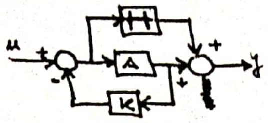
1/2

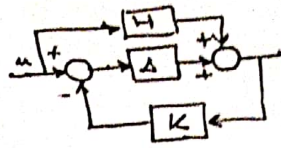
ICI
PARCIAL 1
2003

EJERCICIO 1 2pt c/u (TOTAL 6 puntos)

a) (A) ii) $\frac{Y(s)}{U(s)} = \frac{A+H}{1+AK}$



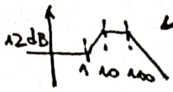
(B) iii) $\frac{Y(s)}{U(s)} = \frac{A+H}{1+AK}$



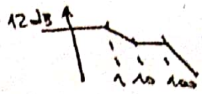
b) (A) iv) Temp horno → regulador

(B) iii) Posicionador brazo robótico → servo

c) (A) i) $F(s) = \frac{4000(s+1)}{(s+10)(s+100)}$



(B) ii) $F(s) = \frac{40(s+10)}{(s+1)(s+100)}$



Resumen: ii) iv) ii)

iv) iii) iii) • i) 1/2 bien

EJERCICIO 2

a) $\begin{cases} \dot{y} = w - 5y \\ \dot{w} = k(u-y) \end{cases} \Rightarrow \boxed{\begin{bmatrix} \dot{y} \\ \dot{w} \end{bmatrix} = \begin{bmatrix} -5 & 1 \\ -k & 0 \end{bmatrix}\begin{bmatrix} y \\ w \end{bmatrix} + \begin{bmatrix} 0 \\ k \end{bmatrix} u \qquad y = \begin{bmatrix} 1 & 0 \end{bmatrix}\begin{bmatrix} y \\ w \end{bmatrix} + [0]u}$

$\boxed{H(s) = \frac{k}{s^2+5s+k}}$

b) $\begin{cases} 5 = 2\zeta w_n \\ K = w_n^2 \end{cases} \Rightarrow K = \left(\frac{2{,}5}{\zeta}\right)^2$

(A) $\zeta = 0{,}625 \Rightarrow \boxed{K = 16,\ w_n = 4,\ H(s) = \frac{16}{s^2+5s+16}}$

(B) $\zeta = 0{,}5 \Rightarrow \boxed{K = 25,\ w_n = 5,\ H(s) = \frac{25}{s^2+5s+25}}$

c) Como cond. iniciales son nulas $\Rightarrow y(t) = \mathcal{L}^{-1}\left\{\frac{H(s)}{s}\right\} = 1 - \frac{1}{\sqrt{1-\zeta^2}} e^{-\zeta w_n t} \cdot \operatorname{sen}\left(w_n\sqrt{1-\zeta^2} \cdot t + \theta\right)$

con $\theta = \arccos \zeta$

(A) $y(t) = 1 - 1{,}28 \cdot e^{-2{,}5 \cdot t} \cdot \operatorname{sen}(3{,}12 \cdot t + 51{,}3°)$

$ST = 100 \cdot e^{-\frac{\pi\zeta}{\sqrt{1-\zeta^2}}}$

$ST = 8{,}1\%$

$t_r \simeq 0{,}49\,s$

Si: $t_r \cong \frac{0{,}366\, e^{2\zeta} + 0{,}654}{w_n}$ $\quad t_r \cong 0{,}483\,s$

$t_r \simeq \frac{1{,}1 - 0{,}04 \cdot \zeta + 2{,}23\zeta^2}{w_n}$

$t_s^{2\%} \simeq 1{,}66\,s$

$t_s^{2\%} \simeq \frac{-1}{\zeta w_n} \cdot \ln\left(0{,}02\sqrt{1-\zeta^2}\right)$

(B) $y(t) = 1 - 1{,}15 \cdot e^{-2{,}5 \cdot t} \cdot \operatorname{sen}(4{,}33 \cdot t + 60°)$

$ST = 16{,}3\%$

$t_r = 0{,}33\,s$

$t_s^{2\%} = 1{,}62\,s$

d) $u(t) = 5 \cdot \operatorname{sen}(0{,}1 \cdot t) + 10 \cdot \operatorname{sen}(400t)$

Como las frecuencias están muy alejadas de w_n (más de una década) es válido aproximar por el Bode asintótico la respuesta en régimen

$G(j0{,}1) \simeq G(0) = 1$

$G(j400)$ → (A) $-80\,dB \to \times 10^{-4}$; (B) $-76\,dB \to 1{,}56 \times 10^{-4}$

(A) $y(t) = 5 \cdot \operatorname{sen}(0{,}1t) + 10^{-3} \cdot \operatorname{sen}(400 \cdot t - 180°)$

(B) $y(t) = 5 \cdot \operatorname{sen}(0{,}1 \cdot t) + 1{,}56 \cdot 10^{-3} \cdot \operatorname{sen}(400 \cdot t - 180°)$

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EJERCICIO 3

a) Balance de energía en recipiente : $cV_0.\dot{T} = \frac{V_2^2}{R_c} + c.q(T_f - T)$

Motor eléctrico de CC : $\left\{\begin{array}{l} V_1 = Ra.I_a + K_M.\dot{\theta}_M \\ J\ddot{\theta}_M = -b\dot{\theta}_M + K_M.I_a \end{array}\right\} \Rightarrow \boxed{\ddot{\theta}_M = \frac{K_M}{JRa}.V_1 - \frac{1}{J}\left(b + \frac{K_M^2}{Ra}\right)\dot{\theta}_M}$

Además : $q = K_V.\dot{\theta}_M$

$\Rightarrow \boxed{\dot{T} = \frac{V_2^2}{cV_0R_c} + \frac{K_V.\dot{\theta}_M}{V_0}(T_f - T)}$

b) En el punto de trabajo : $\dot{T}^0 = 0 = \frac{V_2^{0\,2}}{cV_0R_c} + \frac{K_V}{V_0}.\dot{\theta}_M^0(T_f - T^0) \Rightarrow \boxed{T^0 = \frac{V_2^{0\,2}}{cR_c.K_V\dot{\theta}_M^0} + T_f}$

(A) $\boxed{T^0 = 20}$ (B) $\boxed{T^0 = 20}$

c) El modelo lineal resulta:

$$\left\{\begin{array}{l} \dot{t} = \frac{2V_2^0}{cV_0R_c}.v_2 + \frac{K_V}{V_0}.(T_f - T^0).\dot{\theta}_M - \frac{K_V}{V_0}.\dot{\theta}_M^0.t \\ \ddot{\theta}_M = \frac{K_M}{J.Ra}.v_1 - \frac{1}{J}.\left(b + \frac{K_M^2}{Ra}\right).\dot{\theta}_M \end{array}\right.$$

$$\begin{bmatrix} t \\ \theta_M \\ \dot{\theta}_M \end{bmatrix}^{\bullet} = \begin{bmatrix} -\frac{K_V}{V_0}.\dot{\theta}_M^0 & \frac{K_V}{V_0}.(T_f - T^0) & 0 \\ 0 & 0 & 1 \\ 0 & 0 & -\frac{1}{J}\left(b + \frac{K_M^2}{Ra}\right) \end{bmatrix} . \begin{bmatrix} t \\ \theta_M \\ \dot{\theta}_M \end{bmatrix} + \begin{bmatrix} 0 & \frac{2V_2^0}{c.V_0.R_c} \\ 0 & 0 \\ \frac{K_M}{J.Ra} & 0 \end{bmatrix} . \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

$$t = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} . \begin{bmatrix} t \\ \theta_M \\ \dot{\theta}_M \end{bmatrix}$$

	(A)	(B)
$\frac{2V_2^0}{cV_0R_c}$	$= 40$	$= 20$
$\frac{K_V}{V_0}(T_f - T_0)$	$= -250$	$= -250$
$-\frac{K_V}{V_0}.\dot{\theta}_M^0$	$= -20$	$= -20$
$-\frac{1}{J}\left(b + \frac{K_M^2}{Ra}\right)$	$= -5$	$= -5$
$\frac{K_M}{J.Ra}$	$= 3$	$= 3$

Matriz de transferencia

$$\left(s + \frac{K_V}{V_0}\dot{\theta}_M^0\right)T(s) = \frac{2V_2^0}{cV_0R_c}.V_2(s) + \frac{K_V}{V_0}(T_f - T^0).\theta(s)$$

$$\theta(s)\left(s^2 + \frac{1}{J}\left(b + \frac{K_M^2}{Ra}\right).s\right) = \frac{K_M}{J.Ra}.V_1(s)$$

$$\Rightarrow T(s) = \frac{1}{s + \frac{K_V}{V_0}\dot{\theta}_M^0} . \left[\frac{K_V}{V_0}.(T_f - T^0).\frac{K_M}{J.Ra}.\frac{1}{s\left(s + \frac{1}{J}\left(b + \frac{K_M^2}{Ra}\right)\right)} \quad \frac{2V_2^0}{c.V_0.R_c} \right] \begin{bmatrix} V_1(s) \\ V_2(s) \end{bmatrix}$$

$$H(s) = \left\{\begin{array}{ll} (A) & \frac{1}{s+20}\left[\frac{-750}{s(s+5)} \quad 40\right] \\ (B) & \frac{1}{s+20}\left[\frac{-750}{s(s+5)} \quad 20\right] \end{array}\right.$$