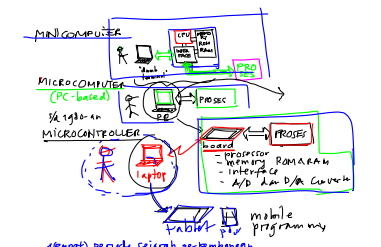
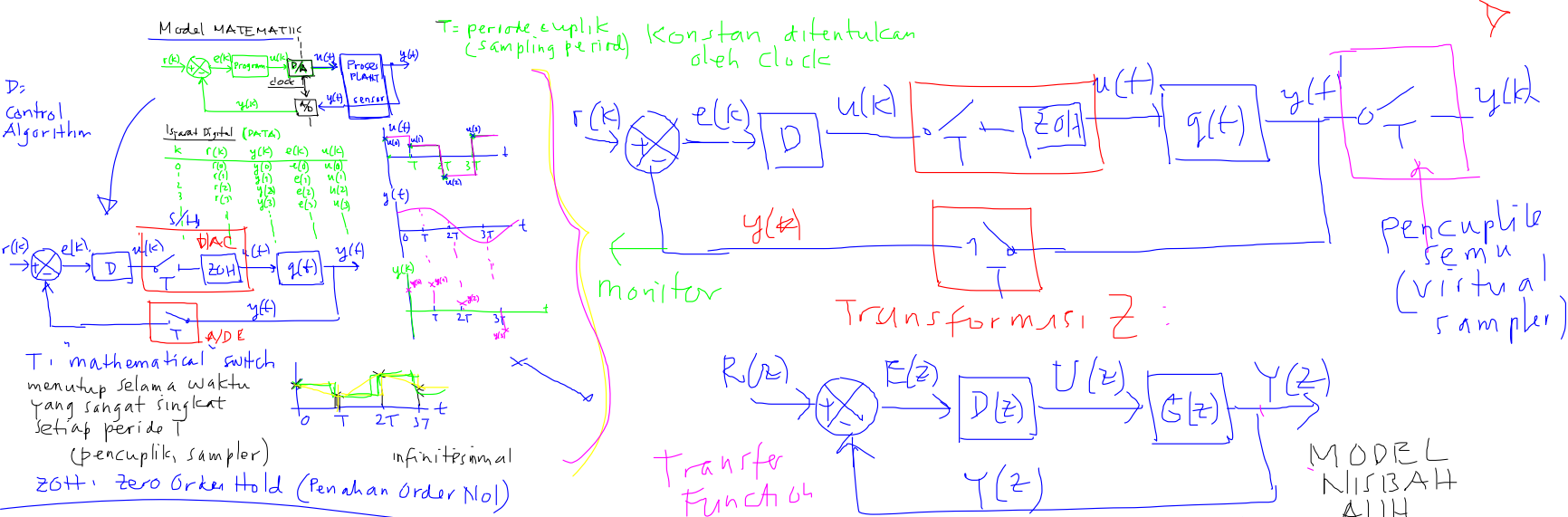


D:
Control
Algorithm



(dapat) periode sejarah perkembangan
 SISTEM KENDALI DIGITAL menurut
 Arifin & Niswanto [1984]

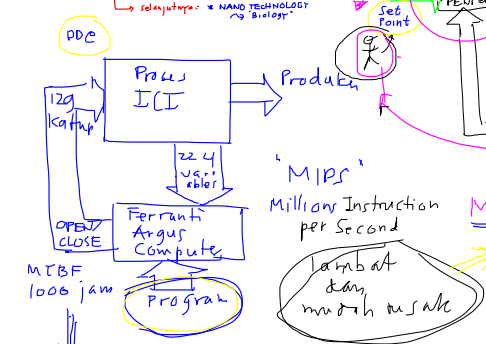
- * Jaman PERINTIS - 1955
- * Jaman DDC
- * Jaman MINIKOMPUTER - 1967
- * Jaman MICROCOMPUTER - 1972

s/d 1984

dari 1984 s/d sekarang

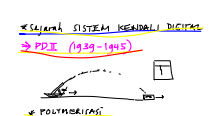
- * Jaman MICROCONTROLLER
- * Jaman PLC → DCS → APC [1986]

↳ selanjutnya : NANO TECHNOLOGY
 & Biotek

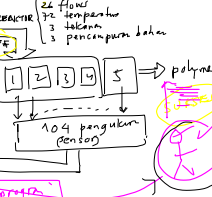


↓ PLC = Programmable Logic Controller
 ↓ DCS = Distributed Control Systems ← LAN
 ↓ APC = Advanced Process Control

AI
"Smart Tech..."



Texaco Refinery → penyulingan minyak
 Port Arthur, TX
 Maret 1956 → atomatisasi unit
 Temp, Level, Pressure
 TRW → aerospace company
 Maret 1959



Mean Time Between Failures
= 100 hours

PROGRAM

LAN



* Pengetahuan

→ (1) Pengetahuan

→ (2) Pengetahuan

→ (3) Pengetahuan

(4) Pengetahuan

SISTEM KENDALI DIGITAL

2 SKS 16x pertemuan (termasuk MID & FIN)

1 SKS

- * Praktekum INDIVIDU
- * Praktekum KELOMPOK → LSK

Course website: <http://www.uns.ac.id/fkiz/amp/kuliah/>
→ Sistem Kendali Digital

Referensi: "Computer Controlled Systems" [1984]

Penilaian: ⇒ MID, FIN, Praktikum Kelompok
Maka: Praktikum Individu
 * PENDAFTARAN: Intro to Digital Control
 * PEMODELAN Digital Control System
 * Transfer Function & State Space
 * ANALISIS Digital Control Systems
 * DESAIN

di I PENDAHULUAN

Introduction to the Digital Control System

Sistem Kontrol Digital

2nd Edition

English

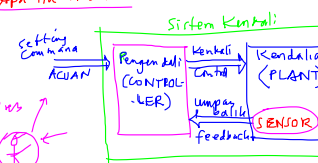
Bah Indonesia

1) Discrete-time Control Systems Sistem Kontrol Waktu Diskrit

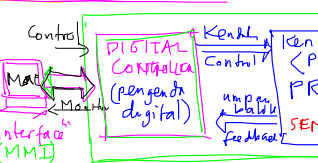
2) Sampled-Data Control Systems Sistem Kontrol Data Terapang

3) Computer-controlled Systems Sistem (di) Kontrol (komputer)

Anda itu SKD ??

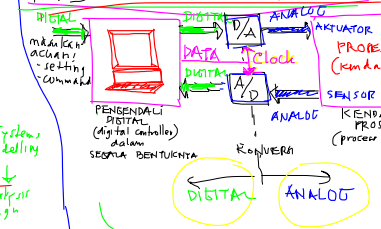


SEM KENDALI DIGITAL :



untuk mempelajari (S
ahuan ttg. PROSES
atum ttg. Teknologi (K
tahu ttg. INSTRUME
KENDALI

1 BAB II PEMODELAN SKD :



MODEL MATEMATIK

computer

output

clock

$r(k)$

$u(k)$

$y(k)$

prog. ctrl.

A

Macam = PENGENDALI DIGITAL

* GERBANG LOGIKA
NOT, AND, OR, NAND

- * Kombinatorik:
 - HA, FA,
- * Sekuensial:

* PROCESSOR =

puter) DINTAL * PLC, DCS, A

- * KOMPUTER
- * JARINGAN

Pencilple
semu
(virtual
sampler)

MODEL
NISBAH
ALIH

Figure 2
hal. 2

Macam ² PENGENDALI DIGITAL :

* GERBANG LOGIKA
NOT AND OR NAND NOR XOR

✗ RANGKAIAN LOGIKA :

* Kugelgröße = $\log |K|$

- * Sekvensial: flip-flo, counter, register, dll

* PROCESSOR $\Rightarrow$ MICRO CONTROLLER

* PLC, DCS, APC, -

* KOMPOTER → PO

* JARINGAN KOMPUTER

$F(z) = \frac{1}{t^2} \rightarrow f(t) = t$
 $f(t) = \frac{1}{t^2}$
 $f(1/T) = T^2$
 $f(2/T) = T^2/4$
 $F(z) = T^2 z^{-1} + 2T^2 z^{-2} + 3T^2 z^{-3} + \dots$
 $= \frac{T^2}{1 - z^{-1}}^2$

k	$x(k)$
0	2
1	0
2	2
3	0
4	2
>4	0

$$X(z) = \sum_{k=0}^{\infty} z^{-k} x(k) = z^{-0} x(0) + z^{-1} x(1) + z^{-2} x(2) + z^{-3} x(3) + z^{-4} x(4) \\ = 1 \cdot 2 + z^{-1} \cdot 0 + z^{-2} \cdot 2 + z^{-3} \cdot 0 + z^{-4} \cdot 2 \\ = 2 + 2z^{-2} + 2z^{-4}$$

$$X(z) = \frac{z(z^4 + z^2 + 1)}{z^4}$$

* Transformasi Z
(Ragunan 2.2.1, 2.2.2)

Definisi $Zf(z) = \sum_{k=0}^{\infty} z^{-k} f(k)$ $k=0,1,2,3,-$

Contoh

Jika f suatu rataan yang
dipangkat dengan periode T

$u(k) = \begin{cases} 0, & k < 0 \\ 1, & k \geq 0 \end{cases}$
 $k=0,1,2,3,-$



$$U(z) = \sum_{k=0}^{\infty} z^{-k} u(k) = z^{-0} u(0) + z^{-1} u(1) + z^{-2} u(2) + \dots$$

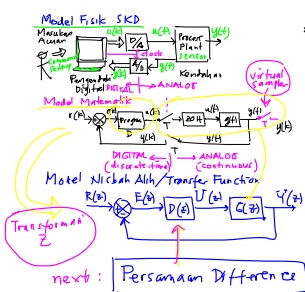
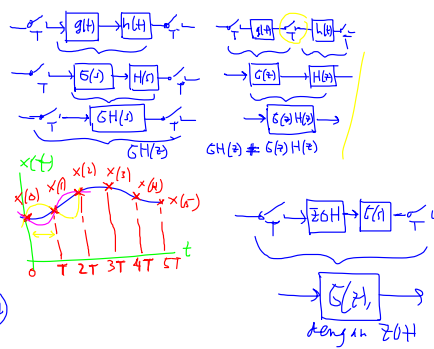
$$U(z) = 1 + z^{-1} + z^{-2} + z^{-3} + \dots$$

$$= 1 + z^{-1} [1 + z^{-1} + z^{-2} + z^{-3} + \dots]$$

$$= 1 + z^{-1} U(z)$$

$$U(z) - z^{-1} U(z) = 1$$

$$(1 - z^{-1}) U(z) = 1 \longrightarrow U(z) = \frac{1}{1 - z^{-1}} = \frac{z}{z - 1}$$

[illegible]

Contoh:

$G(s) = \frac{1}{s+2}$

* $V(s) = \frac{G(s)}{s} = \frac{1}{s(s+2)}$

$V(s) = \frac{1}{s(s+2)} = \frac{1}{s} - \frac{1}{s+2}$

$y(t) = \mathcal{L}^{-1}\left\{\frac{1}{s} - \frac{1}{s+2}\right\} = \frac{1}{s} - \frac{1}{s+2} = \frac{1}{2}(1 - e^{-2t})$

Maka $T = 1$ detik

k	t	y(t)
0	0	0
1	1	$\frac{1}{2}(1 - e^{-2}) = 0,4323$
2	2	$\frac{1}{2}(1 - e^{-4}) = 0,4908$
3	3	$\frac{1}{2}(1 - e^{-6}) = 0,4998$
4	4	$\frac{1}{2}(1 - e^{-8}) = 0,4999$
5	5	$\frac{1}{2}(1 - e^{-10}) = 0,4999$

* Transformasi z

$u(s) \xrightarrow{\text{WA}} \boxed{s+2} \xrightarrow{y(s)} u(z)$

$T=1$

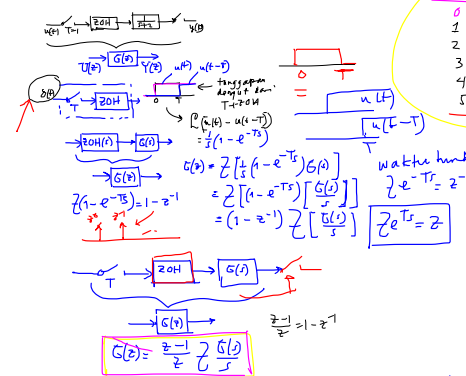
$U(z) = Z(u(s)) = \frac{z}{z-1}$

$\frac{z}{z+2} = \frac{z}{z-(-2)} = \frac{z}{z-1.553}$

$Y(z) = \left(\frac{z}{z-0.1353} \right) \left(\frac{z}{z-1} \right)$

$= \frac{z^2}{z^2 - 1.1372z + 0.1353}$

$y(k) = Z^{-1} Y(z)$ dapat dipecahkan
 dan pembagiannya: $z^2 - 1.1372z + 0.1353 = (z-0.1353)(z-0.7119)$



$$\begin{aligned}
 G(z) &= \frac{1}{s+2}, \quad T=1 \rightarrow G(z) = \frac{z-1}{z} \cdot \frac{1}{s(s+2)} \\
 &= \frac{z-1}{z} \left[\frac{0,8647}{(z-1)(z-0,1353)} \right] \\
 &= \frac{1}{z} \left[\frac{0,8647}{z-0,1353} \right] = \frac{0,4323}{z-0,1353} \\
 Y(z) &= G(z)U(z) = \left(\frac{0,4323}{z-0,1353} \right) \left(\frac{z}{z-1} \right) \\
 &= \frac{0,4323 z}{z^2 - 1,1353 z + 0,1353} \\
 &= \frac{0,4323 z^{-1} + 0,4908 z^{-2} + 0,4992 z^{-3} + \dots}{1 - 1,1353 z^{-1} + 0,1353 z^{-2}} \\
 &= \frac{0,4323 z^{-1} + 0,4908 z^{-2} + 0,0585 z^{-3} + \dots}{1 - 1,1353 z^{-1} + 0,1353 z^{-2}} \\
 &= 0,4908 - 0,5572 z^{-1} + 0,4992 z^{-2} - \dots
 \end{aligned}$$

k	$y(k)$
0	0
1	0,4323
$\frac{2}{3}$	0,4908
3	0,4902

Jadi, $G(z)$ yang diperoleh dengan menambahkan ZOH lebih sesuai dengan "realita" daripada yang tanpa ZOH

Contoh

Alihkan model Nirkabel Alih
 $G(z) = \frac{P(z)}{U(z)} = \frac{7z+1}{10z^5+2z^4+3z^3+4z^2+5z+6}$
 ke model Ruang Keadaan dengan matrix A dalam bentuk Jordan Companion.

Jawab $m=1$ $n=5$ $m < n$

$$\begin{matrix} b_1=7 \\ b_0=1 \end{matrix} \quad \begin{matrix} a_5=10 \\ a_4=2 \\ a_3=3 \\ a_2=4 \\ a_1=5 \\ a_0=6 \end{matrix}$$

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

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

$$A = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ -0,6 & -0,5 & -0,4 & -0,3 & -0,2 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0,1 \end{bmatrix}$$

$$C = [1 \ 7 \ 0 \ 0 \ 0] \quad D = [0]$$

1x5

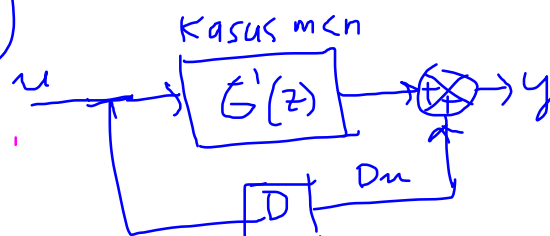
Kasus $m < n$

$$G(z) = \frac{5z^5+7z+1}{10z^5+2z^4+3z^3+4z^2+5z+6} = [0,5] + \frac{-z^4-1,5z^3-2z^2+4,5z-2}{10z^5+2z^4+3z^3+4z^2+5z+6}$$

Matrix A dan B sama, dibuat dari polynomial PENYEBUT yang sama

$$\begin{matrix} m=5 \\ b_0=1 \\ b_1=7 \\ b_2=0 \\ b_3=0 \\ b_4=0 \\ b_5=5 \end{matrix} \quad \begin{matrix} e[-\dots-] \\ [x5] \end{matrix}$$

6 angka



$$\begin{array}{r} 0,5 \rightarrow D \\ 10z^5+2z^4+3z^3+4z^2+5z+6 \overline{) 5z^5+7z+1} \\ \underline{5z^5+2z^4+3z^3+4z^2+5z+6} \\ -z^4-3,5z^3-2z^2+4,5z-2 \end{array}$$

$$C = [-2 \ 4,5 \ -2 \ -1,5 \ -1]$$

$$D = [0,5]$$

$$G^1(z), m < n$$