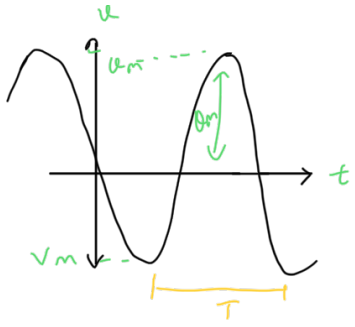
sinusoidal steady state analysis



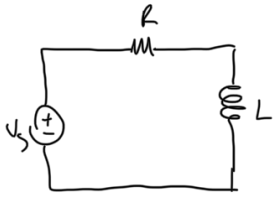
$v(t) = \vartheta_m \cos(\omega t + \phi)$ V

f: $\frac{1}{T}$ (Hz) $\quad \omega$: $2\pi f$ (rad/s) (açısal frekans)

T: periyot(t) $\quad \phi$: faz açısı (derece, rad)

ϑ_m: genlik

ϑ_{rms}: $\frac{\vartheta_m}{\sqrt{2}}$



v_s: $\vartheta_m \cos(\omega t + \phi)$

$L\frac{di}{dt} + Ri = \vartheta_m \cdot \cos(\omega t + \phi)$

giriş sinüsoidal ise çıkış öyle

$i(t) = \underbrace{\ldots e^{-\frac{t}{\tau}}}_{i_t(t)} + \underbrace{\ldots}_{i_{ss}(t)}$ $\quad t \to \infty$ $\Rightarrow$ $\frac{\vartheta_m \cos(}{\sqrt{R^2+\omega^2L^2}}$

$i_t(t)$: geçici durum tepkisi $\quad t \to \infty = 0$

$i_{ss}(t)$: kalıcı durum forced ✓ can be written

$i_{ss}(t) = \mathrm{Re}\{I_m e^{j\beta} \cdot e^{j\omega t}\}$

çıkışta genlik, faz değişir (frekans aynı)

phasor

Bir sinüzoidin genlik ve faz bilgisini taşıyan karmaşık sayı (f biliniyor)

$\bar{V} = \vartheta_m e^{j\phi} = P\{\vartheta_m \cos(\omega t + \theta)\}$ (fazör fonk.)

$\vartheta_m \cos\phi + j\vartheta_m \sin\phi$

$\vartheta_m e^{j\phi} \xrightarrow{P^{-1}} \vartheta_m \cos(\omega t + \phi)$ (ters fazör)

1) $\vartheta_m e^{j\phi} \times e^{j\omega t}$

$\mathrm{Re}\{\vartheta_m e^{j\phi} \cdot e^{j\omega t}\}$

$I_m e^{j\beta} = \frac{\vartheta_m e^{j\phi}}{R + j\omega L}$

$e^{j\theta} = \cos\theta + j\sin\theta$

$M\cos(\omega t + \phi) \Rightarrow M e^{j\phi} = M \angle\phi = x + yj$

$x = M\cos(\phi) \quad y = M\sin(\phi)$

$\phi = \tan^{-1}\left(\frac{y}{x}\right)$

fazör alanında t'li ifade yo

Multiplication: $z_1 \cdot z_2 = r_1 r_2 \angle(\phi_1 + \phi_2)$ $\left(r_1 e^{j\phi_1} \cdot r_2 e^{j\phi_2}\right)$

division: $z_1 / z_2 = \frac{r_1}{r_2} \angle(\phi_1 - \phi_2)$

time domain		phasor domain
$\vartheta_m \cos(\omega t + \phi)$	$\longrightarrow$	$\vartheta_m \angle\phi$

$v_m \sin(wt+\phi) \rightarrow v_m \angle \phi - 90°$

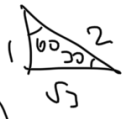
$v_m \cos(wt+\phi)$ — derivation → jwV; integration → $\frac{V}{jw}$ } in phasor domain

example

$y_1 = 20\cos(wt-30)$
$y_2 = 40\cos(wt+60)$ } $y_1+y_2 = ?$

$20\angle -30$, $40\angle 60$

$\bar{y_1} + \bar{y_2} = 20e^{-30i} + 40e^{60i}$



$20\cos(-30) + 20\sin(-30)i + 40\cos(60) + 40\sin(60)$

$\left[\frac{20\sqrt{3}}{2} + \frac{40\cdot 1}{2}\right] + \left[\frac{-20\cdot 1}{2} + \frac{40\sqrt{3}}{2}\right]i = 0$

$37,32 + 24,64i = 0 \rightarrow 44.72\angle 33.43°$

$x+y$, $\tan^{-1}(0.66)$, $\frac{y}{x}$

ters → $m = \sqrt{x^2+y^2}$
$\phi = \tan^{-1}\left(\frac{y}{x}\right)$

$m = \sqrt{1392,78 + 607,13}$
$m = 44,72$

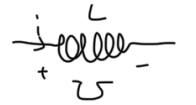
devre elemanları

R → 

$i = I_m \cos(wt+\phi_i) \rightarrow I_m \angle \phi$
$v = R \cdot I_m \cos(wt+\phi_i) \rightarrow RI_m \angle \phi$

$\bar{V} = R\bar{I}$

gerilim ve akım arasında faz farkı yok

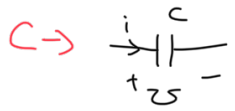
L → 

$i = I_m \cos(wt+\phi_i) \rightarrow I_m \angle \phi$
$v = L \cdot \frac{di}{dt}$

$\bar{V} = wLI_m \angle 90° + \phi$

- I ve V aynı fazda değil
- akım gerilimin 90° gerisinde (lagging current)

C →



$v = v_m \cos(\omega t + \phi_v) \rightarrow v_m \angle \phi_v$

$i = C \cdot \frac{dv}{dt}$

$\bar{V} = \frac{I_m}{\omega C} \angle \phi_i - 90$

- I ve v aynı fazda değil
- akım gerilimin 90° ilerisinde (leading current)

empedance

R → $\bar{V} = R\bar{I}$
L → $\bar{V} = j\omega L \bar{I}$
C → $\bar{V} = \frac{1}{j\omega C}\bar{I}$

$\bar{V} = \bar{Z} \cdot \bar{I}$ (fazör değil) Karmaşık sayı

empedance $\frac{\bar{V}}{\bar{I}}$ ohm (always)

R → R L → jωL C → $\frac{1}{j\omega C}$

reactance = im {empedance}

	empedans	reaktans
R	R	—
L	jωL	ωL
C	$j.(\frac{-1}{\omega C})$	$\frac{-1}{\omega C}$

$j.0{,}6 \angle 25^\circ = 0{,}6 \angle 115^\circ$

$e^{j90} = 1 \angle 90^\circ$