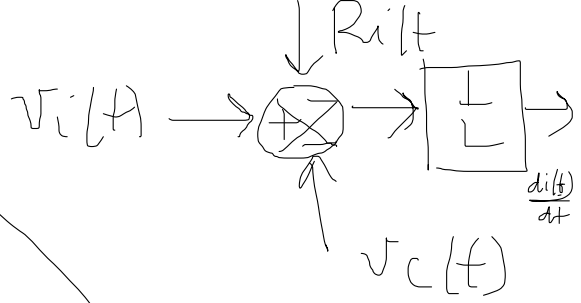
$$\frac{di(t)}{dt} = \frac{1}{L}\left(v_i(t) - v_c(t) - Ri(t)\right)$$

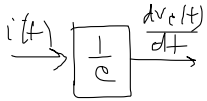
$$\frac{dv_c(t)}{dt} = \frac{1}{C} i(t)$$



* SIMULINK

Hukum Ohm : * $v_i(t) - v_c(t) = Ri(t) + L\frac{di(t)}{dt}$

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



$$\int \frac{di(t)}{dt}\,dt = \int di(t) = i(t)$$

$$\int \frac{dv_c(t)}{dt}\,dt = \int dv_c(t) = v_c(t)$$

$$V_c(s) = \frac{V}{s(LCs^2 + RCs + 1)}$$

$$v_c(t) = \mathcal{L}^{-1}\frac{V}{s(LCs^2 + RCs + 1)}$$ (lihat Fable)

$$I_c(s) = \frac{V_c(s)}{Z_c} = \frac{V/C}{LCs^2 + RCs + 1}$$

$$i_c(t) = \mathcal{L}^{-1} I_c(s)$$ (lihat Fable)

PERANCANGAN SISTEM KENDALI 2013

Project Course → TIDAK ADA UJIAN

SIMULINK @MATLAB

SKRIPSI

- Ujian Akhir (tidak)
- Seminar
- Lampiran Format Journal

PERANCANGAN ← analisis

sistem: DIGITAL | KENDALI | ELEKTRONIK

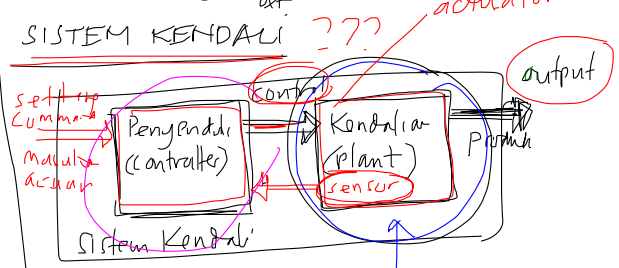
Dasar Komputer, Dasar pemograman, Rangkaian Logika | Dasar Sistem Kontrol | Dasar Elektronika

Persiapan:

* Mencari MITRA (utk yang ingin berkarya berpasangan)
* Akses MATLAB → Simulink

Next project VERIFIKASI SIMULINK

SISTEM KENDALI ???



"designed" | "given"

"MODEL" | "MODEL"

"SIMULINK"

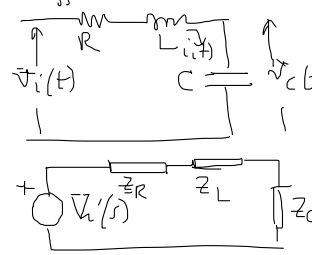
implementasi

Project 1 Verifikasi Simulink

→ toleransi

* ANALITIK

Menggunakan konsep impedansi

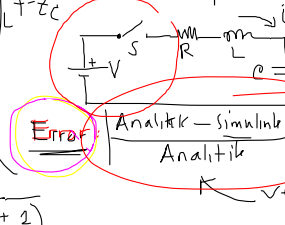


$$G(s) = \frac{V_c(s)}{V_i(s)} = \frac{Z_c}{Z_R + Z_L + Z_c}$$

$$V_c(s) = \frac{Z_c V_i(s)}{Z_R + Z_L + Z_c} = \frac{V_{cs} \cdot \frac{V}{s}}{R + Ls + \frac{1}{Cs}} = \frac{V}{s(LCs^2 + RCs + 1)}$$

* Rangkaian RLC seri

Pemuatan Kapasitor



Error | Analitik − Simulink / Analitik | ×100%

verifikasi

Saklar S ditutup pada $t = 0$, $v_c(0) = \emptyset$

Tentukan $v_c(t)$ dan $i(t)$.

* ANALITIK → exact

* SIMULINK

* Dengan menggunakan spredd-sheet, cari error untuk 3 (tiga) nilai toleransi yang berbeda, 10^{-3}, 10^{-4}, 10^{-5}, — pada simulink

* Carilah solusi ANALITIK untuk $v_c(t)$ dan $i(t)$

* Perbesar dan perkecil nilai R sehingga ada ketiga kasus nilai ξ →
  * $\xi > 1$
  * $\xi = 1$
  * $0 < \xi < 1$

TABEL TIDAK DIKUMPUL → g tabel PENGAMATAN

Tugas I Verifikasi SIMULINK
* Ambil tgl lahir dan salah seorang
  TT-BB-19HH V = 12 Volt
  C = 19HH nF = 19HH * 10^{-6} F
  L = BB Henry
  R = TT Ohm

Tabel Laplace:

$$\mathcal{L}^{-1}\left\{\frac{K}{s(s^2+2\xi\omega_n s+\omega_n^2)}\right\}$$

$v_c(t)$ →
* $\xi > 1 \rightarrow \mathcal{L}^{-1}\dfrac{K}{s(s+a)(s+b)}$
* $\xi = 1 \rightarrow \mathcal{L}^{-1}\dfrac{K}{s(s+\omega_n)^2} \rightarrow \mathcal{L}^{-1}\dfrac{K}{s(s+a)^2}$
* $0 < \xi < 1 \rightarrow \mathcal{L}^{-1}\dfrac{K}{s(s^2+2\xi\omega_n s+\omega_n^2)}$

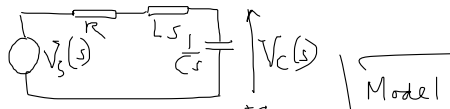
$$i(t) = \mathcal{L}^{-1}\{I(s)\} = \mathcal{L}^{-1}\frac{V_c(s)}{Z_c} = \mathcal{L}^{-1}\frac{V/LC}{s\left(s^2+\frac{R}{L}s+\frac{1}{LC}\right)}$$

$$= \mathcal{L}^{-1}\frac{V/L}{s^2+\frac{R}{L}s+\frac{1}{LC}} = \mathcal{L}^{-1}\frac{K}{s^2+2\xi\omega_n s+\omega_n^2}$$

$\xi > 1 \rightarrow \mathcal{L}^{-1}\dfrac{K}{(s+a)(s+b)}$

$\xi = 1 \rightarrow \mathcal{L}^{-1}\dfrac{K}{(s+a)^2}$

$0 < \xi < 1 \rightarrow \mathcal{L}^{-1}\dfrac{K}{s^2+2\xi\omega_n s+\omega_n^2}$



$$V_s(s) = \mathcal{L}\{V_u(t)\} = \frac{V}{s}$$

$$V_c(s) = \frac{Z_c}{Z_R+Z_L+Z_c}\cdot V_s(s)$$

$$= \frac{\frac{1}{Cs}}{R+Ls+\frac{1}{Cs}}\cdot\frac{V}{s}$$

$$= \frac{V}{s(LCs^2+RCs+1)}$$

$$= \frac{V/LC}{s\left(s^2+\frac{R}{L}s+\frac{1}{LC}\right)}$$

$v_c(t)$ ANALITIK

$$= \mathcal{L}^{-1}\frac{V/LC}{s\left(s^2+\frac{R}{L}s+\frac{1}{LC}\right)}$$

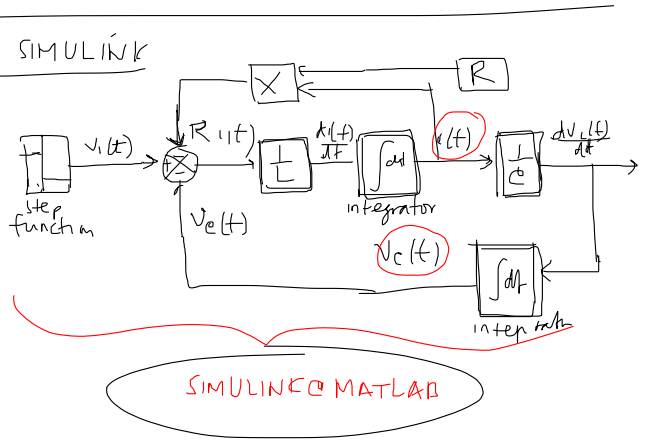
$$= \mathcal{L}^{-1}\frac{K}{s(s^2+2\xi\omega_n s+\omega_n^2)}$$

$\omega_n^2 = 1/LC$

$\omega_n = 1/\sqrt{LC}$

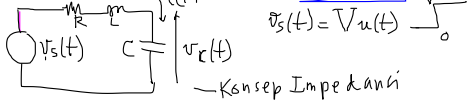
$2\xi\omega_n = \frac{R}{L} \rightarrow \xi$

Model SIMULINK



SIMULINK® MATLAB

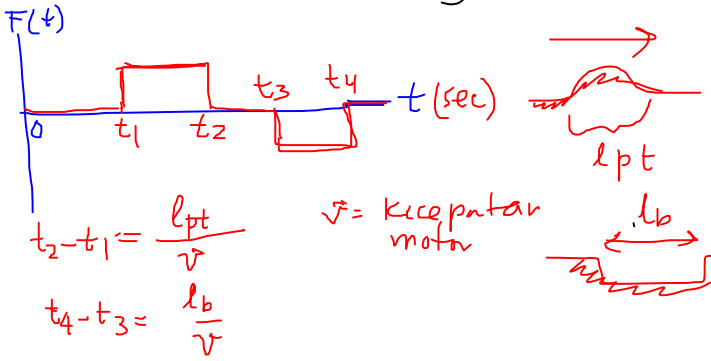
* VALIDASI → di LAB
* VERIFIKASI → referensi: Hasil perhitungan ANALITIK



$V_s(t) = V_u(t)$ V

Konsep Impedansi

Simulasi Gaya guncangan



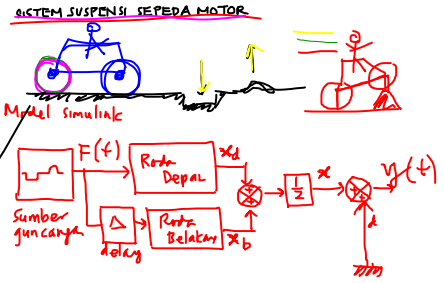
$t_2 - t_1 = \frac{l_{pt}}{v}$ $\quad v$ = kecepatan motor

$t_4 - t_3 = \frac{l_b}{v}$

Diunduh dari :

http://www.unhas.ac.id/rhiza/arsip/kuliah/

Cari Perancangan Sistem Kendali



tanah = permukaan jalan

F(t) gaya guncangan

y(t) posisi pengendara terhadap tanah

d = jarak antara sadel dengan tanah

Δ = delay antara roda depan dan roda belakang

$$\Delta = \frac{l}{v} \text{ [second]}$$

Mis, $v = 5$ km/jam

$l = 1{,}2$ m

Jadi $\Delta = \frac{1{,}2\ m}{5000\ m / 3600\ sec}$

$= \frac{4{,}2 \times 3600}{5000}$ sec

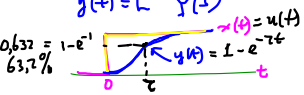
$= 0{,}864$ sec

Simple Lag

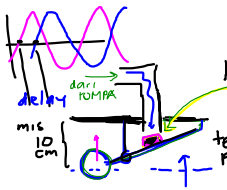
$X(s) \rightarrow \frac{1}{\tau s + 1} \rightarrow Y(s)$

$x(t) = \mathcal{L}^{-1} X(s)$

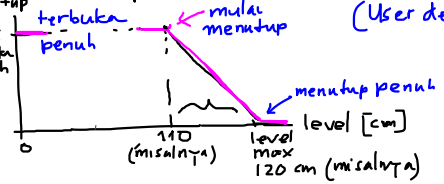
$y(t) = \mathcal{L}^{-1} Y(s)$



Transport Delay



Karakteristik pelampung



x (level) → pelampung.m → y (0..1)

Matlab Function (User defined Function)

$x \le 110 \rightarrow y = 1$ terbuka penuh

$x \ge 120 \rightarrow y = 0$ tertutup penuh

$110 < x < 120$

$\frac{y-1}{0-1} = \frac{x-110}{120-110}$

$10(y-1) = -x + 110$

$y - 1 = -0.1x + 11$

$y = -0.1x + 12$

→ masuk ke pelampung.m

check: (0 < y < 1)

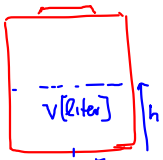
$x = 110 \rightarrow y = -11 + 12 = 1$

$x = 120 \rightarrow y = -12 + 12 = 0$

Volume silinder

$\pi r^2 . h = 1000V$

$r = \frac{1}{2}D$ [cm]



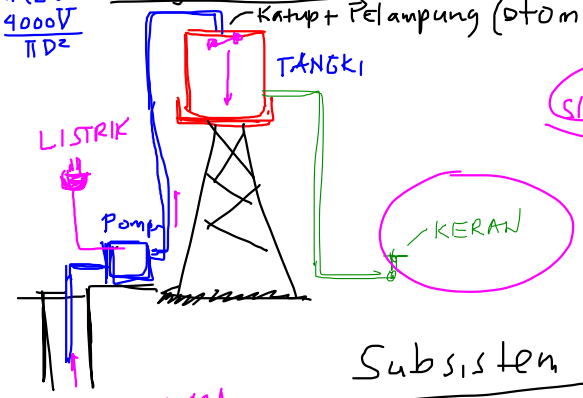
$h = \frac{1000V}{\pi (\frac{1}{2}D)^2}$

$V(\text{liter}) = \frac{4000V}{\pi D^2}$

D [cm]

* Project 3 MENARA AIR

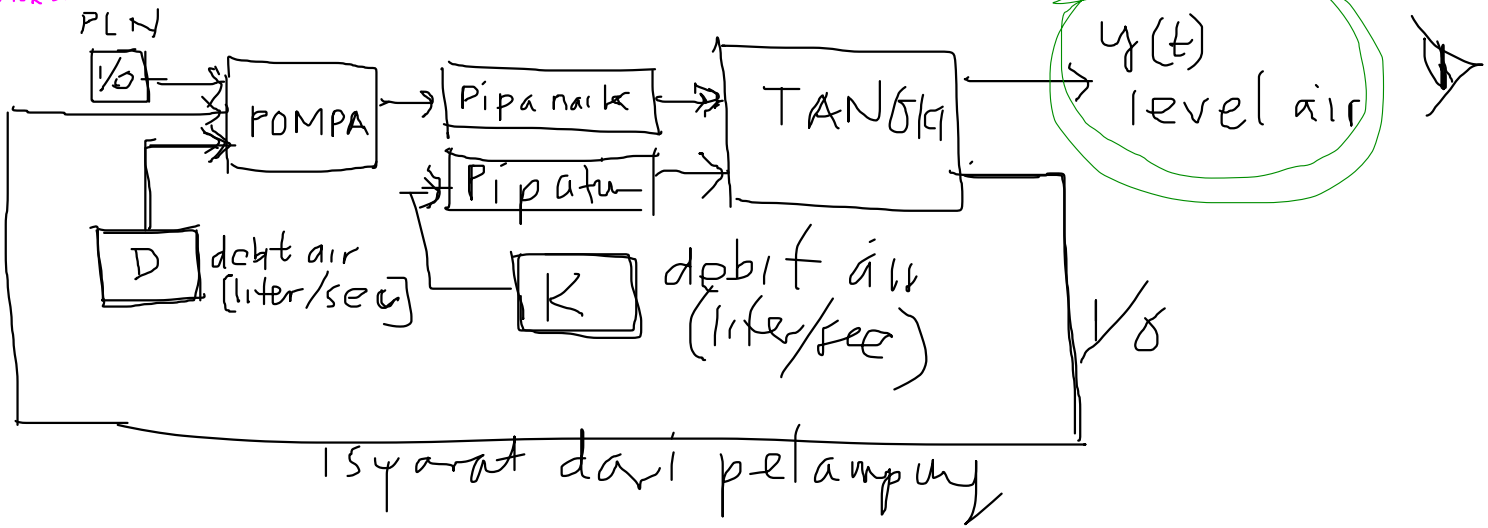
Katup + Pelampung (otomatis)



SIMULINK

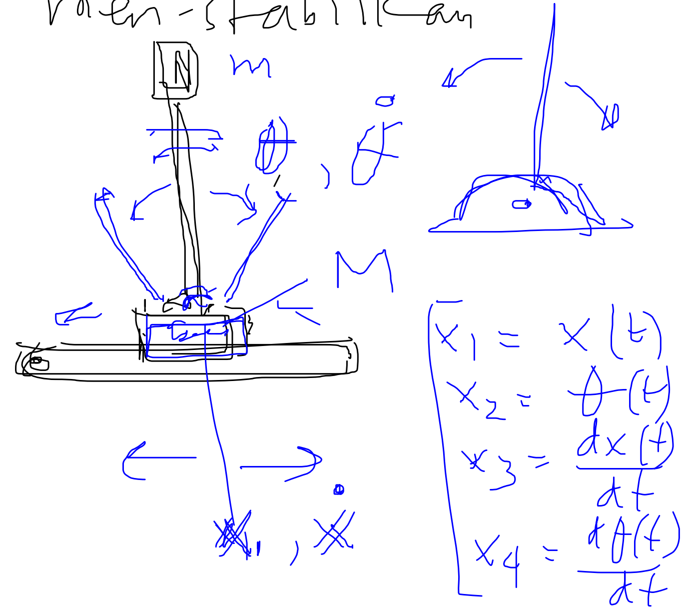
Jika keran dibuka maka air mengalir keluar dengan debit K liter/sec

Subsistem



Skripsi a/n ARIS & Budi Mulyani

PROJECT 5 ✱ Pendulum Terbalik (Non-Linear, Un-stable) ↳ men-stabilkan



$x_1 = x(t)$

$x_2 = \theta(t)$

$x_3 = \frac{dx(t)}{dt}$

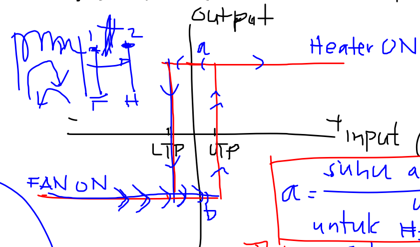
$x_4 = \frac{d\theta(t)}{dt}$

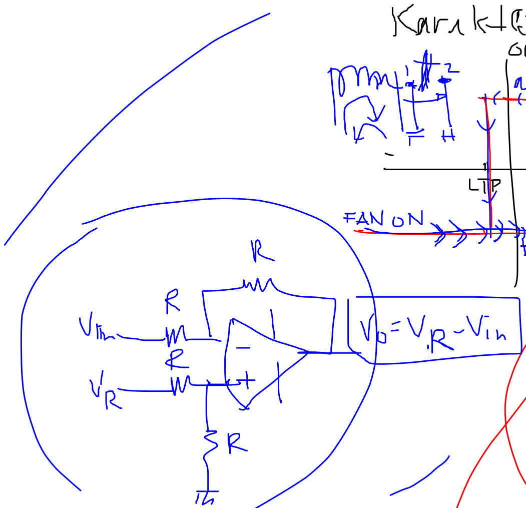
Review:

max B+

* ✱ Project1. VERIFIKASI SIMULINK → toleransi 10^{-3} ...
* ✱ Project2. SISTEM SUSPENSI SEPEDA MOTOR
  Linear, Stable
  (minimisasi gangguan)
* ✱ Project3. MENARA AIR
  linear, Unstable
  (Kendali ON-OFF, pelampung)
* ✱ Project 4 PEMANAS RUANGAN
  Non-Linear, Quasi-stable
  (Kendali PID, minimisasi varian suhu)

Karakteristik RELAY



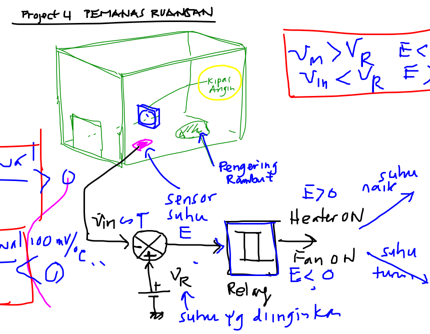


$a = \frac{\text{suhu akhir} - \text{suhu awal}}{\text{waktu}} > 0$ untuk HEATER

$b = \frac{\text{suhu akhir} - \text{suhu awal}}{\text{waktu}} < 0$ untuk FAN

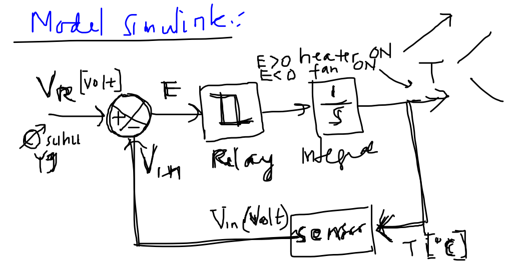
100 mV/°C

Project 4 PEMANAS RUANGAN



$V_{in} > V_R$ E<0 FAN ON
$V_{in} < V_R$ E>0 Heater ON

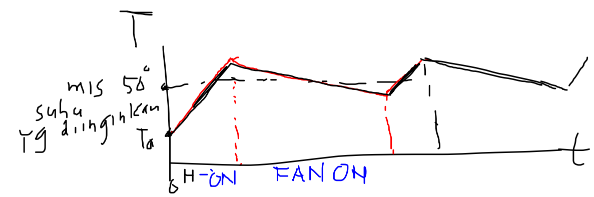
Model Simulink:



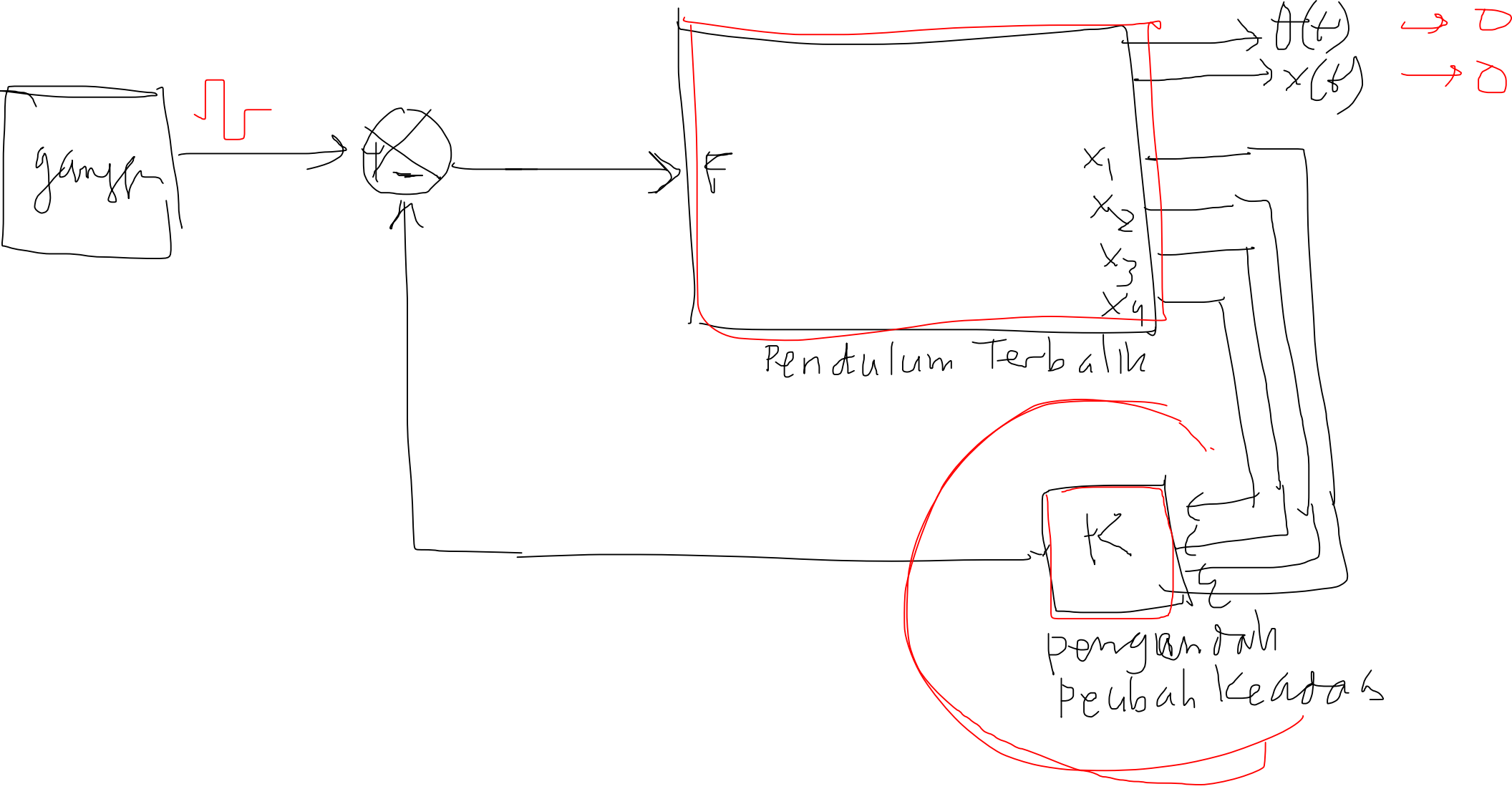
Tugas di lab:

✱ Menyalakan heater.
ukur. suhu awal
suhu akhir
waktu

✱ Menyalakan fan:
ukur: suhu awal
suhu akhir
waktu



T_0 = suhu ruang


gangguan
F
θ(t)
x(t)
x1
x2
x3
x4
Pendulum Terbalik
K
pengendali
pembah keadaan