

FAKULTAS TEKNIK
UNIVERSITAS HASANUDDIN

No. Stb. : D041171002

Mata Pelajaran : Sistem Kendali

Semester : 5

Strata : S-1

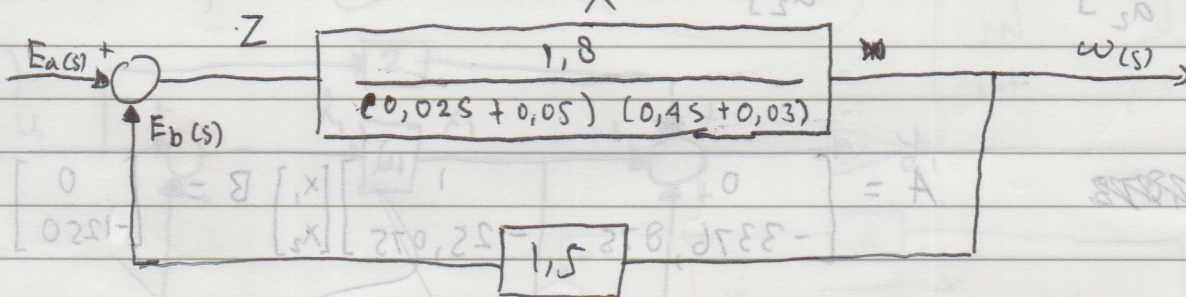
Tgl. Ujian : 20 Desember 2019

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19/10
87

1.) (a)



$$\begin{aligned} Z &= E_a(s) - E_b(s) \\ &= E_a(s) - 1,5 W(s) \end{aligned}$$

$$\begin{aligned} W(s) &= Z \cdot X \\ &= Z \cdot \frac{1,8}{(0,02s + 0,05)(0,4s + 0,03)} \end{aligned}$$

$$W(s) = (E_a(s) - 1,5 W(s)) \cdot \frac{1,8}{(0,02s + 0,05)(0,4s + 0,03)}$$

$$W(s) = (E_a(s) - 1,5 W(s)) \cdot \frac{1,8}{0,0008s^2 + 0,02006s + 0,0015}$$

$$W(s) (0,0008s^2 + 0,02006s + 0,0015) = 1,8 E_a(s) - 2,7 W(s)$$

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$$1,8 E_a(s) = W(s) (0,0008s^2 + 0,02006s + 2,7015)$$

$$\frac{W(s)}{E_a(s)} = \frac{1,8}{0,0008s^2 + 0,02006s + 2,7015}$$

2.)

$$a_0 = 2,70 \text{ s}^2$$

$$b_0 = 1,8$$

$$a_1 = 0,02006$$

$$a_2 = 0,0008$$

$$A = \begin{bmatrix} 0 & 1 \\ -\frac{a_0}{a_2} & -\frac{a_1}{a_2} \end{bmatrix}$$

$$B = \begin{bmatrix} 0 \\ \frac{1}{a_2} \end{bmatrix}$$

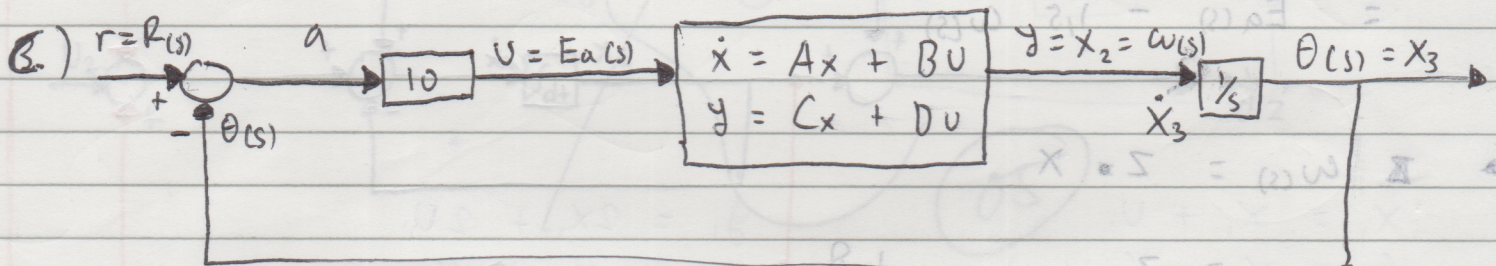
$$C = [b_0 \quad b_1]$$

Ans ~~2,70 s^2~~

$$A = \begin{bmatrix} 0 & 1 \\ -3376,875 & -25,075 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 1250 \end{bmatrix} U$$

(10)

$$C = [1,8 \quad 0] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$



$$\begin{aligned} E_a &= R(s) - \theta(s) \\ &= 10 R(s) - 10 \theta(s) \end{aligned}$$

(03)

$$U = 10 R(s) - 10 \theta(s)$$

$$x_2 = w(s) \quad \dot{x}_3 = w(s)$$

$$x_3 = \theta(s)$$

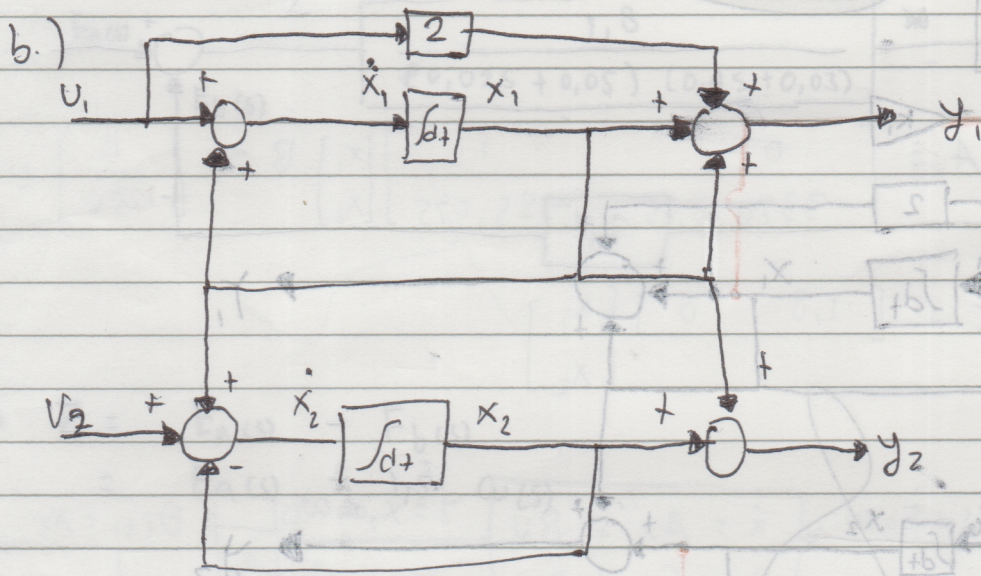
$$A = \begin{bmatrix} +20000,0 & 0,0008 \\ 0,0008 & 0,02006 \end{bmatrix} \begin{bmatrix} w(s) \\ \theta(s) \end{bmatrix} \quad B = \begin{bmatrix} 10 R(s) - 10 \theta(s) \end{bmatrix}$$

2.) a.) masukan $(u) = m = 2$

Perbah keadaan $= n = 2$

Keluaran $= h = 2$

10 $A = [n \times n] = [2 \times 2]$ $B = [n \times m] = [2 \times 2]$ $C = [h \times n] = [2 \times 2]$ $D = [h \times m] = [2 \times 2]$



$$\dot{x}_1 = x_1 + u_1$$

$$\dot{x}_2 = x_1 - x_2 + u_2$$

$$y_1 = 2x_1 + 2u_1$$

$$y_2 = x_1 + x_2$$

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$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$$

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$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} 2 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 2 & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$$

c.)
$$[I\lambda - A] = \begin{bmatrix} \lambda & 0 \\ 0 & \lambda \end{bmatrix} - \begin{bmatrix} 1 & 0 \\ 1 & -1 \end{bmatrix} = \begin{bmatrix} \lambda - 1 & 0 \\ -1 & \lambda + 1 \end{bmatrix}$$

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$$(\lambda^2 - 1) = 0$$

$$\lambda^2 = 1$$

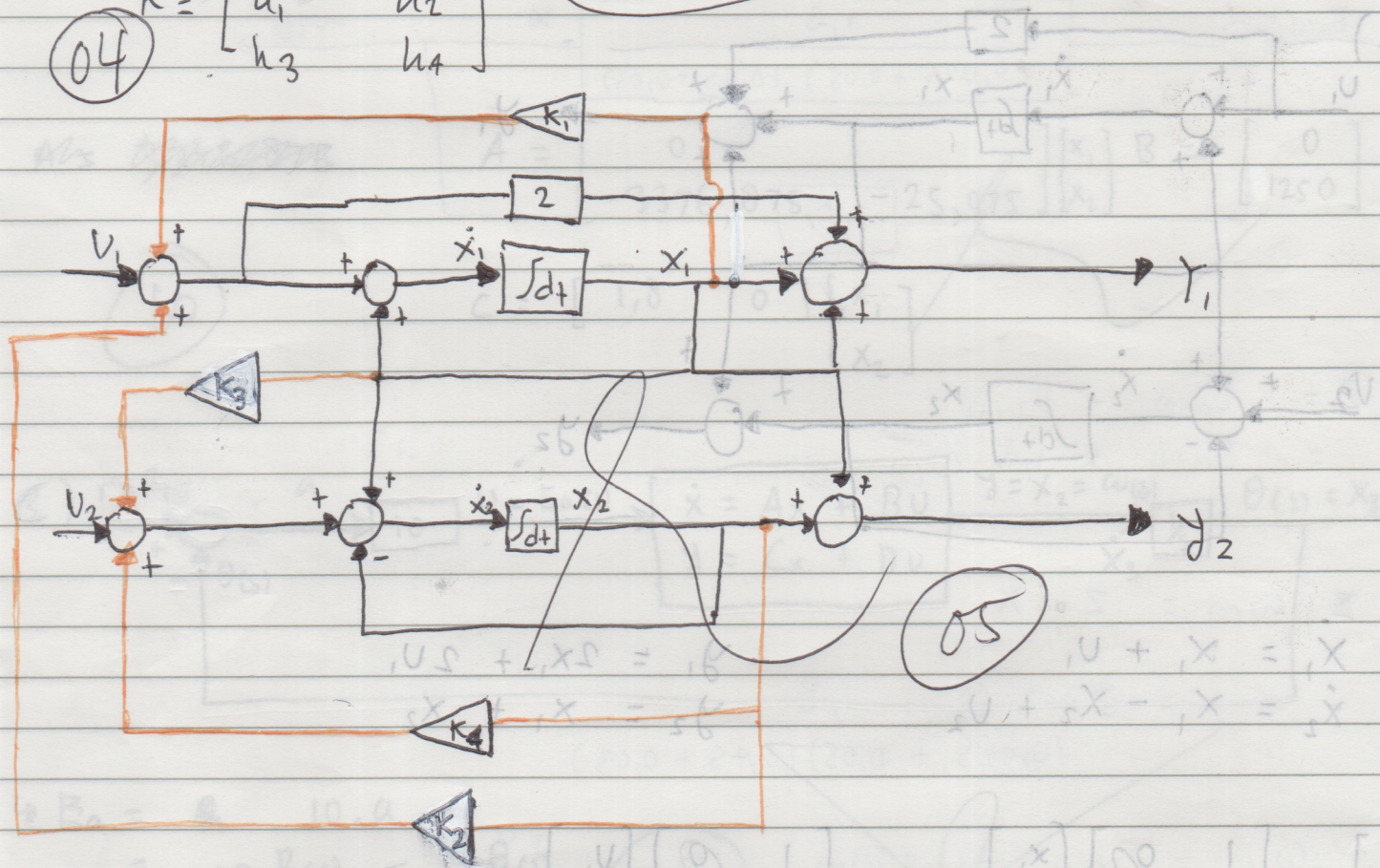
karena salah satu nilai eigen negatif

d.) $m = 2$ (masukan) dan $n = 2$ (Peubah pengikat)

(10) dimensi $K = [M \times n]$
 $= [2 \times 2]$ → terdapat 4 Peubah keadaan

e.) Terdapat 4 Peubah keadaan pengikat

(04) $K = \begin{bmatrix} k_1 & k_2 \\ k_3 & k_4 \end{bmatrix}$



f.)

$$\bar{A} = [A + BK] = \begin{bmatrix} 1 & 0 \\ 1 & -1 \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} K_1 & K_2 \\ K_3 & K_4 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & -1 \end{bmatrix} + \begin{bmatrix} K_1 & K_2 \\ K_3 & K_4 \end{bmatrix}$$

$$= \begin{bmatrix} 1+K_1 & K_2 \\ 1+K_3 & K_4-1 \end{bmatrix}$$

~~det~~ $\lambda_1 = \lambda_2 = -1$

↳ $\det [\lambda I - \bar{A}] = 0$

$\begin{bmatrix} \lambda & 0 \\ 0 & \lambda \end{bmatrix} - \begin{bmatrix} 1+K_1 & K_2 \\ 1+K_3 & K_4-1 \end{bmatrix} = \begin{bmatrix} \lambda-1-K_1 & -K_2 \\ -1-K_3 & \lambda-K_4+1 \end{bmatrix} = 0$

$$\begin{bmatrix} \lambda - 1 - k_1 & -k_2 \\ -1 - k_3 & \lambda - k_4 + 1 \end{bmatrix} = 0$$

$$(\lambda - 1 - k_1)(\lambda - k_4 + 1) - (-1 - k_3)(-k_2) = 0$$

$$\lambda^2 - k_4\lambda + \lambda - \lambda + k_4 - 1 - k_1\lambda + k_1k_4 - k_1 - k_2 - k_2k_3 = 0$$

$$\lambda^2 - (k_1 + k_4)\lambda + (k_1k_4 - k_2k_3 - k_1 - k_2 + k_4 - 1) = 0$$

untuk $\lambda = -1 \rightarrow \lambda^2 + 2\lambda + 1$

$$1 - k_1 - k_4 + k_1k_4 - k_2k_3 - k_1 - k_2 + k_4 - 1 = 0$$

$$\lambda^2 - (k_1 + k_4)\lambda + (k_1k_4 - k_2k_3 - k_1 - k_2 + k_4 - 1) = \lambda^2 + 2\lambda + 1$$

$$\begin{aligned} k_1k_4 - k_2k_3 - k_1 - k_2 + k_4 - 1 &= 1 \\ k_1k_4 - k_2k_3 - k_1 - k_2 + k_4 &= 2 \end{aligned}$$

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$$\begin{aligned} -(k_1 + k_4) &= 2 \rightarrow k_4 = -k_1 - 2 \\ k_4 &= -2 \end{aligned} \quad \text{misalkan } k_1 = 0$$

$$k_1(-k_1 - 2) - k_2k_3 - k_1 - k_2 - k_1 + 2 = 2$$

$$-k_1^2 - 2k_1 - k_2k_3 - 2k_1 - k_2 = 4$$

$$-k_1^2 - 4k_1 - k_2(k_3 + 1) = 4$$

$$-k_2(k_3 + 1) = 4 \rightarrow \text{mis } k_2 = 1$$

$$-k_3 - 1 = 4$$

$$k_3 = -5$$

$$K = \begin{bmatrix} 0 & 1 \\ -5 & -2 \end{bmatrix}$$