

Alwanya Yostha Paramita
D041171320

No. Stb. : D041171320
Mata Pelajaran : Sistem Kendali I
Semester : 5
Strata : S1
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$$I. G(s) = \frac{W(s)}{Ea(s)}$$

20/5/82

(1)

$$a = Ea(s) = 1,5b$$

$$W(s) = b = a$$

$$(0,002s + 0,05)(0,4s + 0,03)$$

$$b = (Ea(s) - 1,5b) \frac{1,8}{0,0008s^2 + 0,00006s + 0,02s + 0,0015}$$

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

$$b = 1,8Ea(s) - 2,7b$$

$$0,0008s^2 + 0,02006s + 0,0015$$

$$b + \frac{2,7b}{0,0008s^2 + 0,02006s + 0,0015} = \frac{1,8Ea(s)}{0,0008s^2 + 0,02006s + 0,0015}$$

$$b \left(\frac{0,0008s^2 + 0,02006s + 0,0015 + 2,7}{0,0008s^2 + 0,02006s + 0,0015} \right) = \frac{1,8Ea(s)}{0,0008s^2 + 0,02006s + 0,0015}$$

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

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

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

$$(2) a_0 = 2,7015$$

$$b_0 = 1,8$$

$$a_1 = 0,02006$$

$$a_2 = 0,0008$$

$$A = \begin{bmatrix} 0 & 1 \\ -\frac{a_0}{a_2} & -\frac{a_1}{a_2} \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -3376,875 & -25,075 \end{bmatrix}$$

$$B = \begin{bmatrix} 0 \\ \frac{1}{a_2} \end{bmatrix} = \begin{bmatrix} 0 \\ 1250 \end{bmatrix}$$

$$C = [b_0 \ b_1] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = [1,8 \ 0] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -3376,875 & -25,075 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1250 \end{bmatrix} u$$

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

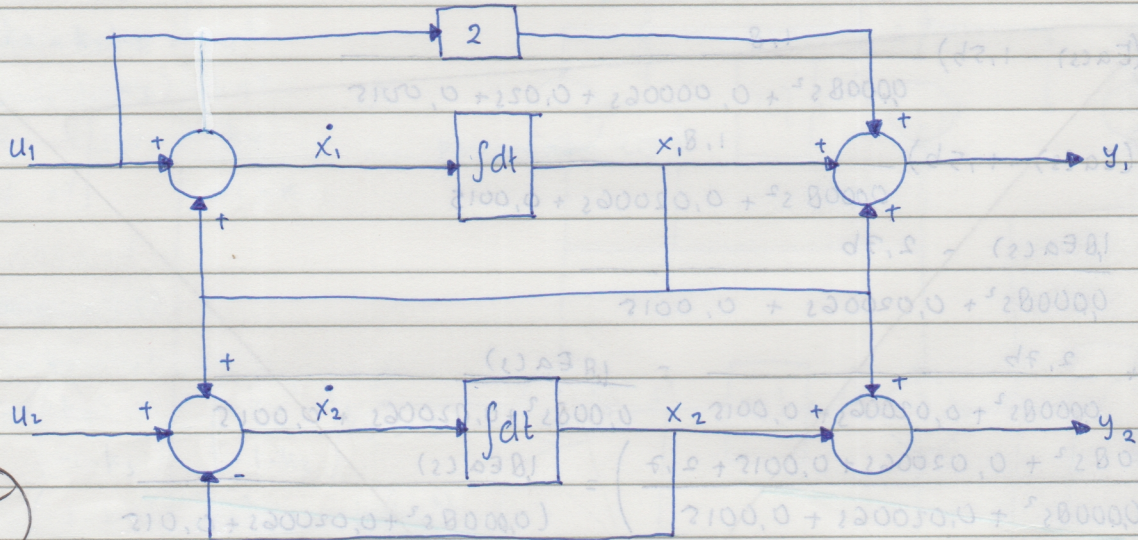
II. (1) masukan (u) $\Rightarrow m=2$

peubah keadaan $\Rightarrow n=2$

keluaran $\Rightarrow k=2$

10 $A = [n \times n] = [2 \times 2]$ $B = [n \times m] = [2 \times 2]$ $C = [k \times n] = [2 \times 2]$ $d = [k \times m] = [2 \times 2]$

(2)



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

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

$y_1 = 2u_1 + 2x_1$

$y_2 = x_1 + x_2$

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

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

(3) $\det([\lambda I - A]) = 0$

$\det \left(\begin{bmatrix} \lambda & 0 \\ 0 & \lambda \end{bmatrix} - \begin{bmatrix} 1 & 0 \\ 1 & -1 \end{bmatrix} \right) = 0$

$\det \begin{pmatrix} \lambda - 1 & 0 \\ -1 & \lambda + 1 \end{pmatrix} = 0$

$(\lambda - 1)(\lambda + 1) = 0$

$\lambda - 1 = 0 \quad \lambda + 1$

$\lambda = 1 \quad \lambda = -1$

Salah satu nilai eigen bernilai positif

maka kendalran ini tidak stabil.

Apabila suatu sistem ingin dikatakan

stabil maka semua nilai eigen

bernilai negatif.

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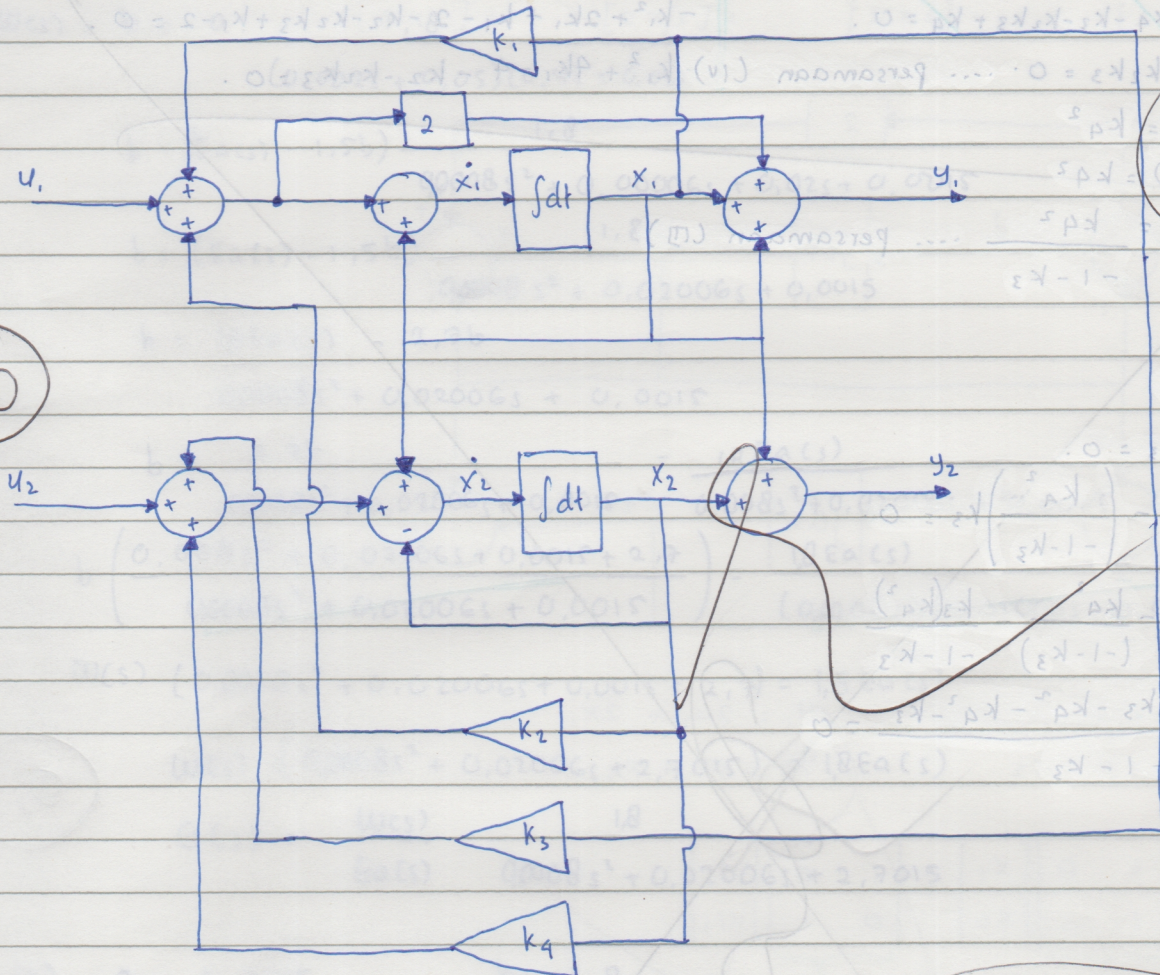
(4) Sistem Kendali dengan Umpan Balik Peubah Keadaan sehingga diperoleh matriks $\bar{A} = [A + BK]$

karena masukan $(m) = 2$, dan

peubah $(n) = 2$

maka dimensi $k = [m \times n] = [2 \times 2]$

(5)



ada 4 buah
penguat yang
digunakan

$$k = \begin{bmatrix} k_1 & k_2 \\ k_3 & k_4 \end{bmatrix}$$

$$k_1 = 1 \times 1$$

$$k_2 = 1 \times 2$$

$$k_3 = 2 \times 1$$

$$k_4 = 2 \times 2$$

$$(6) \bar{A} = [A + BK] = \begin{bmatrix} 1 & 0 \\ 1 & -1 \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} k_1 & k_2 \\ k_3 & k_4 \end{bmatrix}$$

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

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

nilai eigen kembar $\lambda_1 = \lambda_2 = -1$

$$(\lambda - \lambda_1)(\lambda - \lambda_2) = 0$$

$$(\lambda + 1)(\lambda + 1) = 0$$

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

$$\lambda^2 + 2\lambda + 1 = 0$$

lanjutan :

$$\lambda^2 + (k_1 - k_4)\lambda + k_4(-k_1 + 1) + k_1 - 1 - k_2(1 + k_3) = \lambda^2 + 2\lambda + 1$$

$$\underbrace{(k_1 - k_4)\lambda}_{I} + \underbrace{k_4(-k_1 + 1) + k_1 - 1 - k_2(1 + k_3)}_{II} = 2\lambda + 1$$

$$k_1 - k_4 = 2 \dots \text{Persamaan (I)}$$

Persamaan (II) :

$$k_4(-k_1 + 1) + k_1 - k_2(1 + k_3) = 2$$

$$k_4(-k_1 + 1) + k_1 - k_2(1 + k_3) = k_1 - k_4$$

$$\det [\lambda I - \bar{A}] = 0$$

$$\det \left(\begin{bmatrix} \lambda & 0 \\ 0 & \lambda \end{bmatrix} - \begin{bmatrix} 1+k_1 & k_2 \\ 1+k_3 & k_4-1 \end{bmatrix} \right) = 0$$

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

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

$$(\lambda^2 - \lambda k_4 + \lambda - \lambda + k_4 - 1 + \lambda k_1 - k_1 k_4 + k_1) - (k_2 + k_2 k_3) = 0$$

Persamaan (I) $\Rightarrow k_1 = k_4 = 2$

$$k_1 = 2 + k_4 \quad \vee \quad k_4 = k_1 - 2$$

lanjutan $\rightarrow$

$$-k_4 k_1 + k_4 + k_1 - k_2 - k_2 k_3 - k_1 + k_4 = 0.$$

$$-k_4 (2 + k_4) + k_4 - k_2 - k_2 k_3 + k_4 = 0.$$

$$-2k_4 - k_4^2 + k_4 - k_2 - k_2 k_3 + k_4 = 0.$$

$$-k_4^2 - k_2 - k_2 k_3 = 0.$$

$$-k_4 k_1 + k_4 - k_2 - k_2 k_3 + k_4 = 0$$

$$-(k_1 - 2)k_1 + (k_1 - 2) - k_2 - k_2 k_3 + (k_1 - 2) = 0$$

$$-k_1^2 + 2k_1 + k_1 - 2 - k_2 - k_2 k_3 + k_1 - 2 = 0$$

$$-k_1^2 + 4k_1 - 4 - k_2 - k_2 k_3 = 0.$$

Persamaan (IV)

$$\begin{pmatrix} k_4 & -1-k_3 \\ -1-k_3 & k_4 \end{pmatrix} \begin{pmatrix} k_4 \\ -1-k_3 \end{pmatrix} = 0$$

$$k_4^2 - k_4 - k_3 k_4 + k_3 = 0$$

$$k_4^2 - k_4 - k_3 k_4 + k_3 = 0$$

$$k_4^2 - k_4 - k_3 k_4 + k_3 = 0$$

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