Soal MID

Dari soal sebelumnya

$G(s) = \frac{1}{2s+1}$, $T = 0,5$ sec

$X(t) \to$ ZOH $\to G(s) \to Y(t)$

$G(z) = \frac{z-1}{z}\mathcal{Z}\left\{\frac{G(s)}{s}\right\} = \frac{z-1}{z}\mathcal{Z}\left[\frac{1}{s(2s+1)}\right]$

$= \frac{z-1}{z}\mathcal{Z}\left[\frac{1}{2s(s+0,5)}\right]$

$= \frac{1}{2}\frac{z-1}{z}\mathcal{Z}\left[\frac{1}{s(s+0,5)}\right]$

$= \frac{1}{2}\frac{z-1}{z}\mathcal{Z}\left[\frac{\frac{1}{0,5}}{s(s+0,5)}\right]$

$= \frac{z-1}{z}\left[\frac{1(1-e^{-0,5t})}{(s=0)(0-e^{-0,5t})}\right]$

$\frac{1}{s(s+a)}$

$\frac{Y(z)}{X(z)} = \frac{0,0498}{z-0,9512} = \frac{0,0498z^{-1}}{1-0,9512z^{-1}}$

Kali silang:

$(1-0,9512z^{-1})Y(z) = 0,0498z^{-1}X(z)$

$Y(z) = 0,0498z^{-1}X(z) + 0,9512z^{-1}Y(z)$

Inverse Z Transform

$y(k) = 0,0498\,x(k-1) + 0,9512\,y(k-1)$

Tabel.

t	k	x(k)	y(k)
0	0	1	0
0,1	1	1	0,0498
0,2	2	1	⋮
0,3	3	1	⋮
0,4	4	1	⋮
0,5	5	1	⋮

harus sama dengan 2,1 dan 2,3

* Praktikum Individu
* Praktikum Kelompok
- Selasa, 4 Mei 2015, jam 09:30
- Di LSKI, Kampus Tlogo
- Pak Amin (085294944225)
- Assisten Mas Nanang (082292306628)

* 09/05/2015 Kuliah
* 21/05/2015 Kuliah Terakhir
* 28/05/2015 FINAL (materi MID + kuliah 07 & 21/05/15)

DIKUMPUL
* Laporan Praktikum Individu
* Laporan Praktikum Kelompok.

* Model Ruang Keadaan

Persamaan Keadaan

$x(k+1) = Ax(k) + Bu(k)$

Persamaan Keluaran

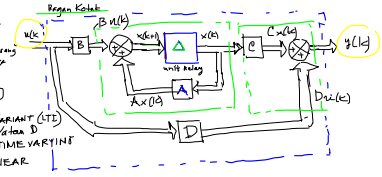
$y(k) = Cx(k) + Du(k)$

$u(k) \to$ Pers Keadaan, Pers Keluaran $\to y(k)$; clock, T

$x(k)$: peubah keadaan [n×1] vektor → sekarang
$x(k+1)$: peubah keadaan "sekuen berikutnya"
$u(k)$: masukan m buah → vektor [m×1]
$y(k)$: keluaran p buah → vektor [p×1]

[A] [n×n] B [n×m] C [p×n] D [p×m]

* Jika semua matrix A, B, C dan D adalah matrix konstanta → LINEAR TIME INVARIANT (LTI)
* Jika ada di antara matrix A, B, C dan/atau D mengandung fungsi k → LINEAR TIME VARYING
* selain yang di atas NON-LINEAR



Model Ruang Keadaan bersifat lebih "umum" (general) dan pada Model Nisbah Alih, karena ini SEMUA model Nisbah Alih pasti bisa diubah menjadi Model Ruang Keadaan, tapi belum tentu sebaliknya

Hanya Model Ruang Keadaan dari sistem LTI dan SISO, yang dapat diubah menjadi Model Nisbah Alih.

$x(k+1) = Ax(k) + Bu(k)$
$y(k) = Cx(k) + Du(k)$

$B = [n\times 1]$, $A = [n\times n]$
$C = [1\times n]$, $D = [1\times 1] \Rightarrow$ skalar

Mundur 1 langkah → $x(k) = Ax(k-1) + Bu(k-1)$

Transf. Z → $X(z) = Az^{-1}X(z) + Bz^{-1}U(z)$

$X(z) - Az^{-1}X(z) = Bz^{-1}U(z)$

$[I - Az^{-1}]X(z) = Bz^{-1}U(z)$

$z[I - Az^{-1}]X(z) = BU(z)$

$[zI - A]X(z) = BU(z)$

$X(z) = [zI - A]^{-1}BU(z)$

Trans. Z.

$Y(z) = CX(z) + DU(z)$

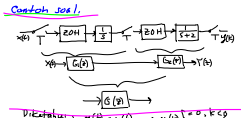
$Y(z) = C[zI-A]^{-1}BU(z) + DU(z)$

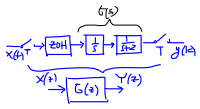
$= \underbrace{[C[zI-A]^{-1}B + D]}_{[1\times 1]}U(z)$

$\boxed{G(z)} = \frac{Y(z)}{U(z)} = \boxed{C[zI-A]^{-1}B + D}$

Contoh:

Contoh soal.





Diketahui: $x(t) = u(t) \to u(k) = \begin{cases} 0, & k<0 \\ 1, & k\geq 0 \end{cases}$

$T = 1$ sec

Tentukan $y(k)$, $k = 0, 1, 2, \ldots$

$G_1(z) = \frac{z-1}{z}\mathcal{Z}\left\{\frac{1}{s^2}\right\} = \frac{z-1}{z}\left[\frac{Tz}{(z-1)^2}\right] = \frac{1}{z-1}$

$G_2(z) = \frac{z-1}{z}\mathcal{Z}\left\{\frac{1}{s(s+2)}\right\} = \frac{z-1}{z}\left[\frac{1}{2}\mathcal{Z}\left\{\frac{2}{s(s+2)}\right\}\right] = \frac{1}{2}\frac{z-1}{z}\left[\frac{z(1-e^{-2})}{(z-1)(1-e^{-2})}\right]$

$= \frac{0,4323}{z-0,1353}$

$G(z) = G_1(z)\cdot G_2(z) = \frac{1}{z-1}\cdot\frac{0,4323}{z-0,1353} = \frac{0,4323}{z^2-1,1353z+0,1353}$

$X(z) = \mathcal{Z}x(t) = \mathcal{Z}u(t) = \frac{z}{z-1}$

$Y(z) = G(z)\cdot X(z) = \frac{0,4323z}{(z-1)(z^2-1,1353z+0,1353)}$

$= \frac{0,4323z}{z^3-2,1353z^2+1,2706z-0,1353}$

$G(z) = \frac{z-1}{z}\left\{\frac{1}{s^2(s+2)}\right\}$

$= \frac{z-1}{z}\left[\frac{1}{2}\left\{\frac{2}{s^2(s+2)}\right\}\right]$

$= \frac{z-1}{z}\left[\frac{1}{2}\left(\frac{T(z-1-e^{-2})z + (1-e^{-2}-2e^{-2})}{(z-1)^2(z-e^{-2})}\right)\right]$

$= \frac{1}{4}\left[\frac{0,8647z + 0,5940}{z^2-1,1353z+0,1353}\right]$

$= \frac{0,8647z + 0,5940}{4z^2-4,5412z+0,5412}$

$\to X(z) = \mathcal{Z}x(t) = \mathcal{Z}u(t) = \frac{z}{z-1}$

$Y(z) = G(z)\cdot X(z)$

Untuk menentukan $y(k)$, ada 2 (dua) cara:

(1) Pembagian.

$0,4323z^{-2} + 0,9231z^{-3} + 1,4218z^{-4} + 1,9216z^{-5}$

$z^3-2,1353z^2+1,2706z-0,1353 \;\big)\; 0,4323z$

$0,4323z - 0,9231 + 0,5493z^{-1} - 0,0585z^{-2}$

$0,9231 - 0,5493z^{-1} + 0,0585z^{-2}$

$0,9231 - 1,9741z^{-1} + 1,1729z^{-2} - 0,1249z^{-3}$

$1,4218z^{-1} - 1,1144z^{-2} + 0,1249z^{-3}$

$1,4218z^{-1} - 3,0360z^{-2} + 1,8065z^{-3} - 0,1924z^{-4}$

$1,9216z^{-2}$

k	x(k)	y(k)
0	1	0
1	1	0
2	1	0,4323
3	1	0,9231
4	1	1,4218
5	1	1,9216

Excell

(2) Pers. difference

$G(z) = \left[\frac{0,4323}{z^2-1,1353z+0,1353}\right]\frac{z^{-2}}{z^{-2}}$

$\frac{Y(z)}{X(z)} = \frac{0,4323z^{-2}}{1-1,1353z^{-1}+0,1353z^{-2}}$

Kali silang:

$(1-1,1353z^{-1}+0,1353z^{-2})Y(z) = 0,4323z^{-2}X(z)$

$Y(z) = 0,4323z^{-2}X(z) + 1,1353z^{-1}Y(z) - 0,1353z^{-2}Y(z)$

Inverse transf. Z :

$\boxed{y(k) = 0,4323x(k-2) + 1,1353y(k-1) - 0,1353y(k-2)}$ → excell

k	x(k)	y(k)
0	1	0
1	1	0
2	1	0,4323
3	1	0,9231
4	1	1,4218
5	1	1,9216

Pembagian			Pers Diff
k	x(k)	y(k)	y(k)
0	1	0	0
1	1	0,2162	0,2162
2	1	0,6101	0,6101
3	1	1,0280	1,0281
4	1	1,4485	1,4495
5	1	1,8701	1,8710