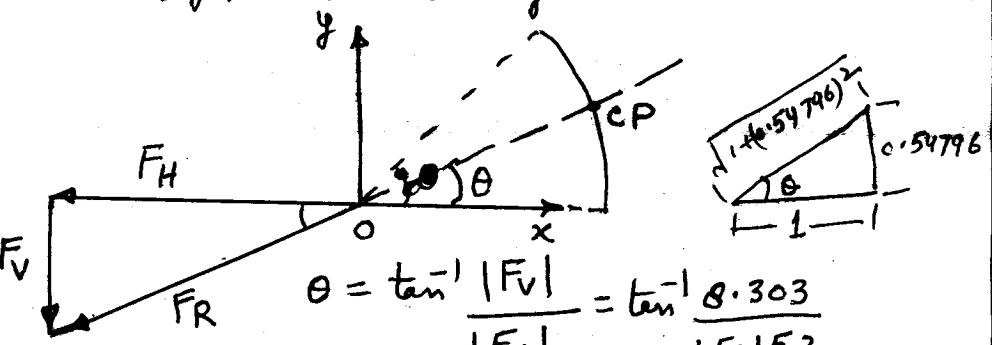
$\frac{1}{4}\left(2 - \frac{\sqrt{3}}{4}\right)\times 2 + \left\{\frac{\sqrt{3}}{4}\times\frac{1}{4} - (\text{area } ABC)\right\}\times 2.$

Area $ABC = \frac{1}{2}\left(\frac{\pi}{3}\right)(0.5)^2 - \frac{1}{2}(OC)(AC)$

$= 0.076825\ m^2.$

$\forall$ Vol $= 0.84635\ m^3$

Force $= \rho g(\text{Vol}) = -8.303\,\hat{j}\ KN$ or $8.303\ KN \downarrow$



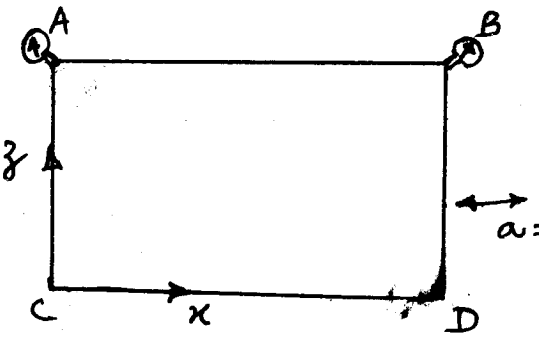
$\theta = \tan^{-1}\frac{|F_V|}{|F_H|} = \tan^{-1}\frac{8.303}{15.152}$

$\tan\theta = 0.54796$

Co-ordinates of CP: $x_{CP} = 0.5\cos\theta = \frac{0.5}{(1+(0.54796)^2)^{1/2}}$

$y_{C.P} = 0.5\sin\theta = \frac{0.5\times 0.54796}{(1+(0.54796)^2)^{1/2}}$

Q.3



$\vec{\nabla}p = \rho(\vec{g} - \vec{a})$, $\frac{\partial p}{\partial x} = -\rho a$

But $\frac{\partial p}{\partial x} = \frac{p_B - p_A}{\Delta x} = \frac{5}{0.7}\times 10^3$

$\Rightarrow \frac{5\times 10^3}{0.7} = -10^3 \times a \Rightarrow a = -7.143$

At the bottom of tank, pressure va
linearly from C to D $\left[\frac{\partial p}{\partial x} > 0\right]$

$\Rightarrow$ pressure force on tank bottom

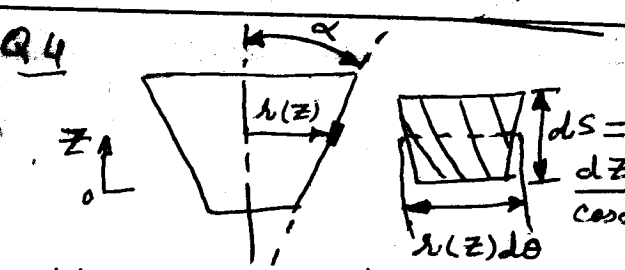
$= p_{CG}A = p(x = 0.35)A$

$p(x = 0.35) = (p_C + p_D)/2$

$p_C = p_A + \rho g h_3$, $p_D = p_B + \rho g h$

$F = 16.75\ KN \downarrow$

Q4



$dA = (r(z)d\theta)\frac{dz}{\cos\alpha}$

Differential shear force, $dF_S = \tau.dA$

$= \frac{\mu r(z)\omega}{h}(r(z)d\theta)\frac{dz}{\cos\alpha}$

Diff shear Torque $= r(z)dF_S$

$= \left[\frac{\mu\omega}{h\cos\alpha}\right] r^3(z)\,d\theta\,dz$

Total Torque $= \int_0^H\int_0^{2\pi}\left(\frac{\mu\omega}{h\cos\alpha}\right) r^3\,d\theta\,dz$

$= \frac{2\pi\mu\omega}{h\cos\alpha}\int_0^H r^3(z)\,dz$

$r(z) = r_i + \frac{(r_o - r_i)}{H}z$

$\cos\alpha = \frac{H}{\left[H^2 + (r_o - r_i)^2\right]^{1/2}}$

$\therefore T(\omega) = \frac{\pi\mu\omega}{2h}\left[H^2 + (r_o - r_i)^2\right]^{1/2}\times$
$\frac{}{(r_o + r_i)(r_o^2 + r_i^2)}$

Q.5

i) $\nabla.V = 0 \Rightarrow 2axy + 2bxy = 0 \Rightarrow a + b = 0$

ii) $dy/dx = v/u = bxy^2/axy^2 = -\frac{y}{x} \Rightarrow \ln y = -\ln x + \ln c$

$\boxed{xy = c}$

Stream line passing (1, 2) $\Rightarrow c = 2 \Rightarrow xy = 2$

$\vec{a} = \frac{D\vec{V}}{Dt} = \frac{\partial \vec{V}}{\partial t}^{0} + (\vec{V}.\vec{\nabla})\vec{V} = u\frac{\partial \vec{V}}{\partial x} + v\frac{\partial \vec{V}}{\partial y}$

$= u\left[2axy\,\hat{i} + by^2\,\hat{j}\right] + v\left[ax^2\,\hat{i} + 2bxy\,\hat{j}\right]$

$= au\left(2xy\,\hat{i} - y^2\,\hat{j}\right) + av\left[x^2\,\hat{i} - 2xy\,\hat{j}\right]$

$= a^2\left[2x^3y^2 - x^3y^2\right]\hat{i} - a^2\left[x^2y^3 - 2x^2y^3\right]\hat{j}$

$= a^2x^2y^2(x\,\hat{i} + y\,\hat{j})$

$\vec{a}_{(1,1)} = a^2(\hat{i} + \hat{j})$.