Instantenous power

$$p(t) = v(t)\, i(t)$$

Avg power :

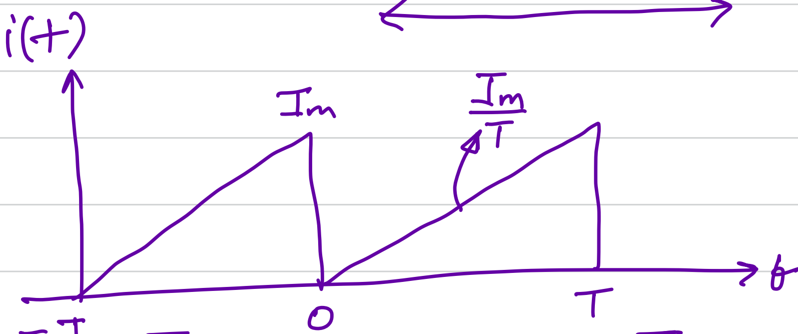
$$P_{av} = \frac{1}{T}\int_{t_0}^{t_0+T} p(t)\, dt$$

$$\left(\frac{I_m^2 R}{3}\right) W$$

I_{eff} ? $\left(\frac{I_m}{\sqrt{3}}\right)$ $\left(\frac{I_m}{\sqrt{2}}\right)$

"R"

$P_{avg} =$



$$p(t) = i^2 R$$

$$= \frac{I_m^2}{T^2} \cdot t^2 R$$

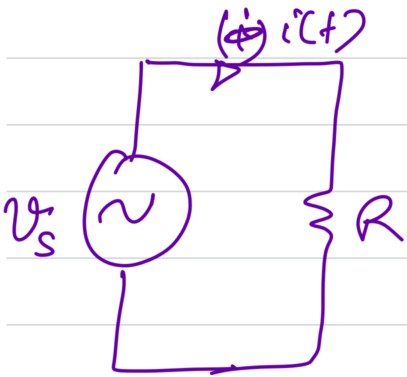
$$\frac{1}{T}\int_0^T \frac{I_m^2}{T^2} \cdot t^2 R\, dt =$$

$$\left[\, i(t) = \boxed{\frac{I_m}{T}\, t} \,\right]$$

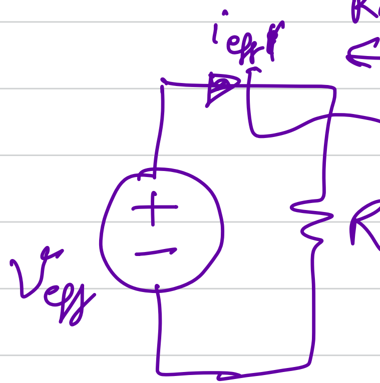
Effective value / RMS value

Root mean square

"AC"



$\equiv$



$$I_{eff} = \sqrt{\frac{1}{T}\int_0^T i^2(t)\,dt}$$

RMS current

$$P_{avg} = \frac{1}{T}\int_0^T i^2(t)\,R\,dt$$

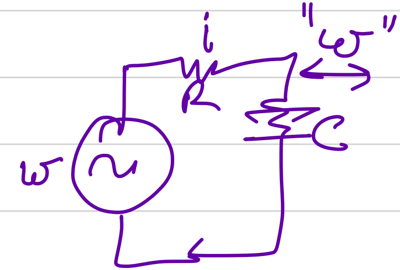
$$P_{dc} = I_{eff}^2 R$$

$$V_{eff} = \sqrt{\frac{1}{T}\int_0^T v^2(t)\,dt}$$

Phasor rep: of sinusoidal signal

cos $\leftrightarrow$ 

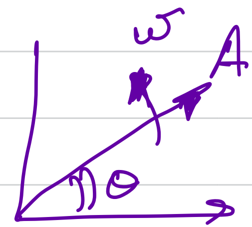
$$A\angle\theta \equiv Ae^{j\theta} \Rightarrow A(\cos\theta + j\sin\theta)$$



$$Re\{Ae^{j\theta}\} \Rightarrow A\cos\theta$$

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

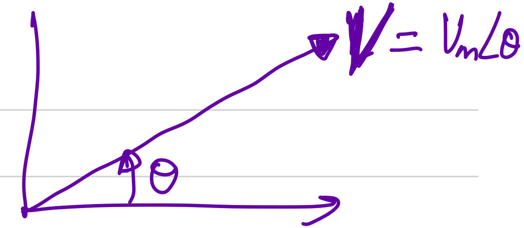
$$Re\{A\angle\theta\}$$



"ω"

$$A\angle\theta$$

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



$$\tilde{V} = \mathbf{V} = V_m \angle \theta$$

$$\tilde{I} = \mathbf{I} = I_m \angle \theta$$

$$i(t) = 25\cos(\omega t + 45^\circ) \qquad \mathbf{I} = 25\angle 45^\circ = \tilde{I}$$

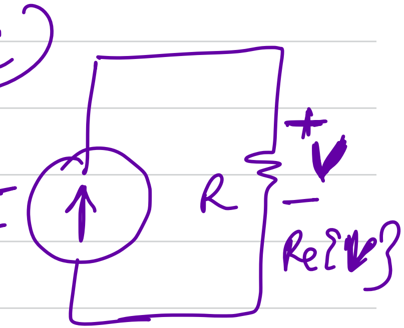
$$v(t) = -15\sin(\omega t + 30^\circ) \qquad \mathbf{V} = 15\angle 120^\circ = \tilde{V}$$

Impedance: R, L, C

$\mathbf{V} = Z(j\omega)\,\mathbf{I}$

$Z(j\omega) = f(R, L, C)$

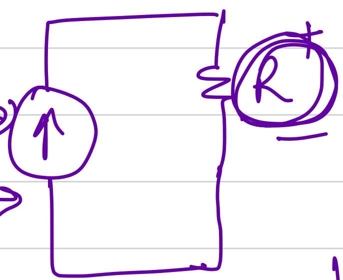
impedance ⇒ freq: dependent



ω

Re{I}

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



$i(t) = I_R e^{j(\omega t+\theta)}$

$v_R(t) = R I_R e^{j(\omega t+\theta)}$

$\Downarrow$

$V_R e^{j(\omega t+\theta)} = R I_R e^{j(\omega t+\theta)}$

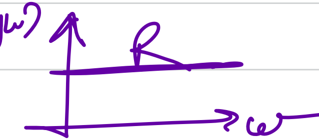
$\cos\omega t$

$\mathrm{Re}\{I_R e^{j(\omega t+\theta)}\}$

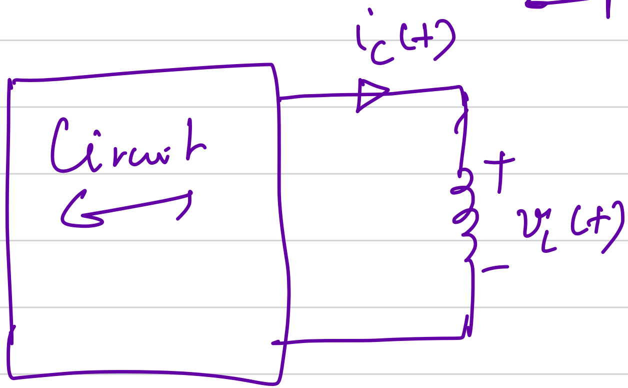
$I_R \cos\omega t$

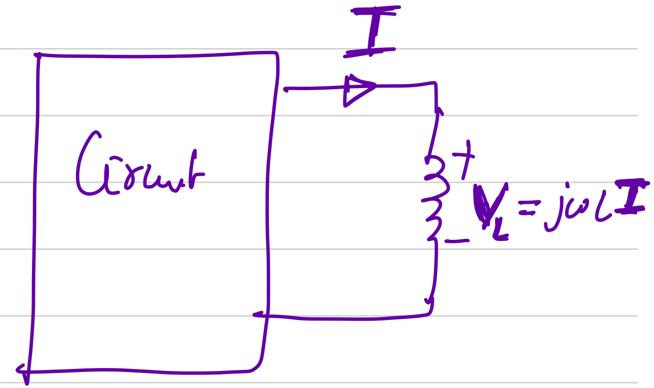
$V_R e^{j\theta} = R I_R e^{j\theta}$

$\mathbf{V} = R\mathbf{I} = Z(j\omega)\mathbf{I}$



Cap





$$i_c(t) = I_c \, e^{j(\omega t+\theta)}$$

$$v_c(t) = V_c \, e^{j(\omega t+\phi)}$$

$$i_c(t) = C \frac{dv_c(t)}{dt} = C \frac{d}{dt}\left\{V_c \, e^{j(\omega t+\phi)}\right\} = j\omega C V_c \, e^{j(\omega t+\phi)}$$

$$I_c \, e^{j(\omega t+\theta)} = j\omega C V_c \, e^{j(\omega t+\phi)}$$

$$I_c e^{j\theta} = j\omega C \, V_c e^{j\phi}$$

$$\mathbf{I} = I_c e^{j\theta} = I_c \angle \theta$$

$$\mathbf{V} = V_c e^{j\phi} = V_c \angle \phi$$

$$\mathbf{I} = j\omega C \, \mathbf{V}$$

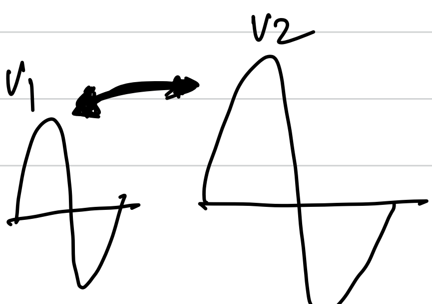
$$-j = 1\angle -90^\circ$$

$$\mathbf{V} = \frac{1}{j\omega C}\mathbf{I} = \frac{-j\, I_c \angle \theta}{\omega C} = \frac{I_c}{\omega C} \angle \theta - 90^\circ$$

dc values

$Z(j\omega) \longrightarrow \omega = 0 \longrightarrow Z(j\omega) = \infty \longrightarrow$ open circuit

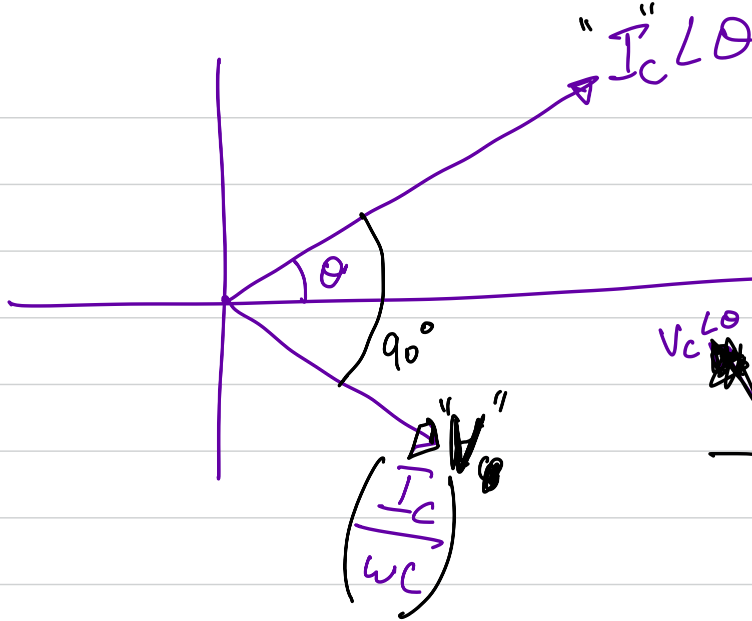
$\omega \to \infty \longrightarrow Z(j\omega) = 0 \longrightarrow$ S.C

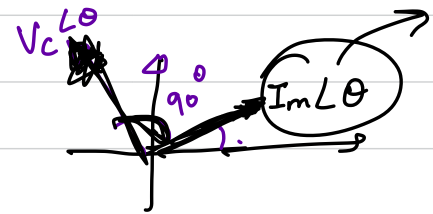


$\frac{V_1+V_2}{2}$ Common

$\frac{V_1-V_2}{2}$ → diff

CMRR





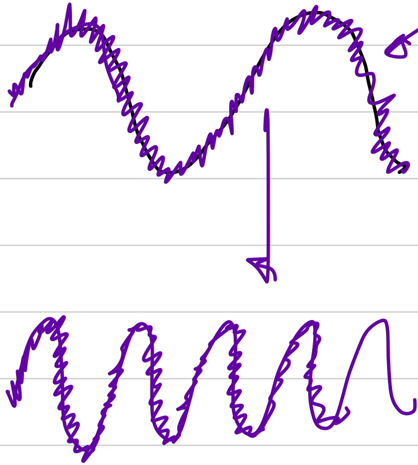
$$j = 1 \angle 90^\circ$$

$$V_L = j\omega L \, I_L = \omega L \, I_m \angle \theta + 90^\circ$$

$$Z(j\omega) = \omega L$$

$\omega = 0 \longrightarrow Z(j\omega) = 0 \longrightarrow$ S.C

$\omega \to \infty \longrightarrow Z(j\omega) = \infty \longrightarrow$ O.C male



$(V_1 - V_2)$ $V_1 + V_2$

"CMRR"

female

9nyhm

$(V_1 - V_2)$