$$\dot{P} = \frac{1}{C_f} Q \approx \dot{V} = \frac{1}{C} I$$

$$\dot{Q} = \frac{1}{I_f} P \approx \dot{I} = \frac{1}{L} V$$

$$P = QR_f \approx V = IR$$

where P =Pressure, Q =fluid flow rate, C_f =fluid capacitance, I_f = fluid interance, R_f = fluid resistance

Transfer function of the system:

$$\frac{Pout(s)}{Pin(s)} = \frac{\frac{1}{I_f C_f}}{s^2 + \frac{R_f}{I_f} s + \frac{1}{I_f C_f}} = \frac{{\omega_n}^2}{s^2 + 2\zeta\omega_n s + {\omega_n}^2}$$

$$\omega_n = \frac{1}{\sqrt{I_f C_f}}$$

$$\zeta = \frac{R_f}{2} \sqrt{\frac{C_f}{I_f}}$$

$$C_f = \frac{A_c}{\rho g} = \frac{\pi(\frac{1}{2} D_c)^2}{\rho g} = \frac{\pi {D_c}^2}{4\rho g}$$

$$I_f = \frac{\rho L}{A_I} = \frac{\rho L}{\pi(1/2 D_I)^2} = \frac{4\rho L}{\pi {D_I}^2}$$

$$\omega_n = \frac{1}{\sqrt{\frac{\cancel{A}\cancel{\rho} L}{\cancel{\pi} {D_I}^2} \frac{\cancel{\pi} {D_c}^2}{\cancel{A}\cancel{\rho} g}}} = \sqrt{\frac{g}{L}} \frac{D_I}{D_c}$$

Notes to self:

ω_n = resonant frequency ζ = damping ρ = fluid constant, 1 for water