SISTEMAS DINAMICOS

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# Video 2

## SISTEMA DE CONTROL POR REALIMENTACIÓN DE ESTADOS

$G(s) = \frac{20(s+5)}{(s+1)(s+4)}$ → Con un overshot 0,5% 1,5%
$ts = 0,74$ Seg

$U(s) \rightarrow \boxed{\frac{1}{s^3+5s^2+4s}} \xrightarrow{X_1(s)} \boxed{0s+20s+100} \rightarrow Y(s)$

$\frac{X_1(s)}{Y(s)} = \frac{1}{s^3+5s^2+4s} \Rightarrow (s^3 5s^2+4s)\, X_1(s) = V(s) \Rightarrow \dddot{x}_1 + 5\ddot{x}_1 - 4\dot{x}_1 = u$

$x_1 = x_1$
$x_2 = \dot{x}_1$
$x_3 = \dot{x}_1 = \ddot{x}_1$

$\dot{x}_3 \ldots \dddot{x}_1$
$\dot{x}_3 = -5x_3 - 4x_2 + u$

$(-K_3 x_3 - K_2 x_2 - K_1 x_1 + 5)$

$x_3 = -K_1 x_1 - (4+K_2)x_2 - (5+K_3)x_3 + 5$

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -K_2 & (-4+K_2) & (-5+K_3) \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} r$$

$\det(SI - (A - BK)) = s^3 + (5+K_3)s^2 + (4+K_2)s + K_1 = 0$

$(s + 5,4 - j\,7,2)(s + 5.4 + j\,7,2)(s + 5.1) = T$

$T = s^3 + 15,9\, s^2 + 136,22\, s + 413,83 = 0$

$s^3 + (5+K_3)s^2 + (4+K_2)s + K_1 = s^3 + 15,9 s^2 + 136,22 s + 413,83$

$(5+K_3)s^2 = 15,9 s^2$
$5+K_3 = 15,95$
$K_3 = 10.9$

$(4+K_2)s = 136.22 s$
$4+K_2 = 136,22$
$K_2 = 132,22$

$K_1 = 413,83$

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ k_1 & k_2 & k_3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} r \qquad y = \begin{bmatrix} 100 & 20 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

$$T(s) = \frac{20s + 100}{s^3 + 15.95s^2 + 136.22s + 413.8}$$

$$y(s) = (b_2 s^2 + b_1 s + b_0)\, X_1(s)$$
$$= (0s^2 + 20s + 100)\, X_1(s)$$
$$= (20s + 100)\, X_1(s)$$

Aplicando $\mathcal{L}^{-1}$ $\rightarrow$ $20\dot{x} + 100x$

$$y = 20x_2 + 100x_1$$

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -4 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u \qquad y = \begin{bmatrix} 100 & 20 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

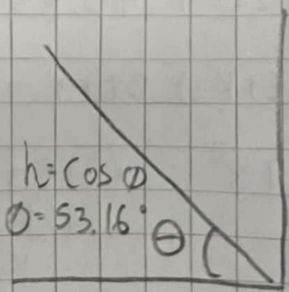
Over $\therefore$ $\%OS = e^{-\left(\mu\pi / \sqrt{1-\mu^2}\right)} \times 100$

$$\ln(0,095) = \ln\left(e^{-\frac{\mu\pi}{\sqrt{1-\mu^2}}}\right)$$

$$-(2,3539(\sqrt{1-\mu^2})) = (-\mu\pi)^2$$
$$5,5407(1-\mu^2) = \mu^2\pi^2$$
$$5,5407 - 5,5407\mu^2 = \mu^2\pi^2$$
$$5,5407 = \mu^2(\pi^2 + 5,5407)$$

$$\mu^2 = \frac{5,5407}{\pi^2 + 5,5407} \rightarrow \mu = 0,5996$$

$s = \sigma + j\omega_d$ $\quad$ $\arccos(0,599)$



$t_s = \frac{4}{\sigma}$

$0{,}74 = \frac{4}{\sigma}$

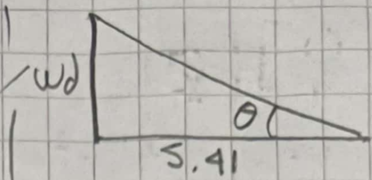
$\sigma = 4/0{,}74$

$\sigma = 5{,}405$

$\sigma = \zeta\omega_n$

$5{,}402 = 0{,}5976\ \omega_n$

$\boxed{\omega_n = 9.02}$



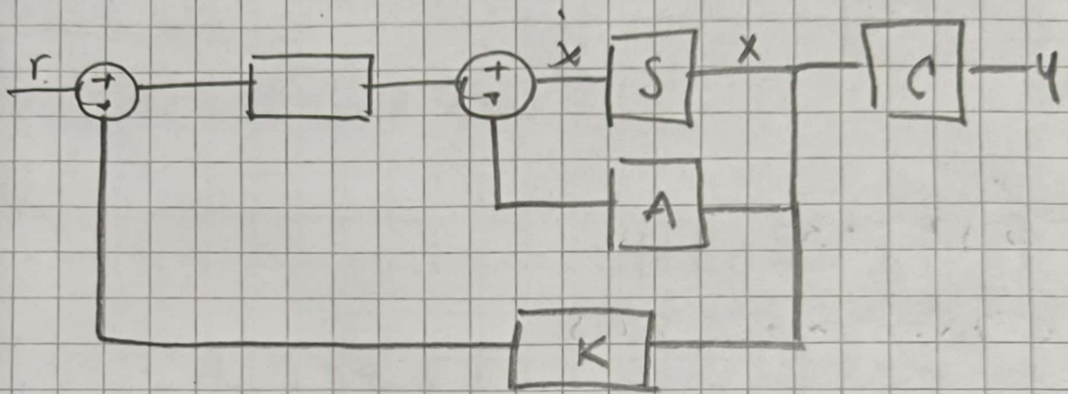

$\tan\theta = \omega_d / 5.41$

$\tan d\,(53.16)\ 5{,}41 = \omega_d$

$\omega_d = 7.22$

$\dot{x} = Ax + Bx$

$y = (x)$




$\dot{x} = Ax + Bn$

$= Ax + B(-nx + r)$

$= Ax - Bx\,n + Br$

$\dot{x} = (A - Bn) + Br)$