ENG4550: Introduction to Control Systems

Sec 1.2 Pre-lab Questions

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Lab #: 3

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PreLab 1

1. $\frac{d}{dt} w_1(t) J_{eq} + B_{eq,v} w_1(t) = A_m V_m(t)$

$s\Omega_1(s) J_{eq} + B_{eq,v}\Omega_1(s) = A_m V_m(s)$

$$\frac{\Omega_1(s)}{V_m(s)} = \frac{A_m}{sJ_{eq} + B_{eq,v}} = \frac{A_m/B_{eq}}{s(J_{eq}/B_{eq}) + 1}$$

2. $K = \frac{A_m}{B_{eq,v}}$ $\quad T = \frac{J_{eq}}{B_{eq,v}}$

9. $|G_{w_1,v}(w)| = \frac{K}{\sqrt{1+\tau^2 w^2}}$

at $w = w_c$

$$\frac{1}{\sqrt{2}} = \frac{K}{\sqrt{1+\tau^2 w_c^2}} \rightarrow \frac{1}{2} = \frac{K^2}{1+\tau^2 w_c^2} \rightarrow 1+\tau^2 w_c^2 = 2K^2$$

$$\tau = \pm\sqrt{\frac{2K^2-1}{w_c^2}}$$

10. $\lim_{t\to\infty} w_1(t) = \lim_{t\to\infty} K A_v\left(1 - e^{\left(\frac{-t-t_0}{\tau}\right)}\right) + w_1(t_0)$

$w_{1ss} - w_1(t_0) = K A_v \qquad K = \frac{w_{1ss} - w_1(t_0)}{A_v} = \frac{w_{ss} - w_0}{V_{max} - V_{min}} = \frac{\Delta y}{\Delta u}$

11. $w_1(t_0+\tau) = K A_v\left(1 - e^{\left(\frac{-t_0+\tau+t_0}{\tau}\right)}\right) + w_1(t_0)$

$w_1(t_0+\tau) = K A_v(1 - e^{-1}) + w_1(t_0)$

$\frac{w_1(t_0+\tau) - w_0(t_0)}{A_v} = K(1 - e^{-1})$

$\frac{w_1(t_0+\tau) - w_0(t_0)}{A_v} = 0.63K = 0.63\frac{\Delta y}{\Delta x}$

At $t = \tau$, $w_1(t_0)$ reaches 63% of steady state