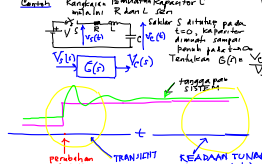
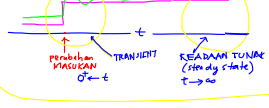
Analisis Transient

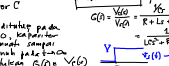
Contoh: Rangkaian RLC seri, Pemodelan Kapasitor C mula-mula R dan L dari



Saklar S ditutup pada t=0, kapasitor dimodel sangat pendek pada t=0

Tentukan $G(s) = \frac{V_C(s)}{V_S(s)}$



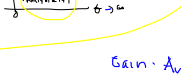


$G(s) = \frac{V_C(s)}{V_S(s)} = \frac{1/LC}{s^2 + \frac{R}{L}s + 1/LC}$

$V_S(t) \to V_S(s) = \mathcal{L}\{V_S(t)\} = \frac{V}{s}$

$V_C(s) = G(s)V_S(s) = \frac{V/LC}{s(s^2 + \frac{R}{L}s + \frac{1}{LC})}$

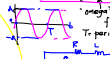
$V_C(t) = \mathcal{L}^{-1}\{V_C(s)\} = \frac{V}{LC}\mathcal{L}^{-1}\left\{\frac{1}{s(s^2 + \frac{R}{L}s + \frac{1}{LC})}\right\}$ → tidak tahu!



* Analisis Keadaan Tunak
steady state analysis

$v_S(t) \to$ isyarat periodik

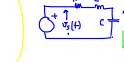
Asumsi: $v_S(t) = A\sin\omega t$



"omega" ω = 2πf [rad/det]

f [Hertz] = $\frac{1}{T}$

T = periode [detik]



$v_C(t) = ???$

$v_S(t) = A_0\sin(\omega t + \phi)$

Pada keadaan tunak (steady state)

Peubah Laplace $s \to j\omega$ $\quad j = \sqrt{-1}$, $\omega = 2\pi f = \frac{2\pi}{T}$

$G(s) = \frac{1}{LCs^2 + RCs + 1} \to G(j\omega) = \frac{1}{LC(j\omega)^2 + RCj\omega + 1}$

$= \frac{1}{\underbrace{j\omega RC}_{Im} + \underbrace{(1 - \omega^2 LC)}_{Re}}$

Gain: $A_v = |G(j\omega)| = \frac{A_0}{A_i} = \frac{1}{\sqrt{(\omega RC)^2 + (1-\omega^2 LC)^2}}$ (low pass filter)

sudut fasa $\phi = -\tan^{-1}\frac{\omega RC}{1 - \omega^2 LC}$

Bab I Pemodelan SISTEM LINIER

Sub I: Pemodelan SISTEM LINIER

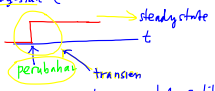
* Urgensi Pemodelan SISTEM
* Pemodelan STATIK ⇒ Watak Alih (Transfer Characteristic)
* Pemodelan DINAMIK
  * Pemodelan Nisbah Alih (Transfer function)
  * Pemodelan Ruang Keadaan (state space)

* Pemodelan STATIK

⇒ Pemodelan Watak Alih (Transfer Characteristic)

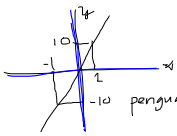
⇒ "static", tidak melibatkan parameter waktu t

⇒ "steady-state" (keadaan tunak) × "transien"

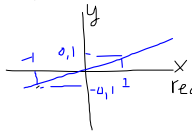


* Digambarkan dalam bentuk salib sumbu

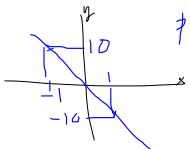
$x(t) \to$ SISTEM $\to y(t)$



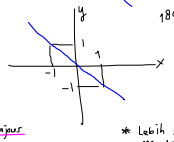
penguat (amplifier)

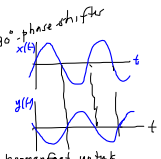


redaman (attenuator)



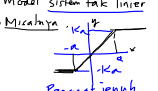
penguat membalik
inverting-amplifier





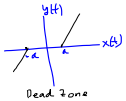
* Lebih bermanfaat untuk model sistem tak linier

→ Misalnya



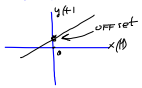
Penguat jenuh (saturating amplifier)

$y(t) \begin{cases} = Kx(t), & |x(t)| \le a \\ = Ka, & x(t) > a \\ = -Ka, & x(t) < -a \end{cases}$

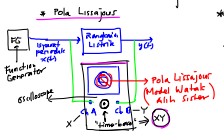


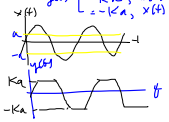
Dead zone

$|x(t)| \ge a \to y(t) \ne 0$



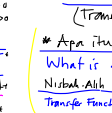
* Pola Lissajous

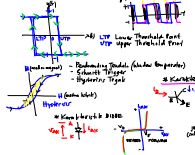




* Pembanding (Komparator)

$y(t) \begin{cases} = +1, & x(t) \le 0 \\ = -1, & x(t) > 0 \end{cases}$





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* Linierisasikan penyearah (rectifier) $y(t) = |x(t)|$ pada titik kerja $G(0,0)$ dengan pendekatan garis singgung

MIDTEST
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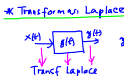
14/04 & LIBUR
21/04
28/04 MIDTEST (open book) 40%

* Transformasi Laplace



~~$y(t) = g(t)x(t)$~~

t = time, peubah REAL } time domain

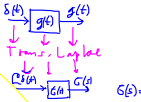
$Y(s) = G(s)X(s)$

s: peubah La Place, peubah KOMPLEKS } frequency domain

Contoh-contoh

* Contoh matematis: * Tentukan $\mathcal{L}\{\delta(t)\}$

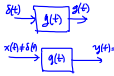
Jawab:

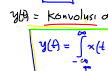


$G(s) = G(s)\,\mathcal{L}\{\delta(t)\}$

$\mathcal{L}\{\delta(t)\} = \frac{G(s)}{G(s)} = 1$

* Tanggapan terhadap isyarat lain





$y(t) = ...??$ $\quad$ ~~$y(t) = x(t)$~~

$y(t) = x(t) * g(t) = x(t)\,g(t)$

$y(t)$ = konvolusi antara $x(t)$ dan $g(t)$

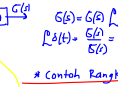
$$y(t) = \int_{-\infty}^{\infty} x(t-\tau)\,g(\tau)\,d\tau = \int_{-\infty}^{\infty} x(\tau)\,g(t-\tau)\,d\tau$$

τ = tau

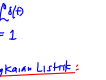
* Contoh Rangkaian Listrik:

KONSEP IMPEDANSI

Hukum Ohm



$v(t) = R\,i(t) \xrightarrow{\text{transf Laplace}}$

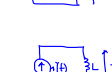


$V(s) = Z_R I(s) = R\,I(s)$

$Z_R = \frac{V(s)}{I(s)} = R$

$\mathcal{L}\{v(t)\} = R\,\mathcal{L}\{i(t)\}$

$V(s) = R \cdot I(s)$



$v(t) = L\frac{di(t)}{dt} \Rightarrow \mathcal{L}\{v(t)\} = \mathcal{L}\{L\frac{di(t)}{dt}\}$

Property #3, hal 58

$= L\,\mathcal{L}\{\frac{di(t)}{dt}\}$

$= L\,s\,I(s)$

$Z_L = \frac{V(s)}{I(s)} = sL$

$i(t) = C\frac{dv(t)}{dt} \Rightarrow \mathcal{L}\{v(t)\} = \frac{1}{C}\mathcal{L}\{\int i(t)\,dt\}$

$v(t) = \frac{1}{C}\int i(t)\,dt$ $\quad V(s) = \frac{1}{C}\frac{I(s)}{s}$

Property #4

$Z_C = \frac{V(s)}{I(s)} = \frac{1}{Cs}$

* Analisis Transien
* Analisis Keadaan Tunak (Steady State)

---

* Apa itu isyarat denyut satuan (unit impulse), $\delta(t)$?

$\delta(t)$ adalah suatu isyarat matematis yang tidak bisa di-realisasi secara fisik.

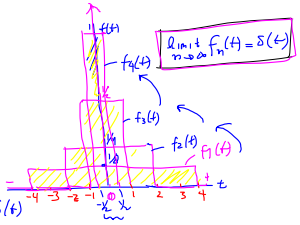
Realisasi fisik yang bisa dianggap mendekati $\delta(t)$, antara lain misalnya.

* sambaran petir
* percikan bunga api listrik
* pukulan stick golf pada bola golf
* dll

Yang bersifat "keras" dan "cepat berlalu"

dinyatakan dengan 2 sifat matematis

* $\delta(t) \begin{cases} = 0, & t \ne 0 \\ \ne 0, & t = 0 \end{cases}$ } $\delta(t)$ hanya ada pada $t = 0$
* $\int_{-\infty}^{\infty} \delta(t)\,dt = 1$ } luas bidang antara $\delta(t)$ dengan sumbu t adalah satu satuan



$\lim_{n \to \infty} f_n(t) = \delta(t)$

* Bagaimana membuat $\delta(t)$?

Ada BANYAK cara membuat $\delta(t)$ secara matematis ------

Salah satu cara, adalah sbb..

Next

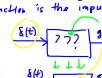
* Mahal Nisbah-Alih (Transfer Function)

* Apa itu Nisbah Alih?

What is a Transfer Function?

Nisbah Alih adalah tanggapan denyut

Transfer Function is the impulse response



Nisbah Alih sistem ini adalah g(t) karena ketika diberi masukan isyarat denyut satuan (unit impulse) δ(t), menghasilkan keluaran g(t).