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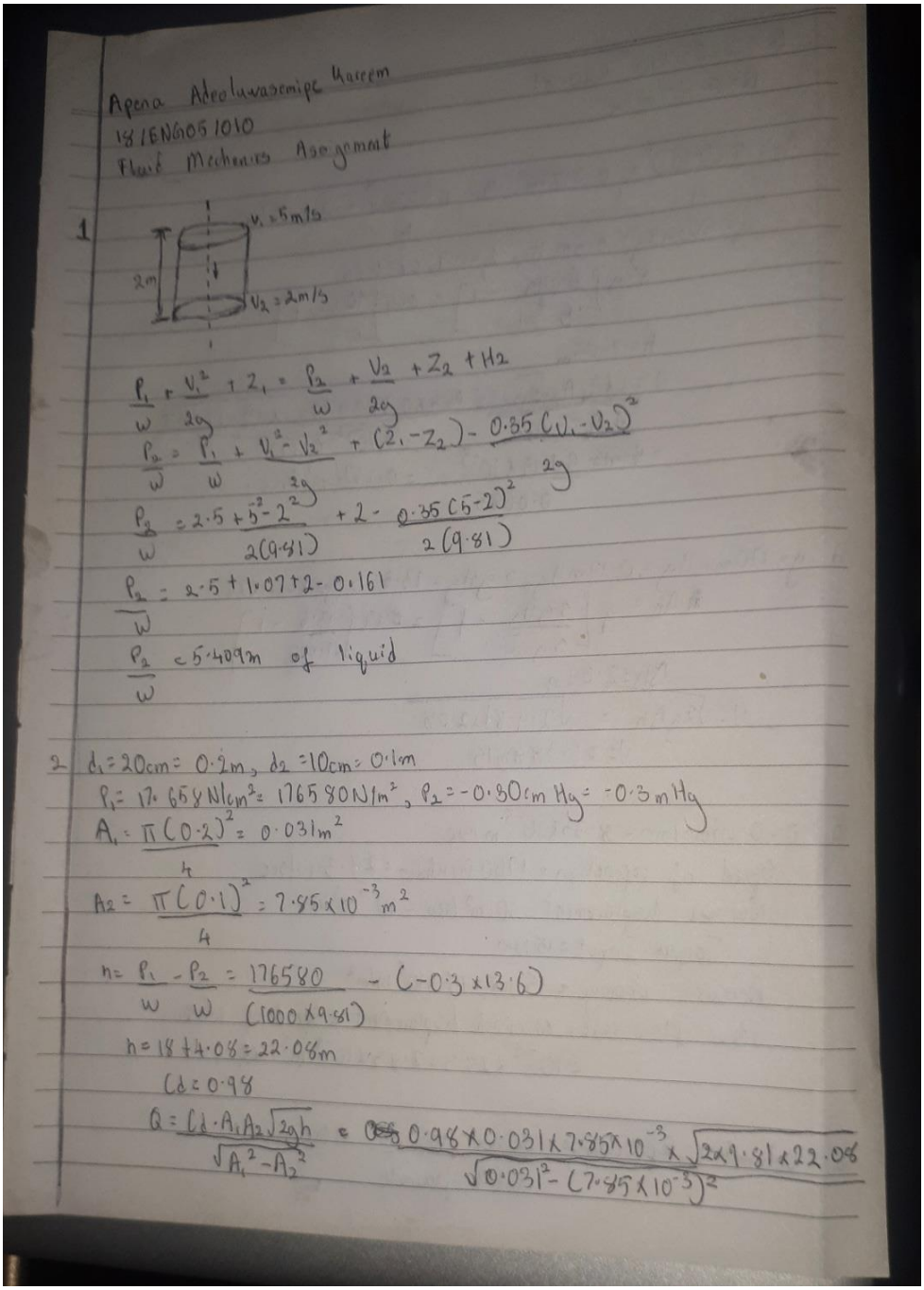
18/ENG05/010 MECHATRONICS

FLUID MECHANICS ASSIGNMENT



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Fluid Mechanics Assignment

1

$$\frac{P_1}{w} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{w} + \frac{V_2}{2g} + Z_2 + H_2$$

$$\frac{P_2}{w} = \frac{P_1}{w} + \frac{V_1^2 - V_2^2}{2g} + (Z_1 - Z_2) - \frac{0.35(V_1 - V_2)^2}{2g}$$

$$\frac{P_2}{w} = 2.5 + \frac{5^2 - 2^2}{2(9.81)} + 2 - \frac{0.35(5-2)^2}{2(9.81)}$$

$$\frac{P_2}{w} = 2.5 + 1.07 + 2 - 0.161$$

$$\frac{P_2}{w} = 5.409m \text{ of liquid}$$

2 $d_1 = 20cm = 0.2m$, $d_2 = 10cm = 0.1m$

$P_1 = 17.65 N/cm^2 = 176580 N/m^2$, $P_2 = -0.30cm\ Hg = -0.3m\ Hg$

$$A_1 = \frac{\pi(0.2)^2}{4} = 0.031m^2$$

$$A_2 = \frac{\pi(0.1)^2}{4} = 7.85 \times 10^{-3} m^2$$

$$h = \frac{P_1}{w} - \frac{P_2}{w} = \frac{176580}{(1000 \times 9.81)} - (-0.3 \times 13.6)$$

$h = 18 + 4.08 = 22.08m$

$Cd = 0.98$

$$Q = \frac{Cd \cdot A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}} = \frac{0.98 \times 0.031 \times 7.85 \times 10^{-3} \times \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{0.031^2 - (7.85 \times 10^{-3})^2}}$$

$Q = 8.05 \times 10^{-5} \times 20.81$

$Q = 0.167 m^3/sec$

3 $A_0 = \frac{\pi (0.15)^2}{4} = 0.0177 m^2$, $A_1 = \frac{\pi (0.336)^2}{4} = 0.0707 m^2$

$y = 50 cm Hg = 0.5 m Hg$, $\xi = 0.9$, $Cd = 0.64$

$h = y\left[\frac{S.g\,Hg}{S.g\,oil} - 1\right] = 0.5\left[\frac{10.6}{0.9} - 1\right]$

$h = 7.05 m$

$Q = \frac{Cd A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}} = \frac{0.64 \times 0.177 \times 0.707 \times \sqrt{2 \times 9.81 \times 7.05}}{\sqrt{0.707^2 - 0.177^2}}$

$= \frac{9.419 \times 10^{-3}}{0.0685} = 0.1376 m^3/sec.$

4 $y = 170 mm Hg = 0.17 m Hg$, $S.g\,Hg = 13.6$, $S.g\,oil = 1.026$

$\Delta h = y\left[\frac{S.g\,Hg}{S.g\,oil} - 1\right] = 0.17\left[\frac{13.6}{1.026} - 1\right]$

$\Delta h = 2.08 m$

$V = \sqrt{2g\Delta h} = \sqrt{2 \cdot 9.81 \times 2.08}$

$V = 6.388 m/s$

5 $Q = 0.05 dm^3/min = 8.33 \times 10^{-5}\ m^3/sec$

Speed of rotation $= 1700$ Rev/min $= 28.3$ rev/sec

Normal displacement $= 10 cm^3/rev = 10^{-5} m^3/rev$

Torque Input $= 15 Nm$

Pressure change $= 15 bar = 15 \times 10^5 N/m^2$

ideal flow rate = Nominal displacement × Speed of rotation

$= 10^{-5} \times 28.3 = 2.83 \times 10^{-4}\ m^3/sec$

a Volumetric Efficiency $= \frac{\text{Actual flowrate}}{\text{Total flowrate}} \times 100$

$= \frac{8.33 \times 10^{-5}}{2.83 \times 10^{-4}} \times 100 = 29.45\%$

b Fluid Power, $P_f = Q \times \Delta p$

$= 8.33 \times 10^{-5} \times 15 \times 10^5 = 124.95$ N m Hg

c shaft Power $= T \times \omega$

$\omega = 2 \times \pi \times$ speed of rotation $= 2 \times \pi \times 28.5$

$= 177.81$ rad/sec

∴ shaft power is $15 \times 177.81 = 2667.2$ watts

d overall efficiency $= \frac{\text{Fluid power}}{\text{shaft power}} \times 100$

$= \frac{124.95}{2667.2} \times 100$

$= 4.68\%$