EC, 24.4.18 ①

Alternating voltage, alternating current

⋮

see last lesson

⋮

$$u(t) = \hat{u} \cdot \sin(\omega t + \varphi_u) = \mathrm{Im}\{\hat{u}\, e^{j(\omega t + \varphi_u)}\}$$

go on here

$$i(t) = \hat{i} \cdot \sin(\omega t + \varphi_i) = \mathrm{Im}\{\hat{i} \cdot e^{j(\omega t + \varphi_i)}\}$$

page ③

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②

$$e^{j\varphi} = \cos(\varphi) + j\sin(\varphi)$$

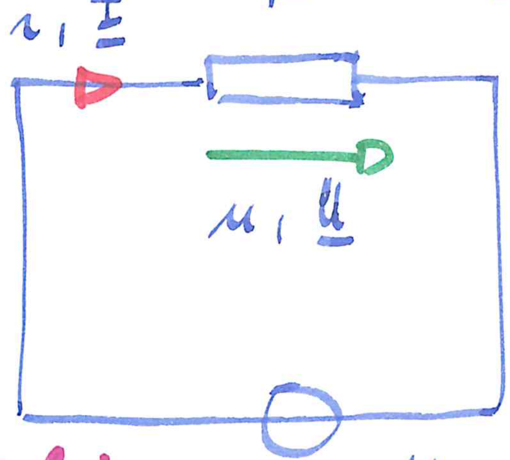
substitution:

$$\hat{u} = U_{eff} \cdot \sqrt{2} = U \cdot \sqrt{2}$$

$$\hat{i} = I_{eff} \cdot \sqrt{2} = I\sqrt{2}$$

- R to alternating voltage source

R → Resistor



$\hat{u} = 325$

$U = 230$

→ later → $\underline{U}$ ~ ; for ex: 230V

③

$$u(t) = \mathrm{Im}\left\{\hat{u}\cdot e^{j(\omega t+\varphi_u)}\right\}$$

$$= \mathrm{Im}\left\{\sqrt{2}\,U\underbrace{e^{j\varphi_u}}\cdot e^{j\omega t}\right\}$$

$$= \mathrm{Im}\left\{\sqrt{2}\,\underline{U}\cdot e^{j\omega t}\right\}$$

$\vdots$

$$i(t) = \mathrm{Im}\left\{\sqrt{2}\,\underline{I}\,e^{j\omega t}\right\}$$

with

$$\boxed{\begin{aligned}\underline{U} &= U\cdot e^{j\varphi_u}\\ \underline{I} &= I\,e^{j\varphi_i}\end{aligned}}$$

$\omega = 2\pi\cdot f$

④

$$u(t) = \mathrm{Im}\left\{\underline{U}\sqrt{2}\,e^{j\omega t}\right\}$$

$$i(t) = \mathrm{Im}\left\{\underline{I}\sqrt{2}\,e^{j\omega t}\right\}$$

OHM's law: $\underbrace{U = R\cdot I}_{DC}$; $\underbrace{u = Ri}_{AC}$

if we have a current $i(t)$!

$$u(t) = R\cdot i(t) = R\cdot\mathrm{Im}\left\{\underline{I}\sqrt{2}\,e^{j\omega t}\right\}$$

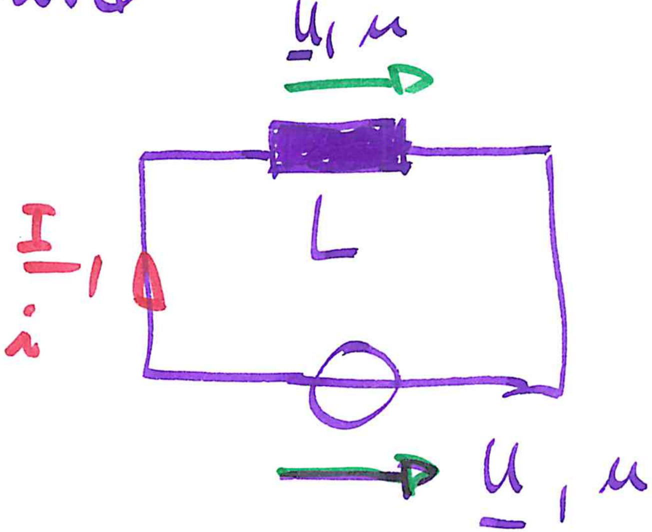
$$= \mathrm{Im}\left\{\sqrt{2}\,\underbrace{\underline{I}\cdot R}_{\underline{U}}\,e^{j\omega t}\right\} = u$$

$$\boxed{\underline{U} = R\,\underline{I}}$$

OHM's law

beg.: AC

• L to alternating voltage source ⑤



if we have a current $i(t)$:

$$u(t) = L\frac{di}{dt} = L\frac{d}{dt}\left(\mathrm{Im}\left\{\sqrt{2}\,\underline{I}\,e^{j\omega t}\right\}\right)$$

$$= \mathrm{Im}\left\{\sqrt{2}\,L\,\underline{I}\cdot\frac{d}{dt}\left(e^{j\omega t}\right)\right\} =$$

⑥

$$\frac{d}{dt}\left(e^{2t}\right) = 2e^{2t}$$

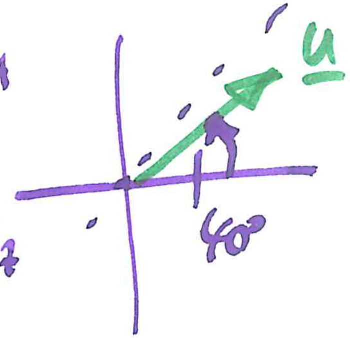
$$f(x) = e^{2x};\quad f'(x) = 2\cdot e^{2x}$$

$$= \mathrm{Im}\left\{\sqrt{2}\,\underbrace{L\,\underline{I}\,j\omega}_{\underline{U}}\cdot e^{j\omega t}\right\}$$

$$\boxed{\underline{U} = j\omega L\underline{I}}$$

Example: $L = 10\,mH$

$$\underline{\underline{U}} = 230V\,e^{j40°},\ 50\,Hz$$



calc: $\underline{I} = ?$

$$\underline{U} = j\omega L\underline{I};\quad \underline{I} = \frac{\underline{U}}{j\omega L}$$

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$$\underline{I} = \frac{230V \cdot e^{j40°}}{j \cdot 2\pi\, 50Hz \cdot 10\,mH} =$$

$Hz = \frac{1}{s}$; $H = \frac{Vs}{A}$!

$$= \frac{230\cancel{V} \cdot e^{j40°} \cdot \cancel{s} \cdot A}{j \cdot 2\pi \cdot 50 \cdot 10 \cdot 10^{-3}\, \cancel{V}\cancel{s}}$$

$j = 0 + 1j = 1 \cdot e^{j90°}$

↑ ↑

kartesian f. $\Rightarrow \boxed{j = e^{j90°}}$

$$= \frac{230V \cdot e^{j40°} \cdot A \cdot 10^3}{e^{j90°} \cdot 314 \cdot 10 \cdot} = 73.25A \cdot e^{-j50°}$$

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