EL 1207 - Rangkaian Listrik 2

Frekuensi Kompleks, Respon Frekuensi, dan Resonansi

Mifta Nur Farid, S.T., M.T.

November 25, 2019

Teknik Elektro - Institut Teknologi Kalimantan
Karang Joang, Balikpapan

Frekuensi Kompleks

Frekuensi Kompleks

- Frekuensi kompleks = Fungsi Sinusoidal + Konstanta Peredam
- Fungsi Sinusoidal

$$V_m \cos(\omega t + \theta)$$

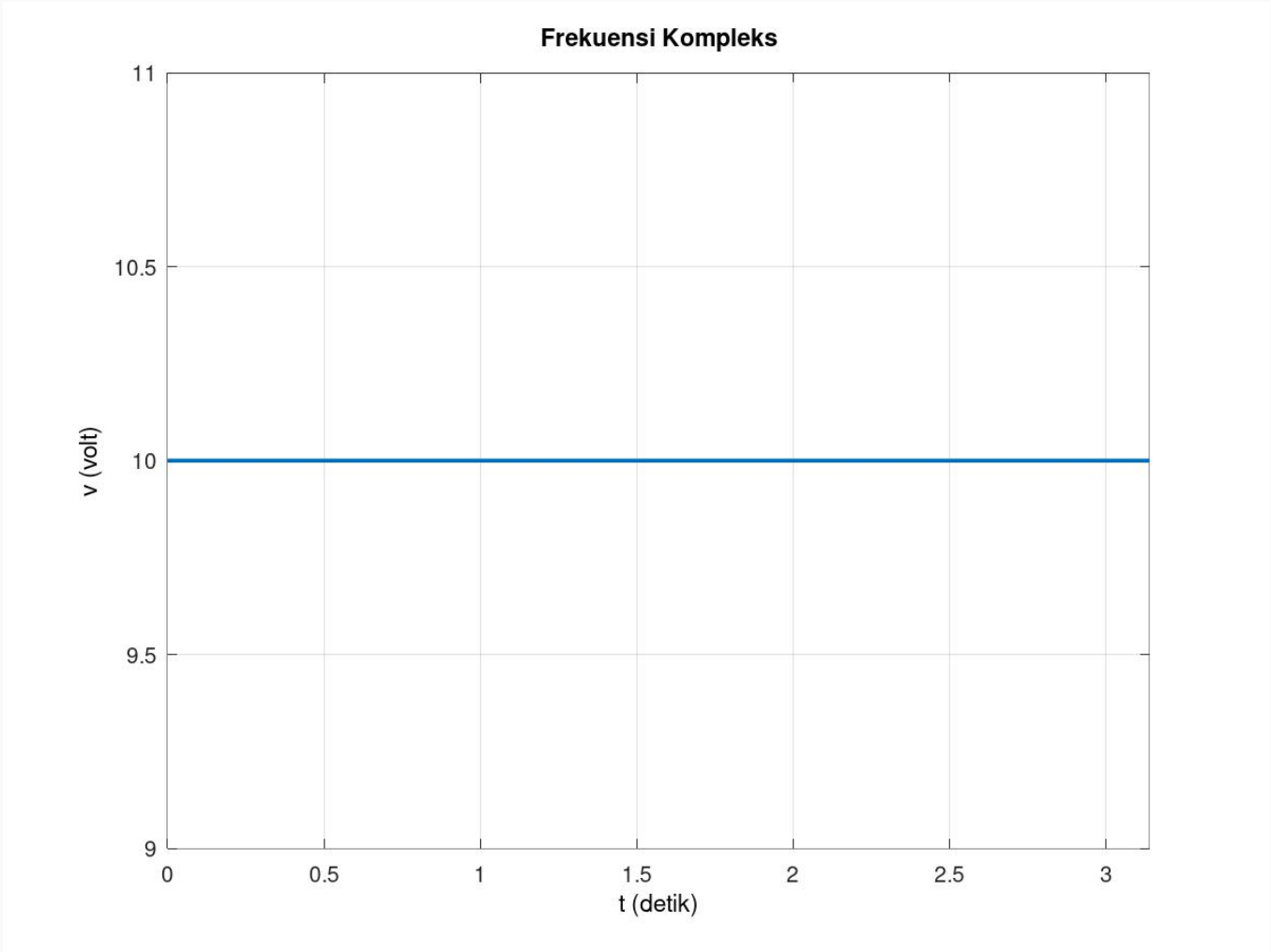
- Konstanta Peredam

$$e^{\sigma t}$$

  dimana σ adalah faktor peredam atau frekuensi Neper dengan satuan Np/s
- Fungsi Sinusoidal dengan berbagai konstanta peredam dapat digambarkan dalam bentuk kurva

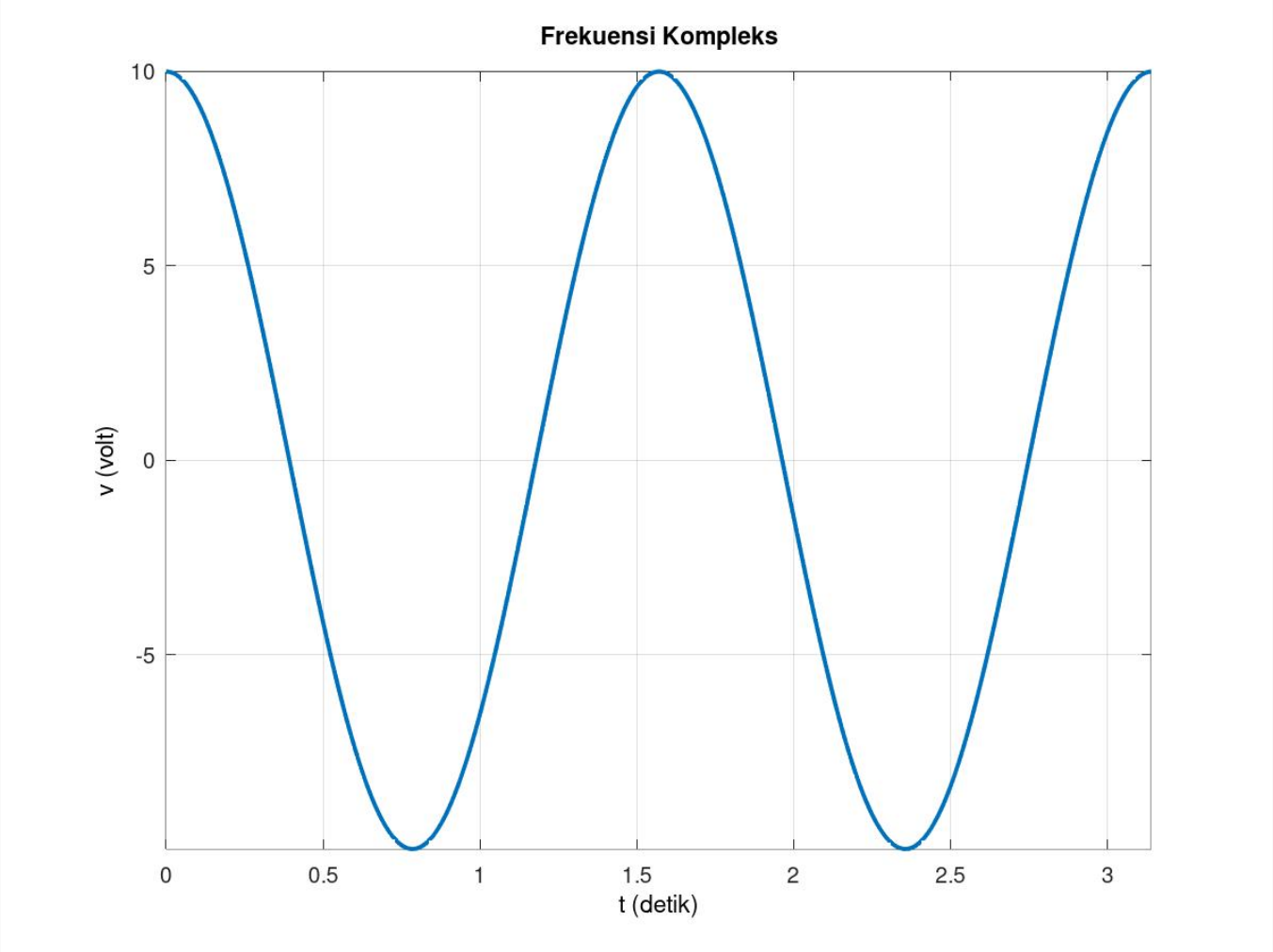
Frekuensi Kompleks

- Nilai $\sigma = 0$ dan $\omega = 0$ maka $v(t) = V_m$



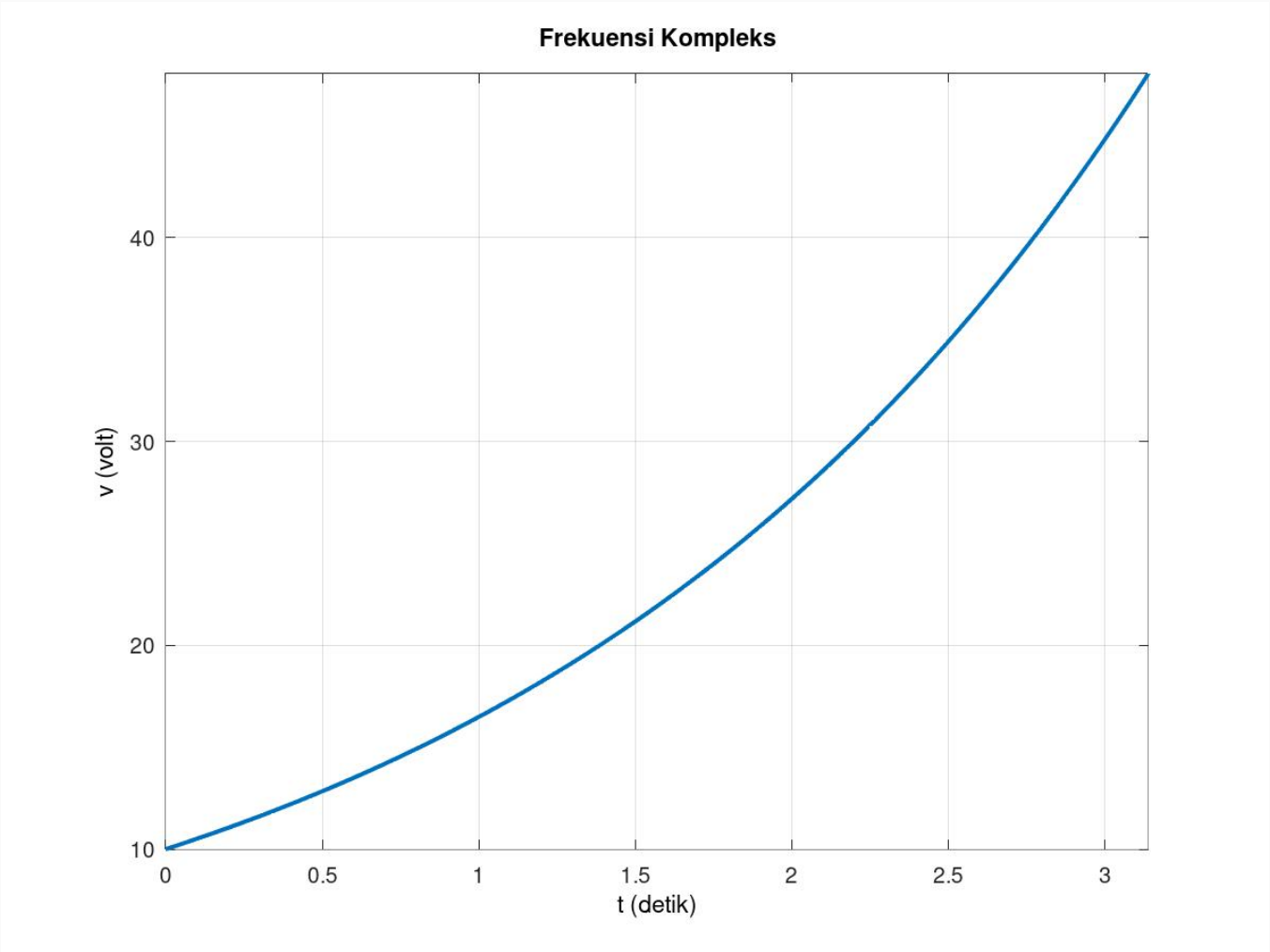
Frekuensi Kompleks

- Nilai $\sigma = 0$ maka $v(t) = V_m \cos(\omega t + \theta)$



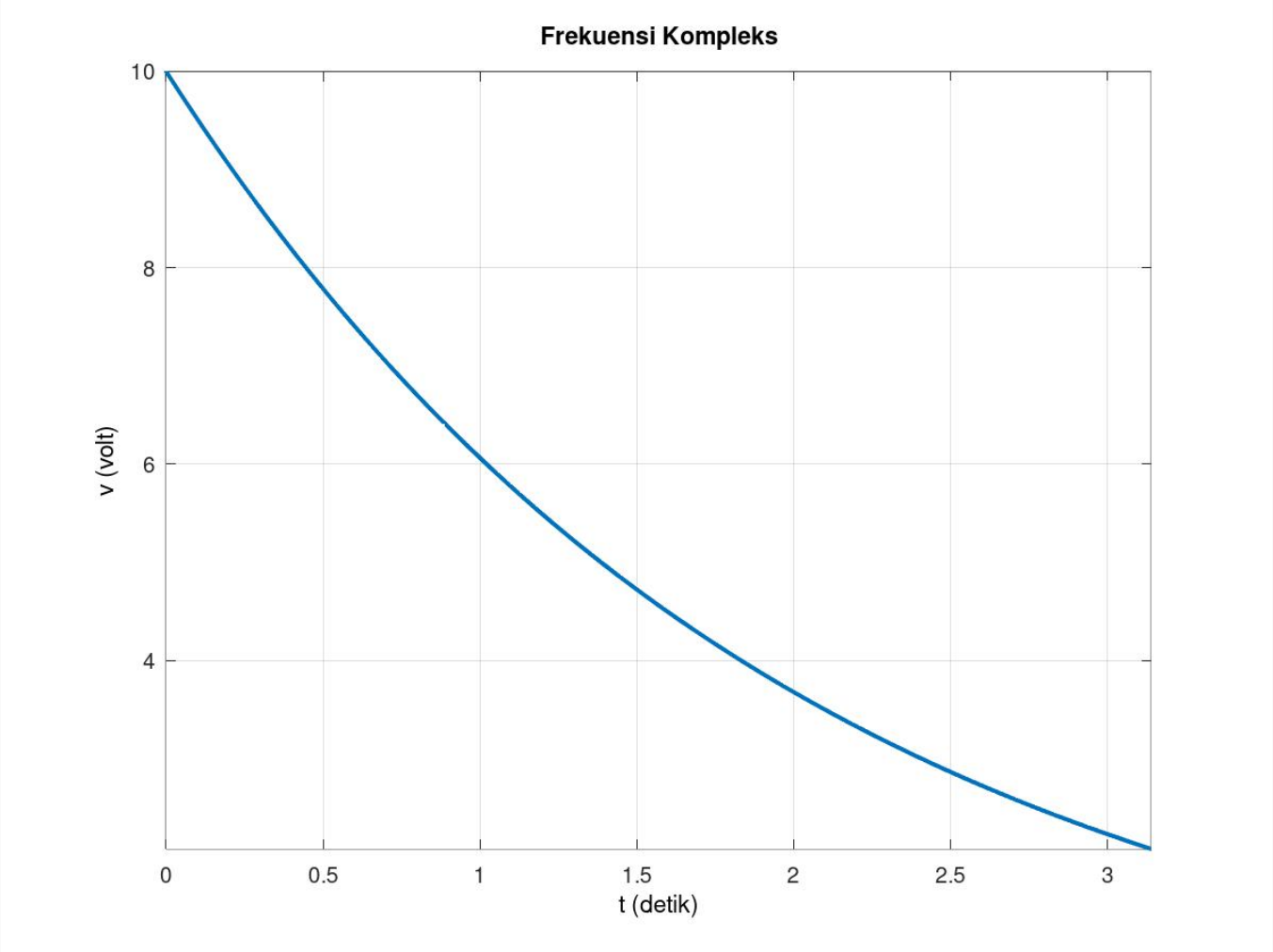
Frekuensi Kompleks

- Nilai $\sigma > 0$ dan $\omega = 0$ maka $v(t) = V_m e^{\sigma t}$



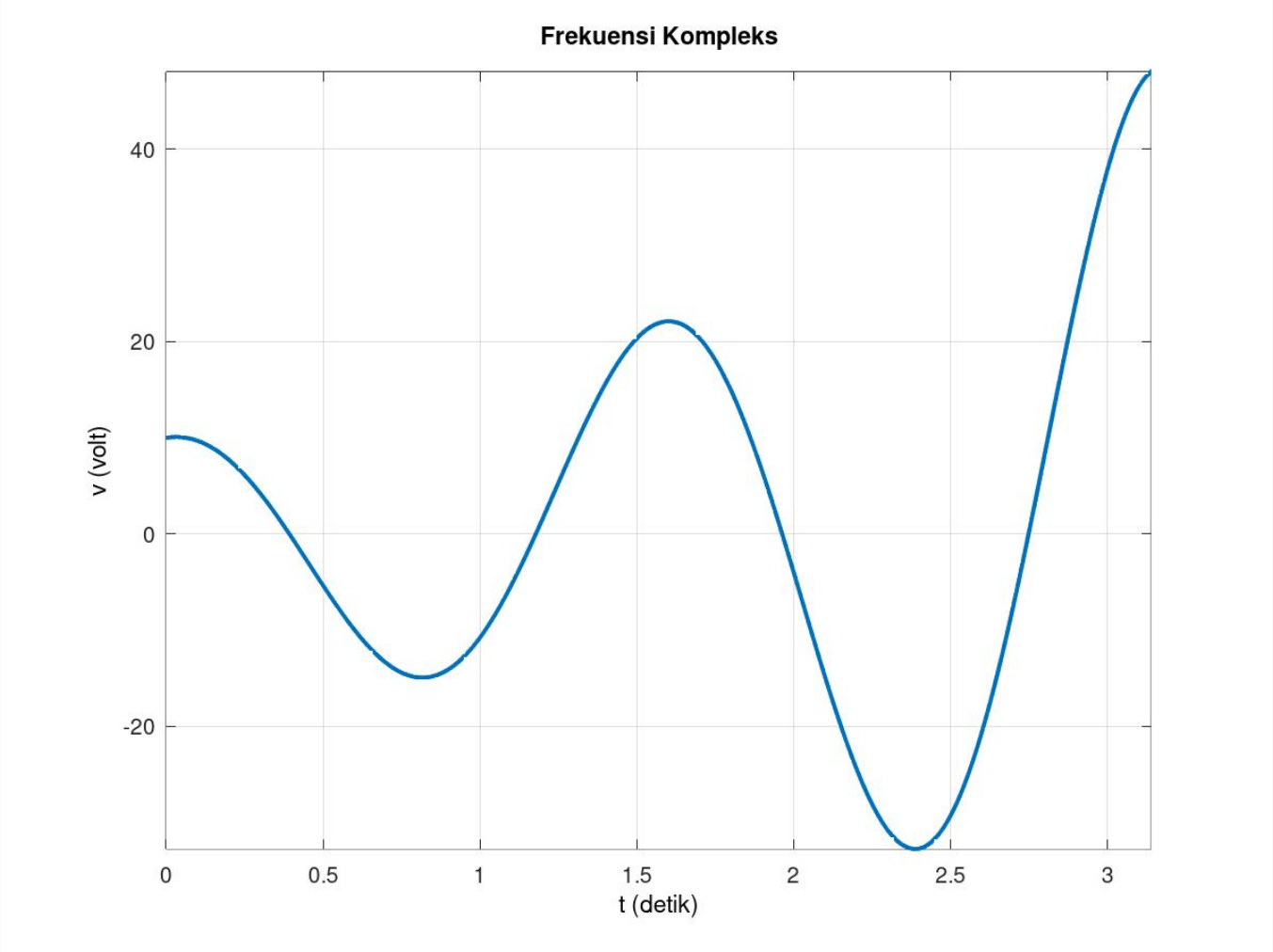
Frekuensi Kompleks

- Nilai $\sigma < 0$ dan $\omega - 0$ maka $v(t) = V_m e^{\sigma t}$



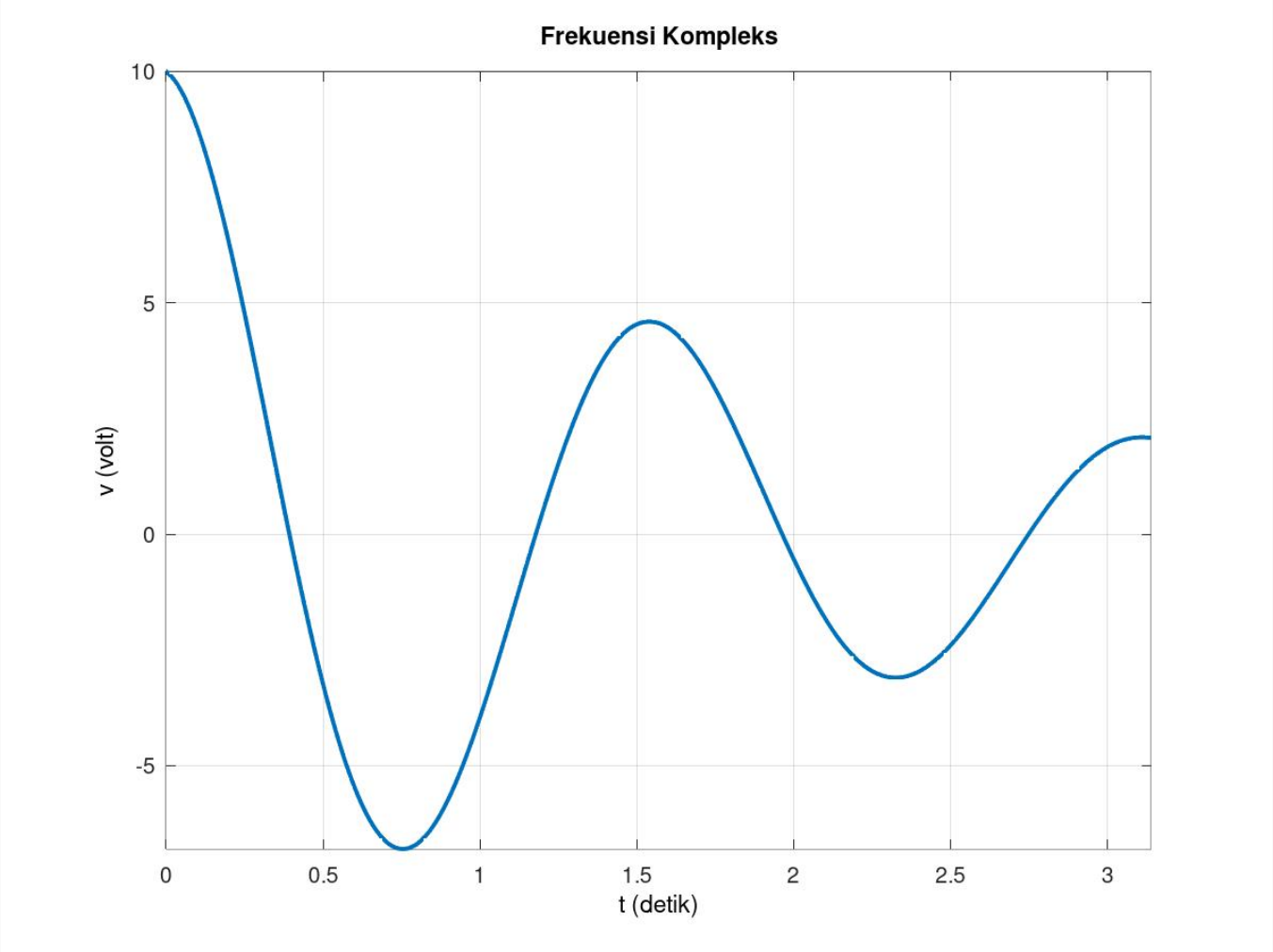
Frekuensi Kompleks

- Nilai $\sigma > 0$ maka $v(t) = V_m e^{\sigma t} \cos(\omega t + \theta)$



Frekuensi Kompleks

- Nilai $\sigma < 0$ maka $v(t) = V_m e^{\sigma t} \cos(\omega t + \theta)$



Frekuensi Kompleks

Fasor sinyal AC

$$v(t) = V_m \cos(\omega t + \theta)$$

$$V = \text{Re}\left[V_m e^{j(\omega t+\varphi)}\right]$$

$$V = \text{Re}\left[V_m e^{j(\varphi)} e^{j\omega t}\right]$$

$$V(j\omega) = V_m e^{j\varphi}$$

$$V(j\omega) = V_m \angle\varphi$$

Fasor sinyal frekuensi kompleks

$$v(t) = V_m e^{\sigma t} \cos(\omega t + \theta)$$

$$V = \text{Re}\left[V_m e^{\sigma t} e^{j(\omega t+\varphi)}\right]$$

$$V = \text{Re}\left[V_m e^{j(\varphi)} e^{(\sigma+j\omega t)}\right] \leftrightarrow s = \sigma + j\omega$$

$$V = \text{Re}\left[V_m e^{j\varphi} e^{st}\right]$$

$$V(s) = V_m e^{j\omega}$$

$$V(s) = V_m \angle\varphi$$

Impedansi dalam frekuensi kompleks

$$V(s) = \frac{Z(s)}{I(s)}$$

$$Z_R(s) = R \qquad Y_R(s) = \frac{1}{R}$$
$$Z_L(s) = sL \qquad Y_L(s) = \frac{1}{sL}$$
$$Z_C(s) = \frac{1}{sC} \qquad Y_C(s) = sC$$

Contoh Soal

Tentukan nilai $i(t)$ dari rangkaian berikut ini.

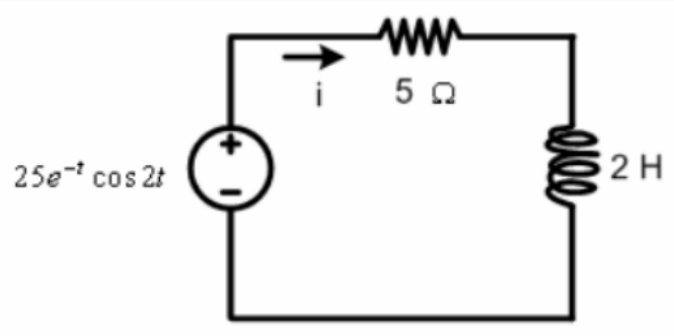


Figure 1:

$$
\begin{aligned}
s &= \sigma + j\omega \\
&= -1 + j2 \\
Z_R(s) &= 5\omega \\
Z_L(s) &= sL = 2s\omega \\
Z_T(s) &= 5 + 2s\omega \\
V &= 25e^{-t}\cos(2t) = 25\angle 0^\circ \text{v} \\
i(s) &= \frac{V(s)}{Z_T(s)} = \frac{25\angle 0^\circ}{5+2s} = \frac{25\angle 0^\circ}{5+2(-1)} \\
&= 5e^{-t}\cos(2t - 53,1^\circ)\text{A}
\end{aligned}
$$

Ada Pertanyaan?