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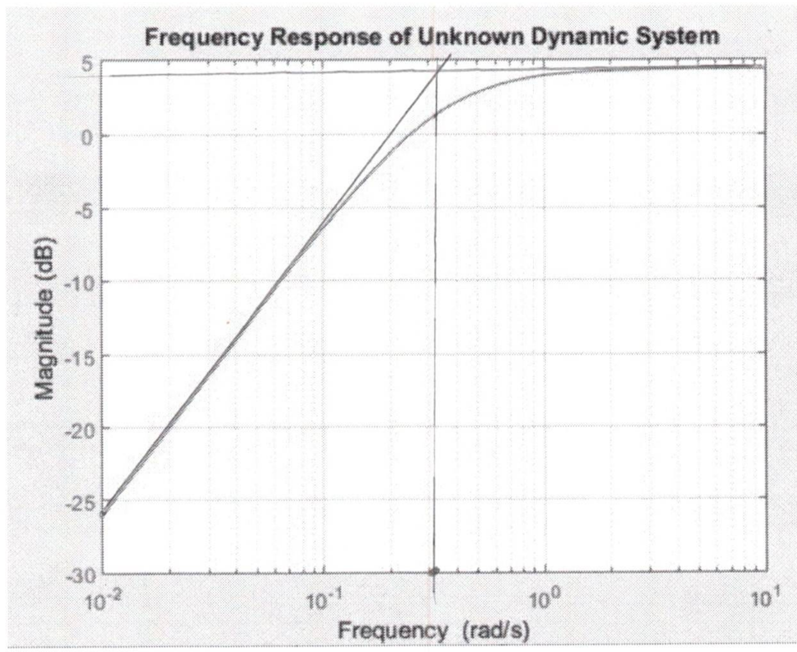
MAE 3723, System Analysis –

Fall 2019

Homework Assignment #12

Homework Assignment #12 - Due at 11:59 pm, Friday, Nov. 22, 2019, in the Canvas Homework 12 dropbox.

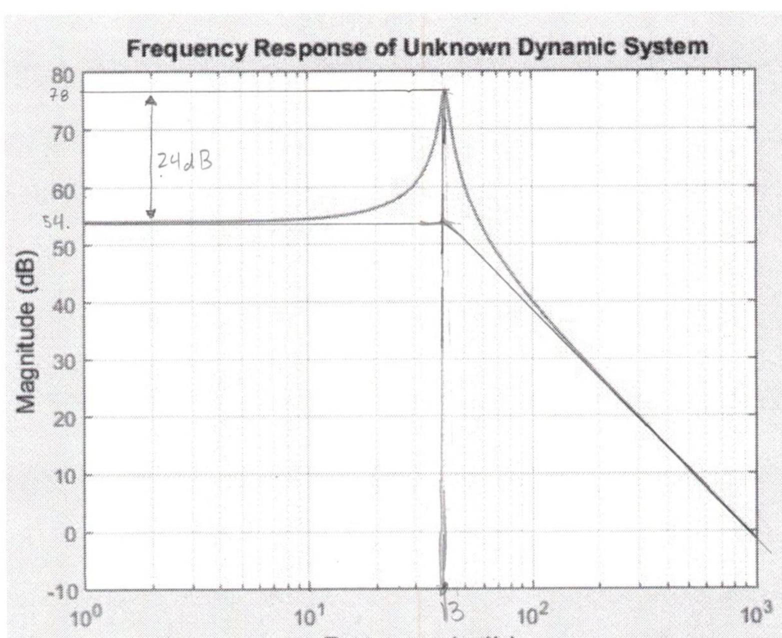


Problem 1 Determine the system transfer function from the following Bode plot: $T(s) = \frac{\tau s}{\tau s+1}$

$\omega\tau = 1$ @ intersection of asymptotes.

$\tau = \frac{1}{\omega}\Big|_{\omega = 0.8\,rad/s} = 1.25\,s$

$$\boxed{T(s) = \frac{1.25\,s}{1.25s+1}}$$



Problem 2 Determine the system transfer function from the following Bode plot: $T(s) = \frac{K}{s^2+2\zeta\omega_n+\omega_n^2}$

low ω:

$m = 54 \approx 20\log K \rightarrow K = 501.18$

ω_r:

$m_r = 20\log K - 20\log\left(2\zeta\sqrt{1-\zeta^2}\right)$

$4\zeta^4 - 4\zeta^2 + 10^{-\frac{1}{20}(m_r - 20\log K)} = 0$

$\zeta = \{-0.992, -0.127, 0.127, 0.992\}$

$\zeta = 0.127$ because of peak and $\zeta \geq 0$

$\omega_r = 13\,rad/s = \omega_n\sqrt{1-2\zeta^2}$

$\omega_n = 13.21\,rad/s$

$$\boxed{T(s) = \frac{501.18}{s^2+3.355s+174.50}}$$

3)

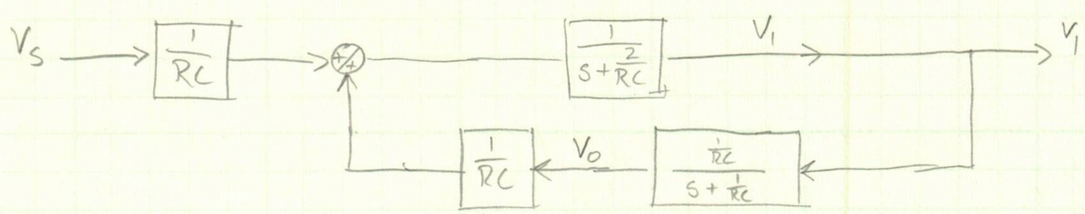
$$\dot{V}_0 = \frac{1}{RC}V_1 - \frac{1}{RC}V_0$$

$$\dot{V}_1 = \frac{1}{RC}V_S - \frac{2}{RC}V_1 + \frac{1}{RC}V_0$$

$$\rightarrow \begin{bmatrix} \dot{V}_0 \\ \dot{V}_1 \end{bmatrix} = \begin{bmatrix} -\frac{1}{RC} & \frac{1}{RC} \\ \frac{1}{RC} & -\frac{2}{RC} \end{bmatrix} \begin{bmatrix} V_0 \\ V_1 \end{bmatrix} + \begin{bmatrix} 0 \\ \frac{1}{RC} \end{bmatrix} V_S$$

$$V_0\left(s + \frac{1}{RC}\right) = \frac{1}{RC}V_1 \qquad V_1\left(s + \frac{2}{RC}\right) - \frac{1}{RC}V_0 = \frac{1}{RC}V_S$$

$$V_0 = \frac{\frac{1}{RC}}{s + \frac{1}{RC}}V_1 \qquad V_1 = \left[\frac{1}{RC}V_0 + \frac{1}{RC}V_S\right]\left(\frac{1}{s + \frac{2}{RC}}\right)$$



4

$$m\ddot{x} + c\dot{x} + Kx = K_f i$$

$$L_a i + R i + K_b \dot{x} = v$$

$$\longrightarrow \begin{bmatrix} \ddot{x} \\ \dot{x} \\ i \end{bmatrix} = \begin{bmatrix} -\frac{c}{m} & -\frac{K}{m} & \frac{K_f}{m} \\ 1 & 0 & 0 \\ -\frac{K_b}{L_a} & 0 & -\frac{R}{L_a} \end{bmatrix} \begin{bmatrix} \dot{x} \\ x \\ i \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1/L_a \end{bmatrix} V$$

$$X(ms^2 + cs + K) = K_f I$$

$$I(sL_a + R) + K_b s X = V$$