Universidade Federal do Rio de Janeiro

Escola Politécnica

DATA: 05/10/2009

GRAUS: 1, 2, 3, 4, 5

Aluno: GABARITO DA PROVA PARCIAL #1

Disciplina: CONTROLE LINEAR II-A

Turma: EEL760

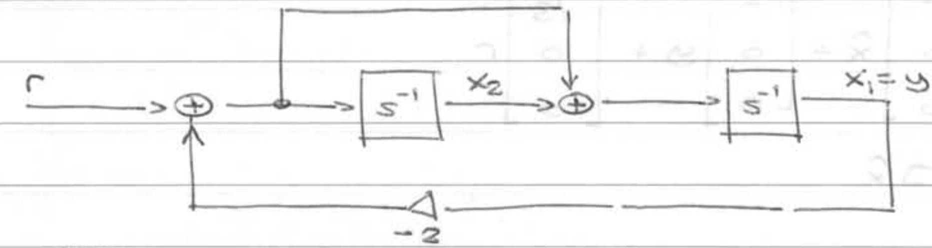
Professor: JOSÉ GABRIEL R. C. GOMES

QUESTÃO #1:

a) $T = \begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix}$

b) $K = [\,2 \;\; 0\,]$

c)




d) $$\frac{\dfrac{s+1}{s^2}}{1 + \dfrac{2s+2}{s^2}} = \frac{s+1}{s^2+2s+2}$$

QUESTÃO #2:

a) $Y(s) = \dfrac{1}{s^2+2s+2} \Longrightarrow y(t) = \left(e^{-t}\sin t\right)u(t)$

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

$$y(t) = \left(e^{-t}\sin t\right)u(t) + \frac{1}{2}\left(1 - e^{-t}(\cos t + \sin t)\right)u(t)$$

$$y(t) = \frac{1}{2}\left(1 - e^{-t}(\cos t - \sin t)\right)u(t)$$

c) $H(s) = \dfrac{s+1}{s^2+2s+2} \Longrightarrow h(t_p) = \cancel{e^{-t_p}\sin t_p} - \cancel{e^{-t_p}\sin t_p} + e^{-t_p}\cos t_p = 0$

$t_p = \dfrac{\pi}{2}$

OVERSHOOT: $\dfrac{1}{2}\left(1 + e^{-\frac{\pi}{2}}\right)u(t) \Longrightarrow M_p = 20\%$

d) $\overline{N} = 2$

QUESTÃO #3:

a) $\hat{x}' = \begin{bmatrix} 0 & 0 & -3 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} \hat{x} + \begin{bmatrix} 2 \\ 0 \\ 0 \end{bmatrix} y$

$u = -[0 \quad 0 \quad 1]\,\hat{x}$

b) $-[0 \quad 0 \quad 1] \begin{bmatrix} s & 0 & 3 \\ -1 & s & 0 \\ 0 & -1 & s \end{bmatrix}^{-1} \begin{bmatrix} 2 \\ 0 \\ 0 \end{bmatrix} = \dfrac{-2}{s^3+3}$

c) $\dfrac{\frac{1}{s^3}}{1 + \frac{2}{(s^3+3)s^3}} = \dfrac{s^3+3}{s^6+3s^3+2} = \dfrac{s^3+3}{(s^3+1)(s^3+2)}$

$s = e^{\frac{j\pi}{3}} \Rightarrow s^3+1=0$ O SISTEMA É INSTÁVEL.

d) $\hat{x}' = \begin{bmatrix} 0 & 0 & -3 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} \hat{x} + \begin{bmatrix} 2 \\ 0 \\ 0 \end{bmatrix} y + \begin{bmatrix} 1/3 \\ 0 \\ 0 \end{bmatrix} r$

$u = -[0 \quad 0 \quad 1]\,\hat{x}$

QUESTÃO #4:

a) $(a - bx_{20}) = 0 \Rightarrow x_{20} = a/b$

$-(c+1) + dx_{10} = 0 \Rightarrow x_{10} = (c+1)/d$

$F = \begin{bmatrix} 0 & -b(c+1)/d \\ ad/b & 0 \end{bmatrix} \qquad G = \begin{bmatrix} 0 \\ -a/b \end{bmatrix}$

b) $|sI - F| = s^2 + a(c+1)$

PÓLOS: $\pm j\sqrt{a(c+1)}$ O SISTEMA É INSTÁVEL, MARGINALMENTE.

(NÃO É BIBO ESTÁVEL)

c) $|sI - F + GK| = s^2 - 0.5k_2 s + 1 + 0.5k_1 = s^2 + 2s + 2 \Rightarrow K = [2 \quad -4]$

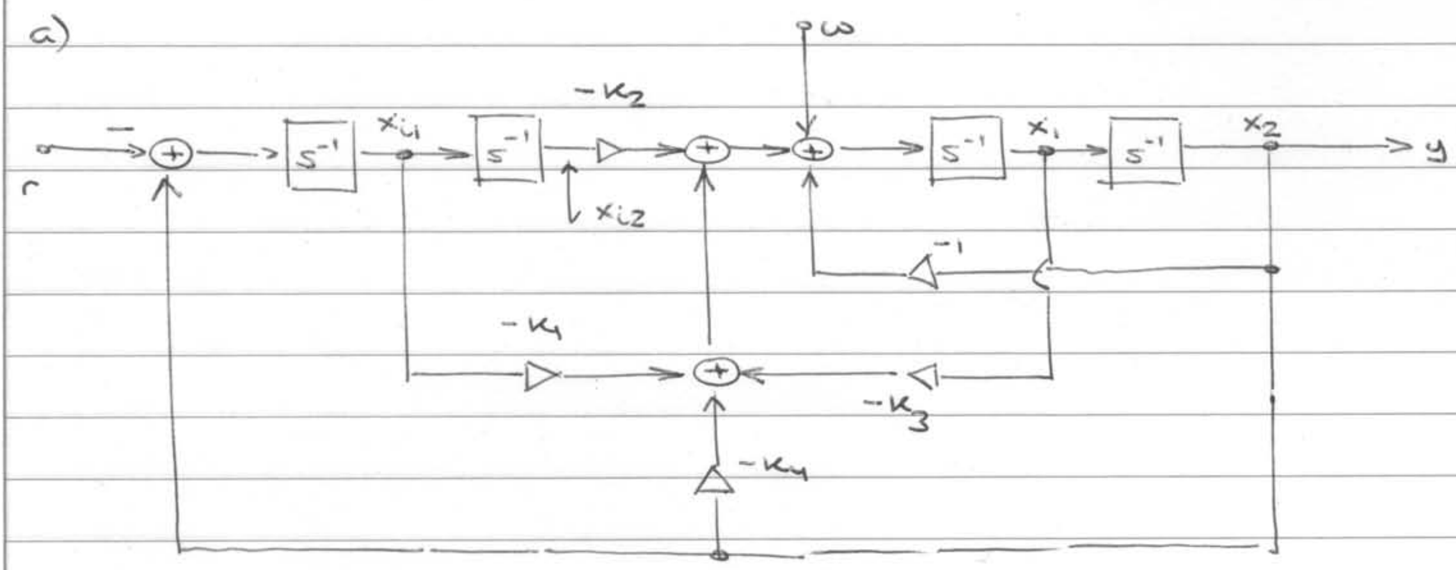
d) $P = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \Rightarrow T^{-1}FT = \begin{bmatrix} 0 & ad/b \\ -b(c+1)/d & 0 \end{bmatrix}$

$|sI - F_{bb} + LF_{ab}| = s + \dfrac{Lad}{b} = s + 10$

$L = \dfrac{10b}{ab}$

Questão #5:

a)




b)
$$\begin{bmatrix} x_{i1}' \\ x_{i2}' \\ x_1' \\ x_2' \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 \\ -k_1 & -k_2 & -k_3 & -1-k_4 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} x_{i1} \\ x_{i2} \\ x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} -1 \\ 0 \\ 0 \\ 0 \end{bmatrix} r + \begin{bmatrix} 0 \\ 0 \\ 1 \\ 0 \end{bmatrix} \omega$$

$$\begin{vmatrix} s & 0 & 0 & \overset{-1}{\cancel{x}} \\ -1 & s & 0 & 0 \\ k_1 & k_2 & s+k_3 & 1+k_4 \\ 0 & 0 & 0 & s \end{vmatrix} = s^4 + k_3 s^3 + (k_4+1)s^2 + k_1 s + k_2$$

$$K = [k_1 \ k_2 \ k_3 \ k_4] = [1 \ 1 \ 1 \ 0]$$

c)
$$[0 \ 0 \ 0 \ 1] \begin{bmatrix} s & 0 & 0 & -1 \\ -1 & s & 0 & 0 \\ -1 & -1 & s+1 & 1 \\ 0 & 0 & -1 & s \end{bmatrix}^{-1} \begin{bmatrix} -1 \\ 0 \\ 0 \\ 0 \end{bmatrix} = \frac{(s+1)}{\alpha_c(s)}$$

d)
$$[0 \ 0 \ 0 \ 1] \begin{bmatrix} s & 0 & 0 & -1 \\ -1 & s & 0 & 0 \\ -1 & -1 & s+1 & 1 \\ 0 & 0 & -1 & s \end{bmatrix}^{-1} \begin{bmatrix} 0 \\ 0 \\ 1 \\ 0 \end{bmatrix} = \frac{s^2}{\alpha_c(s)}$$