

Electromechanics and Contromechanics
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Knowledge Test - Answers

1.)

$$L\ddot{Q} + R\dot{Q} + \frac{1}{C}Q = V$$

$$Q = \int I \cdot dt$$

with:

Q: Charge [As]

I: Current [A]

V: Voltage [V]

R: Resistance [Ω] $\left[\frac{V}{A} \right]$

L: Inductance [H] $\left[\frac{Vs}{A} \right]$

C: Capacity [F] $\left[\frac{As}{V} \right]$

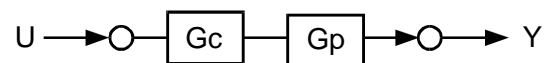
$$\omega_d = \omega \sqrt{1 - D^2}, \quad D < 1,$$

$$D = \frac{R}{2 \sqrt{\frac{L}{C}}}$$

2.)

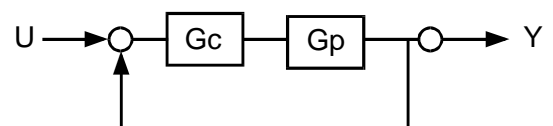
Open loop transfer function

$$G(s) = \frac{y(s)}{U(s)} \quad G_a = \frac{K_p + K_d s}{ms^2 + ds + C}$$



Closed loop transfer function with PD controller

$$G_{CL}(s) = \frac{y(s)}{U(s)} = \frac{K_p + K_d s}{ms^2 + (d + K_d)s + (K + K_p)}$$



3.)

$$\bar{q} = \begin{Bmatrix} x \\ y \\ \varphi \end{Bmatrix} \quad \underline{M} \ddot{\bar{q}} + \underline{K} \bar{q} = \bar{Q}$$

$$\underline{M} = \begin{bmatrix} M & & \\ & M & \\ & & \frac{5}{6} Ma^2 \end{bmatrix} \quad \underline{K} = \begin{bmatrix} 4c & & \\ & 4c & \\ & & 6a^2 c \end{bmatrix} \quad \bar{Q} = \begin{Bmatrix} 0 \\ -1 \\ a/2 \end{Bmatrix} F(t)$$

4.)

$$\omega_1 = 2 \sqrt{\frac{c}{m}} \quad \text{horizontal vibration mode}$$

$$\omega_2 = 2 \sqrt{\frac{c}{m}} \quad \text{vertical vibration mode}$$

$$\omega_3 = 6 \sqrt{\frac{c}{5m}} \quad \text{rotational mode}$$

5.)

$$\frac{y_p(t)}{F(t)} = - \frac{15 - 7 \frac{\Omega^2}{\omega_2^2}}{8c \left(1 - \frac{\Omega^2}{\omega_2^2}\right) \left(9 - 5 \frac{\Omega^2}{\omega_2^2}\right)}$$