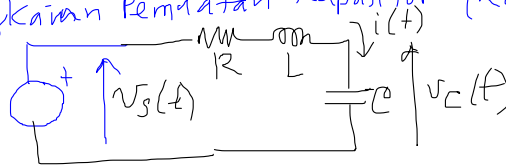


* Contoh Elektrik Rangkaian Pemertan Kapasitor (RLC seri)



Susunlah Model Ruang Keadaan.

$$\dot{x} = Ax + Bu$$

$$y = Cx + Du$$

dengan penugasan (state assignment)

$$u \triangleq v_s(t)$$

$$y_1 \triangleq v_c(t)$$

$$y_2 \triangleq i(t)$$

$$x_1 \triangleq i(t)$$

$$x_2 \triangleq v_c(t)$$

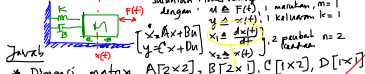
Hukum Ohm

$$(1) v_s(t) - v_c(t) = L \frac{di(t)}{dt} + Ri(t)$$

$$(2) i(t) = C \frac{dv_c(t)}{dt}$$

* Contoh Mekanik

Spring-Mass-Damper System



$$F(t) = M \frac{d^2x(t)}{dt^2} + B \frac{dx(t)}{dt} + Kx(t)$$

$$\dot{x}_1 = x_2$$

$$\dot{x}_2 = -\frac{K}{M}x_1 - \frac{B}{M}x_2 + \frac{1}{M}u$$

$$y = x_2$$

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -\frac{K}{M} & -\frac{B}{M} \end{bmatrix} x + \begin{bmatrix} 0 \\ \frac{1}{M} \end{bmatrix} u$$

$$y = \begin{bmatrix} 0 & 1 \end{bmatrix} x + \begin{bmatrix} 0 \end{bmatrix} u$$

$$A = \begin{bmatrix} 0 & 1 \\ -\frac{K}{M} & -\frac{B}{M} \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ \frac{1}{M} \end{bmatrix}$$

$$C = \begin{bmatrix} 0 & 1 \end{bmatrix} \quad D = \begin{bmatrix} 0 \end{bmatrix}$$

$$Fada: A = \begin{bmatrix} -\frac{R}{L} & -\frac{1}{L} \\ \frac{1}{C} & 0 \end{bmatrix} \quad B = \begin{bmatrix} \frac{1}{L} \\ 0 \end{bmatrix}$$

$$C = \begin{bmatrix} 0 & 1 \end{bmatrix} \quad D = \begin{bmatrix} 0 \end{bmatrix}$$

* Contoh Matematis

Susunlah Model Ruang Keadaan

$$\dot{x} = Ax + Bu$$

$$y = Cx + Du$$

a) Dimensi Matriks A, B, C dan D

* jumlah masukan m = 2

* jumlah keluaran k = 3

* jumlah peubah keadaan n = 2

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

$$\dot{x} = Ax + Bu$$

$$y = Cx + Du$$

$$x = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \quad u = \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$$

$$y = \begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix}$$

$$C = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 1 \end{bmatrix} \quad D = \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}$$

$$b) \text{ Pers Keadaan}$$

$$\dot{x}_1 = 2x_1 + u_1$$

$$\dot{x}_2 = 4x_1 - 24x_2 + u_2$$

$$\dot{x}_1 = \begin{bmatrix} 2 & 0 \\ 4 & -24 \end{bmatrix} x + \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} u$$

$$A = \begin{bmatrix} 2 & 0 \\ 4 & -24 \end{bmatrix} \quad B = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$C = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 1 \end{bmatrix} \quad D = \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}$$

$$c) \text{ Pers Keluaran}$$

$$y_1 = x_1 + 3u_1$$

$$y_2 = x_1$$

$$y_3 = x_1 + x_2 + 7u_2$$

* Dimensi Matrix

$$m = 1 \quad k = 2 \quad n = 2$$

$$A [2 \times 2], B [2 \times 1], C [2 \times 2], D [2 \times 1]$$

* Persamaan Keadaan

$$(1) u - x_2 = L \dot{x}_1 + R x_1$$

$$\dot{x}_1 = -\frac{R}{L} x_1 - \frac{1}{L} x_2 + \frac{1}{L} u$$

$$(2) x_1 = C \dot{x}_2 \rightarrow \dot{x}_2 = \frac{1}{C} x_1$$

$$\dot{x} = \begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -\frac{R}{L} & -\frac{1}{L} \\ \frac{1}{C} & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} \frac{1}{L} \\ 0 \end{bmatrix} u$$

* Persamaan Keluaran

$$y = \begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \end{bmatrix} u$$

$$y_1 = v_c(t) \rightarrow y_1 = x_2$$

$$y_2 = i(t) \rightarrow y_2 = x_1$$