1.)

.1 $\dot{y} = V \sin(\theta) \Rightarrow f(t) = \dot{y} \Rightarrow f_0 = 0$

$y_0 = 0$

$\theta_0 = 0$

$\dot{y} = V\cos(\theta_0) \cdot \delta\theta$

$\delta\dot{y} = \delta\theta \Rightarrow TL \Rightarrow \frac{\Delta Y(s)}{\Delta \Theta(s)} = \frac{1}{s}$

.2 $J\dot{\omega} = \tau_a + \tau$ $\quad \dot{\omega}_0 = 0$

$J\dot{\omega} = -\beta\omega|\omega| + \tau$

$\delta\dot{\omega} = \delta\tau + \delta\omega \cdot (\overbrace{-\beta\omega + \beta\omega}^{0})$

$\delta\dot{\omega} = \delta\tau \Rightarrow \frac{\Delta\Omega}{\Delta T} = \frac{1}{s}$

.3 $\frac{\Delta Y}{\Delta\Theta} = \frac{1}{s} \Rightarrow \frac{\Delta Y}{\Delta\Omega} = \frac{1}{s^2}$

$\frac{\Delta Y}{\cancel{\Delta\Omega}} \cdot \frac{\cancel{\Delta\Omega}}{\Delta T} = \frac{1}{s^2} \cdot \frac{1}{s} \Leftrightarrow \frac{\Delta Y}{\Delta T} = \frac{1}{s^3}$ //

.4)

$P(s) = \frac{1}{s^3}$

$U(s) = \frac{s}{s^2+1}$

$P(s)U(s) = \frac{1}{s^2(s^2+1)} = \frac{1}{s^4 + s^2}$

Pelo Critério de Hurwitz é instável

.5) $\dot{y} = -V$ $\quad$ Taylor

$\theta_0 = \frac{3\pi}{2}$

$\delta\dot{x} = -V\sin(\theta_0)\,\delta\theta \Leftrightarrow$

$\dot{x}_0 = 0$

$\frac{X}{\Delta\Theta} = V\frac{1}{s}$

2.1

$G(s) = \frac{1}{s^2}$

$K(s) = K$

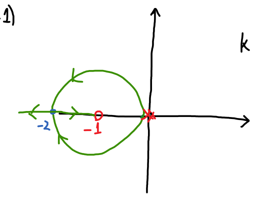
$H(s) = \frac{\frac{K}{s^2}}{1 + \frac{K}{s^2}} = \frac{K}{s^2+K}$

Polos em $\pm\sqrt{-K}$

Como $K>0$ o sistema é marginalmente estável

.2 $K(s) = K(s+1)$

$G(s) = \frac{1}{s^2}$



$K\frac{(s+1)}{s^2} = -1 \Leftrightarrow K = -\frac{s^2}{s+1}$

$-2s(s+1) + s^2 = 0 \Leftrightarrow \begin{cases} s = 0 \\ s = -2 \end{cases}$

.3 $d_2(t) = u(t)$ $\quad \Theta(s) = D_2(s) - G(s)K(s)\Theta(s) \Leftrightarrow \Theta(s) = \frac{D_2(s)}{1 + G(s)K(s)}$

$r(t) = d_1(t) = 0$

$\lim_{t\to\infty} \theta(t) = \lim_{s\to 0} s\Theta(s) = \lim_{s\to 0} \cancel{s}\frac{\frac{1}{\cancel{s}}}{1 + K\frac{(s+1)}{s^2}} = 0$

$d_1(t) = u(t)$ $\quad \Theta(s) = (D_1(s) - K(s)\Theta(s))G(s) \Leftrightarrow \Theta(s) = D_1(s)G(s) - K(s)G(s)\Theta(s) \Leftrightarrow$

$r(t) = d_2(t) = 0$

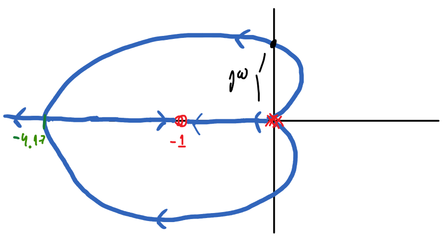
$\Leftrightarrow \Theta(s) = \frac{D_1(s)G(s)}{1 + K(s)G(s)}$

$\lim_{s\to 0} s\Theta(s) = \lim_{s\to 0} \cancel{s}\frac{\frac{1}{\cancel{s}} \cdot \frac{1}{s^2}}{1 + K\frac{(s+1)}{s^2}} = \lim_{s\to 0} \frac{\frac{1}{s^2}}{1 + K\frac{(s+1)}{s^2}} = \lim_{s\to 0} \frac{1}{s^2 + K(s+1)} = \frac{1}{K}$

.4) $K(s) = K\frac{(s+1)^2}{s}$ $\quad m = 2$, $n = 3$

$G(s) = \frac{1}{s^2}$

$K\frac{(s+1)^2}{s^3} = -1 \Leftrightarrow K = -\frac{s^3}{(s+1)^2} \Leftrightarrow$



$\frac{dK}{ds} = 0 \Leftrightarrow -3s^2(s+1)^2 + s^3(2s+2) = 0 \Leftrightarrow$

$\Leftrightarrow -3s^2(s^2+2s+1) + 2s^4 + 2s^3 = 0 \Leftrightarrow$

$\Leftrightarrow -3s^4 - 6s^3 - 3s^2 + 2s^4 + 2s^3 = 0 \Leftrightarrow$

$\Leftrightarrow -s^4 - 4s^3 - 3s^2 = 0 \Leftrightarrow \begin{cases} s = 0 \\ s = -4{,}172 \end{cases}$

$1 + K\frac{(s+1)^2}{s^3} = 0 \Big|_{s = j\omega} \Leftrightarrow 1 + K\frac{(j\omega+1)^2}{-j\omega^3} = 0 \Leftrightarrow K(-\omega^2 + 2j\omega + 1) = j\omega^3 \Leftrightarrow -\omega^2 K + 2\omega K j + K = j\omega^3 \Leftrightarrow \begin{cases} -\omega^2 K + K = 0 \\ 2\omega K = \omega^3 \end{cases} \Leftrightarrow \begin{cases} \omega = 1 \\ K = \frac{1}{2} \end{cases}$

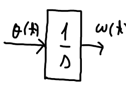
2.5) $\Theta(s) = \frac{D_1(s)G(s)}{1 + K(s)G(s)}$

$\lim_{s\to 0} s\Theta(s) = \lim_{s\to 0} s \cdot \frac{\frac{1}{s} \cdot \frac{1}{s^2}}{1 + \frac{K(s+1)^2}{s^3}} = \lim_{s\to 0} s \cdot \frac{1}{1 + K(s+1)^2} = \frac{0}{1+K} = 0$

2.6) $K(s) = K\frac{(s+1)^2}{s} = K\frac{s^2+2s+1}{s} = K(s + 2 + \frac{1}{s})$ $\begin{cases} \rightarrow K_P = 2 \\ \rightarrow K_I = 1 \\ \rightarrow K_D = 1 \end{cases}$

2.7) $\omega(t) = \dot{\theta}(t)$

$\frac{\Delta W}{\Delta\Theta} = s \Leftrightarrow \frac{\Delta\Theta}{\Delta W} = \frac{1}{s}$



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