Numerical analysis assignment 2

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$\alpha_1 = 7$ $\alpha_2 = 6$ $\alpha_3 = 5$

Question 1:

Assumptions: $r = 0.175\ m$ $L = 1.66m$ $\rho_c = 985\ kg/m^3$

$\rho_w = 1000\ kg/m^3$ $g = 9.81\ m/s^2$ $0 < h < 0.5m$

convergence when $\Delta h < 0.01m$ or 30 iter

RtF: • height above water, h, with Bisection & F.P

• first 2 iterations by hand

Archimedes principle:

$$\rho_c V_c g = \rho_w V_w g \ ;$$

$$V_w = \left(\sqrt{2hr - h^2}(h-r) + r^2\left(\pi - \cos^{-1}\left(\frac{h-r}{r}\right)\right)\right) \cdot L$$

$$V_C = \pi r^2 L$$

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Solving the equation:

$$0 = \frac{4067\pi}{80} - \frac{4067\cos^{-1}\left(\frac{40h}{7}-1\right)}{80} +$$

$$1660\left(\sqrt{-h^2+\frac{7h}{20}}\cdot h-\frac{7}{40}\right) - \frac{5535031457702571}{35184372088832}$$

Bisection first iteration:

$f(0) = -157.3151$ when $h=0$

$hr = \frac{0+0.5}{2} = 0.25$

$f(0.25) = -35.258$

$f(0)\,f(0.25) \not< 0$

$\therefore$ the root is between 0.25 & 0.5

Bisection second iteration:

$hr = \frac{0.25+0.5}{2} = 0.375$

$f(0.375) = 2.3957 + 6.2855i$

$f(0.25)\,f(0.375) < 0$

$\therefore$ the root is between 0.25 & 0.375

false Position first iteration:

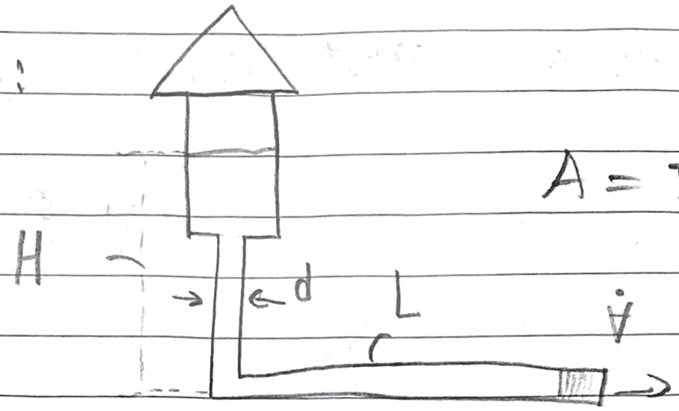
$$h_r = h_u - \frac{f(h_u)(h_l - h_u)}{f(h_l) - f(h_u)}$$ false Position equation

$h_r = 0$ for first iter

second iteration

$h_r = 0.2467$

Question 2:



$A = \pi r^2 = \frac{\pi d^2}{4}$

Assumptions: $g = 9.81\ m/s^2$ $H = 37m$ $L = 76m$

$f = 0.025$ $d = 0.1m$ $L_{elbow}/d = 30$ $L_{valve}/d = 8$

$K = 0.5$ $L_{elbow} = 3m$ $L_{valve} = 0.8m$

Convergence when $\Delta \dot{V} < 0.0001\ m^3/s$ or

# of iterations reaches 30

Rtf: flow rate of the moving water, $\dot{V}$; using Newton-Raphson method (m^3/s)

$$0 = f\left(\frac{L+H}{d} + \frac{L_{elbow}}{d} + \frac{L_{valve}}{d}\right)\frac{V^2}{2} + K\frac{V^2}{2} + \frac{V^2}{2} - gH = g(V)$$

$$V_{i+1} = V_i - \frac{g(V_i)}{g'(V_i)}$$ assume $V_i = 0.1\ m/s$

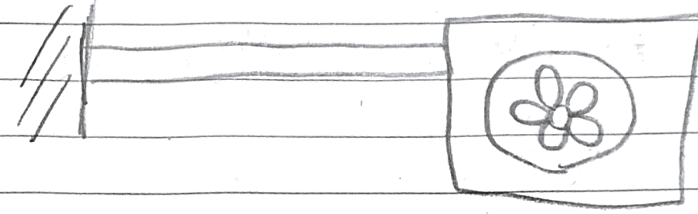
first iteration $V_{i+1} = 118.28\ m/s$

second iteration $V_{i+2} = 59.2406\ m/s$

the Area $A = \frac{\pi d^2}{4}$

tofind flow rate $Q = AV$

Question 3:



Assumptions: $\forall' = 17 - (7.7 \times 10^{-5}) P_{static}$ fan

$P_{static} = 96 + 12\,\forall'^2$ Duct

Rtf: volume flow rate, $\forall$, and static pressure, P_{static}, using successive substitution

Let P_{static_i} be 200 Pa for the intial guess

$\therefore \forall'_i = 17 - (7.75 \times 10^{-5}) \times P_{static}^2 = 13.92\ m/s$

$\therefore P_{static_{i+1}} = 96 + 12\,\forall_i'^2 = 2421.2\ Pa$

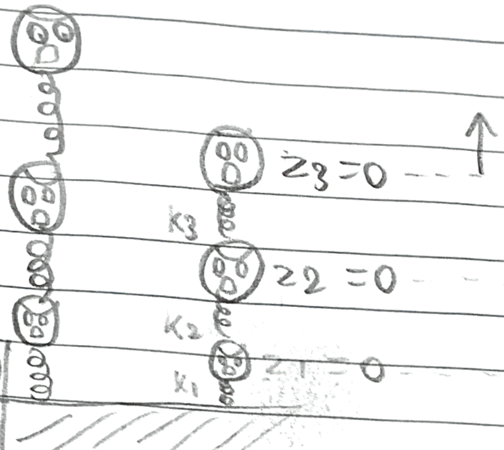
do same steps for different equations till you get a convergence

$\forall = \sqrt{\dfrac{P_{static} - 96}{12}}$ or $P_{static} = \dfrac{17 - \forall'}{7.7 \times 10^{-5}}$

Question 4:

Assumptions:

$z_s = 0.1m$ $V = 0.0001 m^3$



Float	Density	spring
1	870	17
2	760	16
3	650	15

Rtf: stretching of each spring, z_1, z_2, z_3, using

$$m_1 \, d^2 z_1 / dt^2 = m_1 g + k_2 (z_2 - z_1) - k_1 z_1$$

$$m_2 \, d^2 z_2 / dt^2 = m_2 g + k_3 (z_3 - z_2) - k_2 (z_2 - z_1)$$

$$m_3 \, d^2 z_3 / dt^2 = m_3 g - k_3 (z_3 - z_2)$$

matrix form

at equilibrium:

$$m_1 g = k_1 z_1 + k_2 z_1 - k_2 z_2$$

$$m_2 g = \overset{-k_2 z_1}{k_2 z_2} + k_3 z_2 - k_3 z_3$$

$$m_3 g = -k_3 z_2 + k_3 z_3$$

$$\begin{bmatrix} (k_1 + k_2) & -k_2 & 0 \\ -k_2 & (k_2 + k_3) & -k_3 \\ 0 & -k_3 & k_3 \end{bmatrix}$$