

328D4103
Sistem Kendali + Praktikum
MODUL 01
Model RUANG KEADAAN
(revisited)
(Semester Awal 2020-2021)

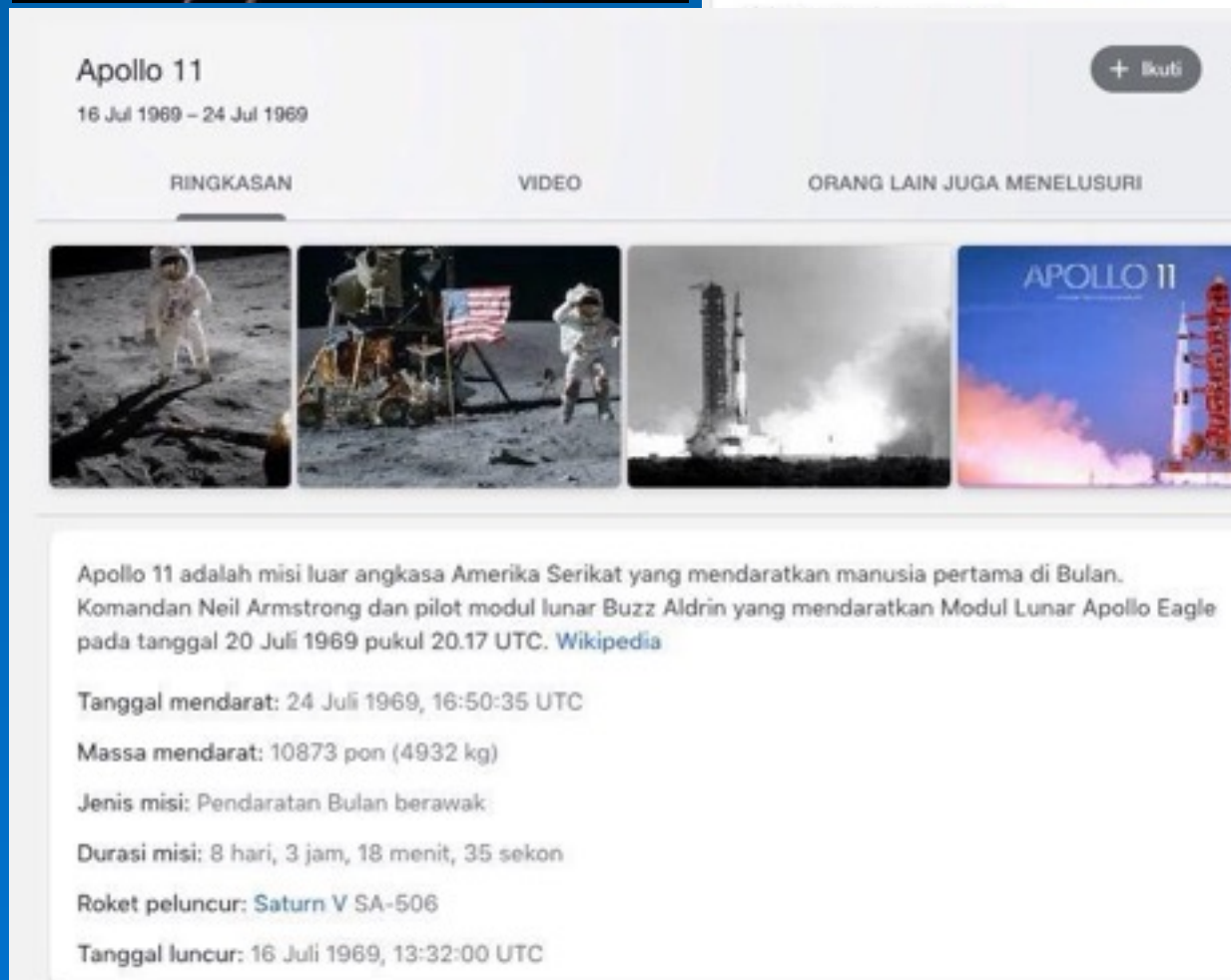


MODEL RUANG KEADAAN

- Sumber pembelajaran: <https://web.unhas.ac.id/rhiza/arsip/kuliah/Sistem-Kendali/Catatan-Kuliah-2017/>
- Catatan Kuliah Lengkap 2016-2017: <https://web.unhas.ac.id/rhiza/arsip/kuliah/Sistem-Kendali/Catatan-Kuliah-Sistem-Kendali-2016-2017.pdf> (dibuka *on-line* saja, tidak perlu diunduh)

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Name		Last modified	Size	Description
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MODEL RUANG KEADAAN (sekilas SEJARAH)



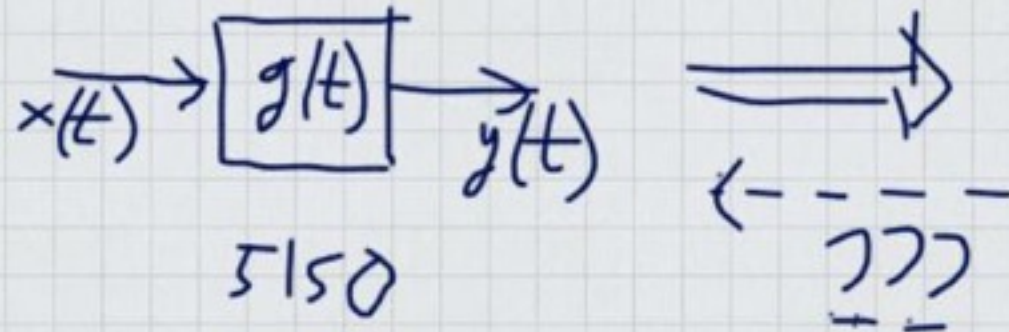
STATE SPACE MODEL (KRONOLOGI)



- 1945: Akhir PD II,awal “Perang Dingin”
- 1957: SPUTNIK 1, wahana ruang angkasa tanpa awak pertama Uni Sovyet
- 1960: **KONGRES PERTAMA SISTEM KENDALI SEDUNIA, IFAC, di MOSKOW**
State Space Model diperkenalkan sebagai alternatif “modern” dari *Transfer Function Model*, yang lebih “classical”.
- 1961: Wahana tanpa awak Uni Sovyet mendarat di bulan, kosmonot **Yuri Gagarin** menjelajah ruang angkasa, lepas dari medan gravitasi bumi.
- 1969: **Apollo 11** mendaratkan **Neil Armstrong** dan **Buzz Aldrin** di permukaan bulan
- 1992: Berakhirnya “Perang Dingin”, Jerman bersatu, Uni Sovyet bubar

PERBANDINGAN MODEL RUANG KEADAAN dan MODEL NISBAH ALIH

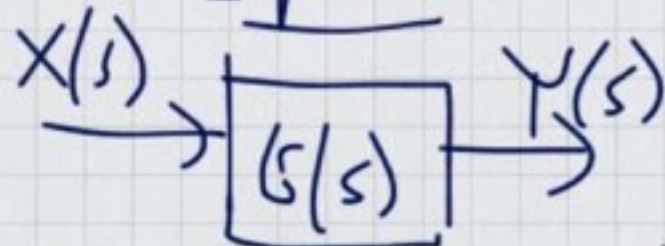
NISBAH ALIH



SISO

linier

memerlukan Transformasi Laplace



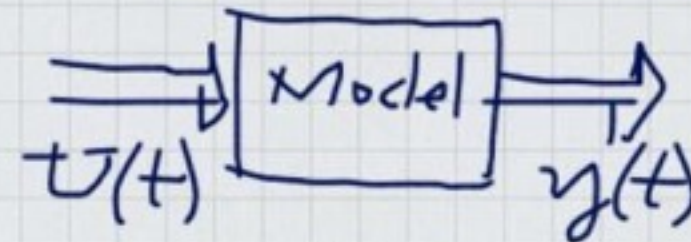
"pencil & paper"

$$G(s) = \frac{3}{2s + 4}$$



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

RUANG KEADAAN



MIMO

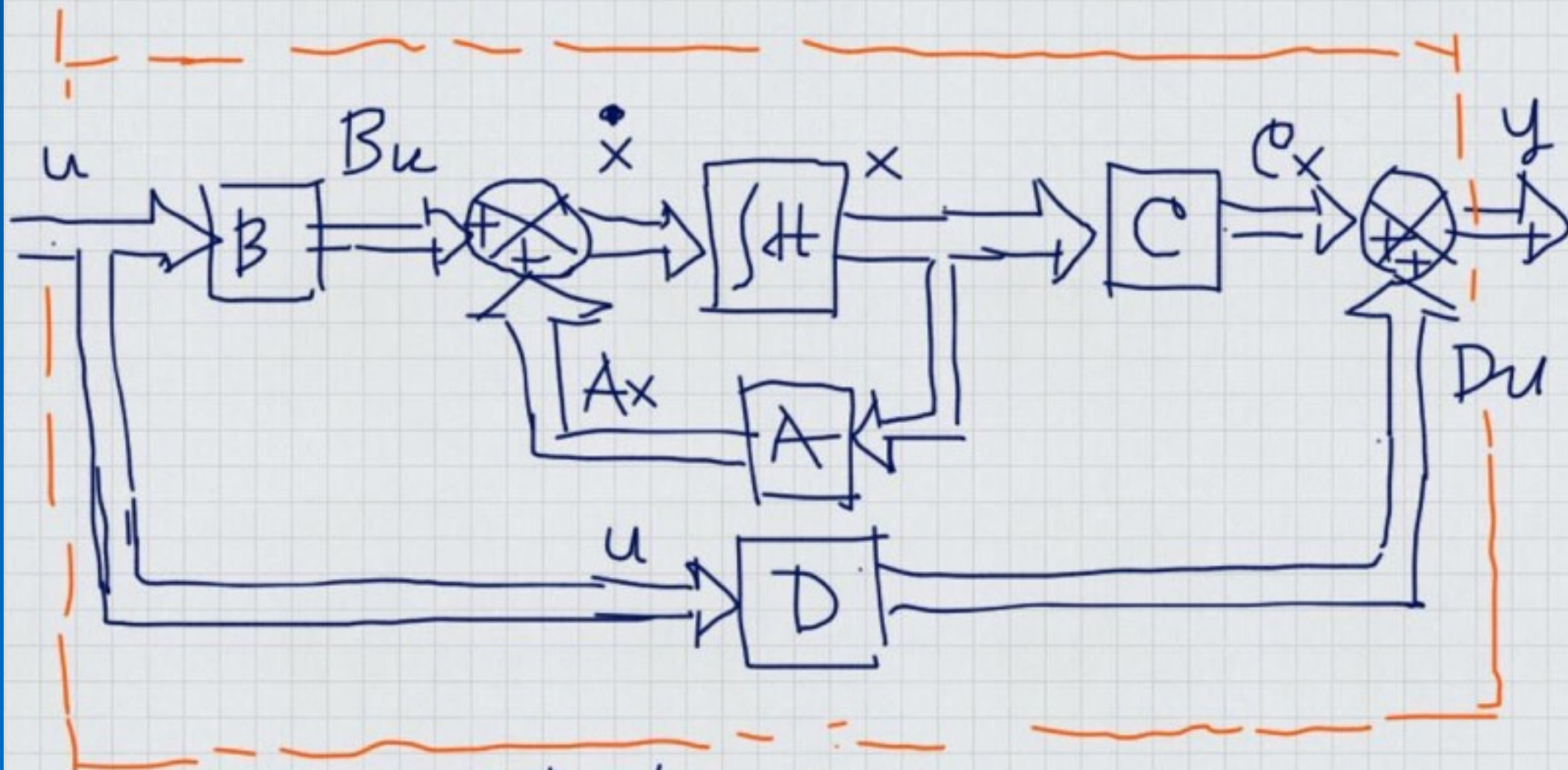
linier + tak linier

tidak perlu
Transformasi
(time domain)

"simulasi komputer"

Aljabar Matriks
Aljabar Linier

BAGAN KOTAK MODEL RUANG KEADAAN

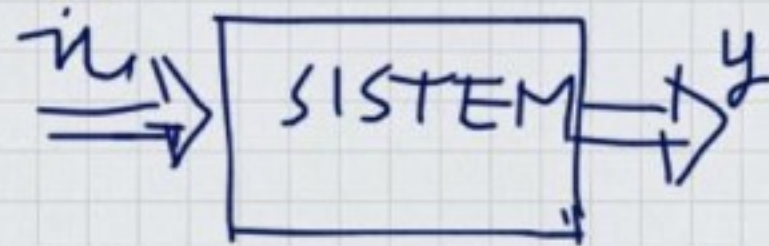


$$\begin{bmatrix} \dot{x} = Ax + Bu \\ y = Cx + Du \end{bmatrix}$$

← operasi matrix

PERSAMAAN KEADAAN dan PERSAMAAN KELUARAN

Model Ruang Keadaan



$u \equiv \text{vektor } [m \times 1]$

$$\begin{bmatrix} u_1(t) \\ u_2(t) \\ \vdots \\ u_m(t) \end{bmatrix} \quad \begin{matrix} m \geq 1 \\ k \geq 1 \end{matrix}$$

Model:

Pers. Keadaan
(State Equation)

Pers. Keluaran
(Output Equation)

$$\begin{cases} \dot{x} = Ax + Bu \\ y = Cx + Du \end{cases}$$

$y = \text{vektor } [k \times 1]$

$$\begin{bmatrix} y_1(t) \\ y_2(t) \\ \vdots \\ y_k(t) \end{bmatrix}$$

$x \equiv \text{peubah keadaan} = \text{vektor } [n \times 1]$

(state variables)

$$\dot{x} = \frac{dx}{dt} = \begin{bmatrix} dx_1(t)/dt \\ dx_2(t)/dt \\ \vdots \\ dx_n(t)/dt \end{bmatrix} \quad \begin{bmatrix} x_1(t) \\ x_2(t) \\ \vdots \\ x_n(t) \end{bmatrix}$$

vektor: $[n \times 1]$

n-dynamics

DIMENSI MATRIX dan VEKTOR

Pers. Keadaan: $\overset{\downarrow [n \times 1]}{\underset{\uparrow [n \times 1]}{x}} = \underset{\downarrow [n \times 1]}{\overset{\downarrow [n \times 1]}{A}} \underset{\downarrow [n \times 1]}{x} + \underset{\downarrow [n \times 1]}{\overset{\downarrow [m \times 1]}{B}} \underset{\downarrow [m \times 1]}{u}$

Pers. Keluaran: $\underset{\uparrow [k \times 1]}{y} = \underset{\downarrow [k \times 1]}{\overset{\downarrow [k \times 1]}{C}} \underset{\downarrow [k \times 1]}{x} + \underset{\downarrow [k \times 1]}{\overset{\downarrow [k \times 1]}{D}} \underset{\downarrow [k \times 1]}{u}$

$$\begin{aligned} A &= [n \times n] \\ B &= [n \times m] \\ C &= [k \times n] \\ D &= [k \times m] \end{aligned}$$

Contoh:

Suatu sistem mempunyai 2 masukan, 3 keluaran dan 5 peubah keadaan, akan dimodelkan dengan model Ruang Keadaan. Tentukan dimensi matrix A, B, C dan D!

Jawab:

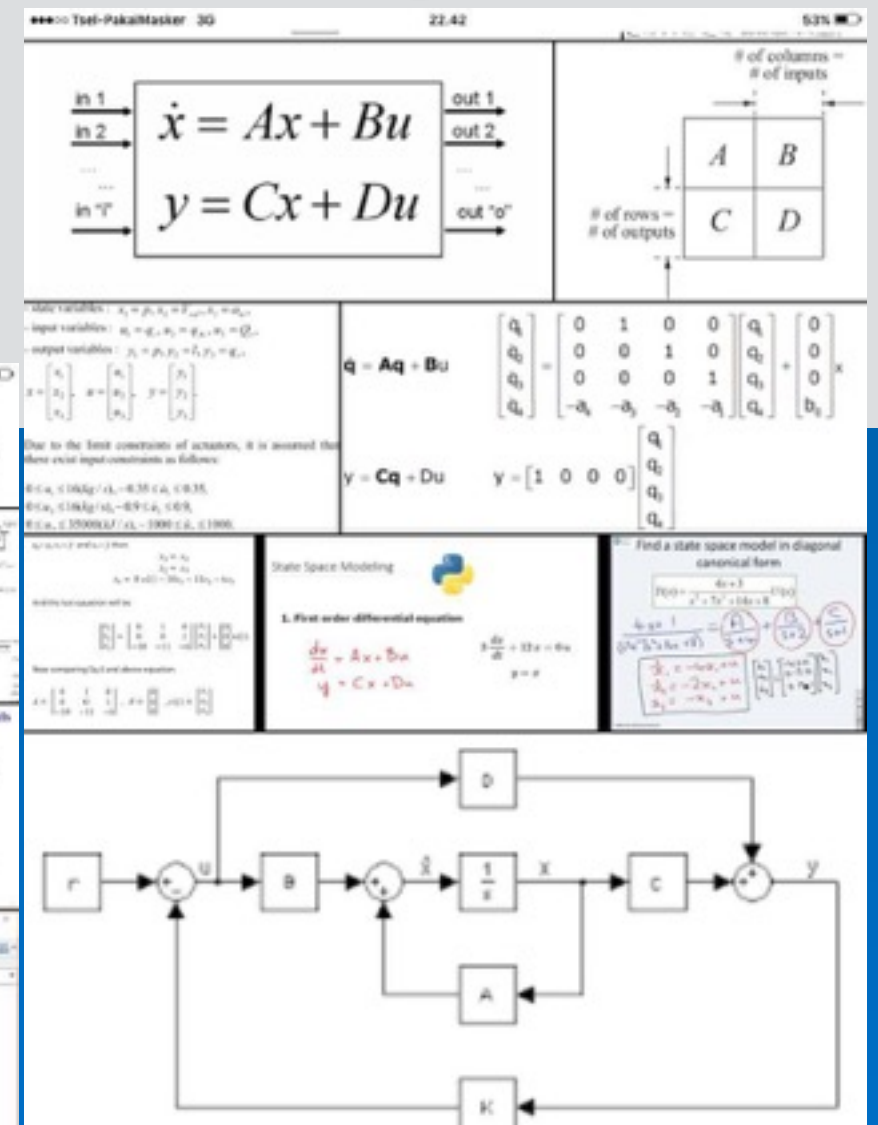
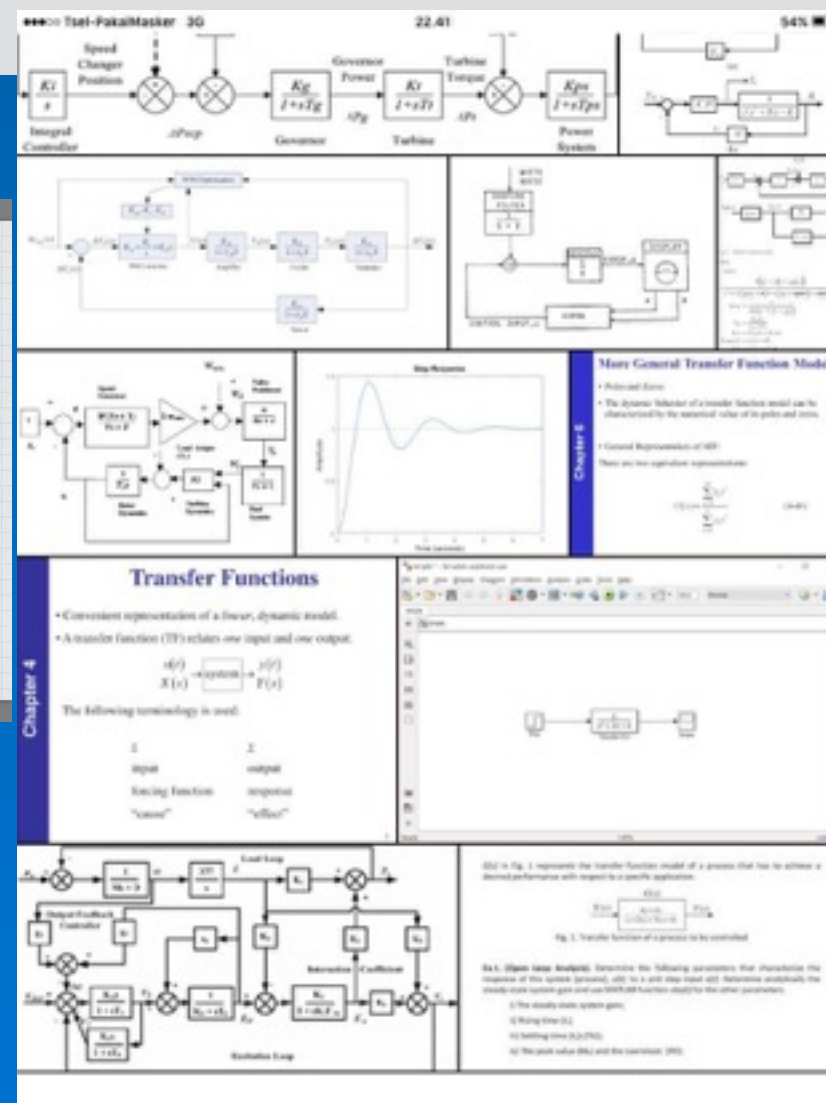
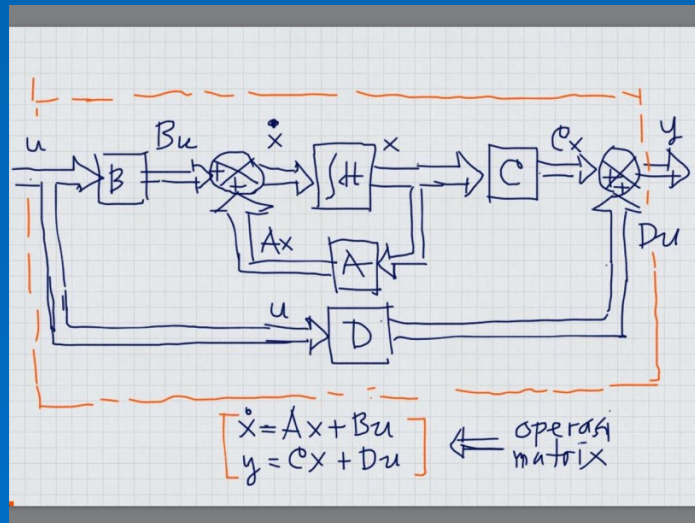
$$m=2 \quad k=3 \quad n=5$$

$$A[5 \times 5], B[5 \times 2], C[3 \times 5], D[3 \times 2]$$

TUGAS MANDIRI (tidak dikumpul)

Dengan menggunakan **GOOGLE**, cari dan baca berbagai **referensi** dengan kata kunci:

- **Transfer Function Model**
- **State Space Model**



MODUL PEMBELAJARAN SELANJUTNYA

- MODUL 01: (Pengantar/Review) Model RUANG KEADAAN (*State Space*)
- **MODUL 02: Konversi Model RUANG KEADAAN ke NISBAH ALIH (ss2tf)**
- MODUL 03: Konversi Model NISBAH ALIH ke RUANG KEADAAN (tf2ss)
- MODUL 04: Transformasi SIMILARITAS
- MODUL 05: TANGGAPAN dan KESTABILAN
- MODUL 06: KETERKENDALIAN dan KETERAMATAN
- MODUL 07: UMPAN-BALIK PEUBAH KEADAAN
- MODUL 08: PRAKTIKUM INDIVIDU

SELAMAT BELAJAR

Semoga SUKSES meraih PRESTASI!

