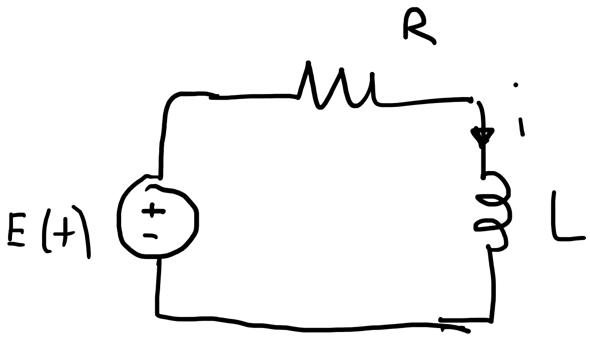


$$E(t) = E_m \sin(\omega t)$$

$$\begin{cases} L \dfrac{di}{dt} + R i = E_m \sin(\omega t) \\ i(0) = 0 \end{cases}$$

$$i(t) = \underbrace{A e^{-\frac{R}{L} t}}_{\to 0 \quad t \to \infty} + i_p(t)$$

$$i_p(t) = I_m \sin(\omega t + \alpha)$$

$$\frac{di_p}{dt} = \omega I_m \cos(\omega t + \alpha)$$

$$L \omega I_m \cos(\omega t + \alpha) + R I_m \sin(\omega t + \alpha) = E_m \sin(\omega t)$$

$$L \omega I_m \left[\cos(\omega t)\cos\alpha - \sin(\omega t)\sin\alpha\right] + R I_m \left[\sin(\omega t)\cos\alpha + \cos(\omega t)\sin\alpha\right]$$
$$= E_m \sin(\omega t)$$

$$\cos(\omega t)\left[\underbrace{\omega L I_m \cos\alpha + R I_m \sin\alpha}_{=0}\right] + \sin(\omega t)\left[\underbrace{-\omega L I_m \sin\alpha + R I_m \cos\alpha}_{= E_m}\right]$$
$$= E_m \sin(\omega t)$$

$$\begin{cases} \omega L \cancel{I_n} \cos\alpha + R \cancel{I_n} \sin\alpha = 0 \\ -\omega L I_n \sin\alpha + R I_n \cos\alpha = E_n \end{cases} \quad \rightarrow \quad \sin\alpha = -\frac{\omega L}{R}\cos\alpha$$

$$\frac{\omega^2 L^2}{R}\cos\alpha + R\cos\alpha = \frac{E_n}{I_n}$$

$$\cos\alpha = \frac{\dfrac{E_n}{I_n}}{R + \dfrac{\omega^2 L^2}{R}} = \frac{R}{R^2+\omega^2 L^2} \cdot \frac{E_n}{I_n} > 0$$

$$\sin^2\alpha + \cos^2\alpha = 1 \qquad \frac{\omega^2 L^2}{R^2}\cos^2\alpha + \cos^2\alpha = 1$$

$$\cos^2\alpha = \frac{1}{1+\dfrac{\omega^2 L^2}{R^2}} = \frac{R^2}{R^2+\omega^2 L^2} \qquad \cos\alpha = \frac{R}{\sqrt{R^2+\omega^2 L^2}},$$

$$\sin\alpha = -\frac{\omega L}{\sqrt{R^2+\omega^2 L^2}}$$

$$I_n = \frac{E_n}{\sqrt{R^2+\omega^2 L^2}}$$

REGIME DI CORRENTE ALTERNATA:

TUTTE LE TENSIONI E LE CORRENTI SONO FUNZIONI SINUSOIDALI DEL TEMPO ISOFREQUENZIALI

UN CIRCUITO LINEARE, STABILE, IN CUI TUTTE LE GRANDEZZE IMPRESSE SONO FUNZIONI SINUSOIDALI DEL TEMPO ISOFREQUENZIALI, RAGGIUNGE UN REGIME DI CORRENTE ALTERNATA ALLA FREQUENZA DEI GENERATORI QUANDO SI SONO ESTINTI I TERMINI TRANSITORI

$$a(t) = A_M \cos(\omega t + \alpha)$$

A_M = VALORE MASSIMO > 0

ω = PULSAZIONE $\left(\frac{rad}{s}\right)$

α = (ANGOLO DI) FASE (rad)

$T = \frac{2\pi}{\omega}$ PERIODO (s)

$f = \frac{1}{T}$ FREQUENZA (Hz)

$\omega = 2\pi f$

TRASFORMATA DI STEINMETZ $\underline{A}$ (FASORE)

$$a(t) = A_M \cos(\omega t + \alpha) \longrightarrow \underline{A} = \frac{A_M}{\sqrt{2}} e^{j\alpha} = A_e e^{j\alpha}$$

j = UNITÀ IMMAGINARIA $(0, 1)$

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

$$A_{rms}, A_{eff}, A_e = \sqrt{\frac{1}{T}\int_0^T a^2(t)\,dt} = \frac{A_M}{\sqrt{2}}$$

VALORE EFFICACE

TRASFORMATA

$$a(t) = A_M \cos(\omega t + \alpha) \longrightarrow \underline{A} = \frac{A_M}{\sqrt{2}} e^{j\alpha}$$

$$a(t) = R_e \left\{ \underline{A} \sqrt{2} \, e^{j\omega t} \right\} \longleftarrow \underline{A}$$

ANTITRASFORMATA

$$a(t) = A_M \cos(\omega t + \alpha) \longrightarrow \underline{A} = A_M e^{j\alpha}$$

$$a(t) = R_e \left\{ \underline{A} \, e^{j\omega t} \right\} \longleftarrow \underline{A}$$

$$a(t) = A_M \sin(\omega t + \alpha) \longrightarrow \underline{A} = \frac{A_M}{\sqrt{2}} e^{j\alpha}$$

$$a(t) = I_m \left\{ \underline{A} \sqrt{2} \, e^{j\omega t} \right\} \longleftarrow \underline{A}$$

PROPRIETÀ DI LINEARITÀ

$$a(t) = A_m \cos(\omega t + \alpha)$$

$$b(t) = B_m \cos(\omega t + \beta)$$

$$c_1, c_2 \in \mathbb{R}$$

$$c(t) = c_1\, a(t) + c_2\, b(t) = C_m \cos(\omega t + \gamma)$$

$$\underline{C} = \frac{C_m}{\sqrt{2}} e^{j\gamma} \qquad \underline{A} = \frac{A_m}{\sqrt{2}} e^{j\alpha}, \quad \underline{B} = \frac{B_m}{\sqrt{2}} e^{j\beta}$$

$$\underline{C} = c_1 \underline{A} + c_2 \underline{B}$$

TRASFORMAZIONE DELLA DERIVATA

$a(t) = A_M \cos(\omega t + \alpha)$, $\boxed{b(t) = \frac{da}{dt}}$

$\underline{A} = \frac{A_M}{\sqrt{2}} e^{j\alpha}$

$b(t) = -\omega A_M \sin(\omega t + \alpha)$ $\qquad -\sin x = \cos\left(x + \frac{\pi}{2}\right)$

$b(t) = \omega A_M \cos\left(\omega t + \alpha + \frac{\pi}{2}\right) = B_M \cos(\omega t + \beta)$

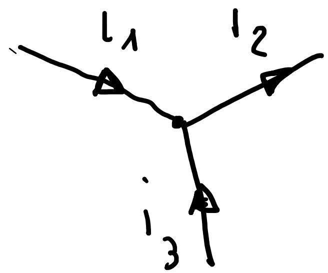
$B_M = \omega A_M$, $\beta = \alpha + \frac{\pi}{2}$

$$\underline{B} = \frac{B_M}{\sqrt{2}} e^{j\beta} = \frac{\omega A_M}{\sqrt{2}} e^{j\left(\alpha + \frac{\pi}{2}\right)} = \omega \underbrace{\frac{A_M}{\sqrt{2}} e^{j\alpha}}_{= \underline{A}} \underbrace{e^{j\frac{\pi}{2}}}_{= j}$$

$e^{j\frac{\pi}{2}} = \cos\left(\frac{\pi}{2}\right) + j\sin\left(\frac{\pi}{2}\right) = j$

$$\boxed{\underline{B} = j\omega \underline{A}}$$

LKC

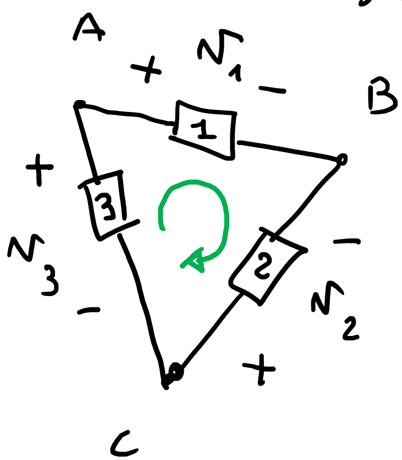


AI VALORI ISTANTANEI

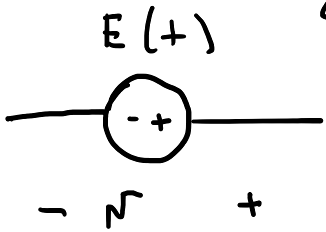
PER I FASORI

$$-i_1(t)+i_2(t)-i_3(t)=0 \qquad -\underline{I}_1+\underline{I}_2-\underline{I}_3=0$$

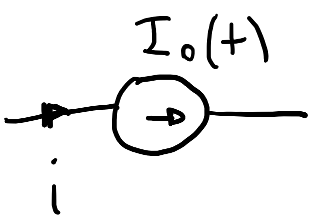
LKT



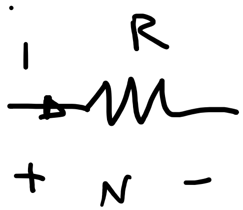
$$v_1(t)-v_2(t)-v_3(t)=0 \qquad \underline{V}_1-\underline{V}_2-\underline{V}_3=0$$



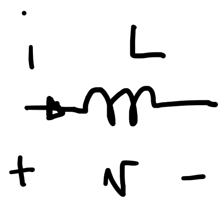
$$v(t)=E(t)=E_m\cos(\omega t+\alpha) \qquad \underline{V}=\underline{E}=\frac{E_m}{\sqrt{2}}e^{j\alpha}$$



$$i(t)=I_0(t)=I_{0m}\cos(\omega t+\alpha) \qquad \underline{I}=\underline{I}_0=\frac{I_{0m}}{\sqrt{2}}e^{j\alpha}$$

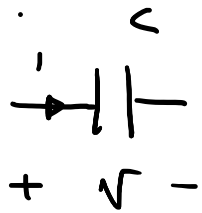


$$v(t) = R\, i(t) \qquad \underline{V} = R\, \underline{I} \qquad Z_R = R \qquad X_R = 0$$



$$v(t) = L \frac{di}{dt} \qquad \underline{V} = L\, j\omega\, \underline{I} = j\omega L\, \underline{I}$$

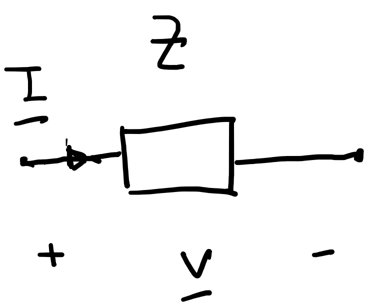
$$Z_L = j\omega L \;,\; X_L = \omega L > 0$$



$$i(t) = C \frac{dv}{dt} \qquad \underline{I} = C\, j\omega\, \underline{V}$$

$$Z_C = -\frac{j}{\omega C}$$

$$\underline{V} = \frac{\underline{I}}{j\omega C} = -\frac{j}{\omega C}\, \underline{I} \qquad X_C = -\frac{1}{\omega C} < 0$$



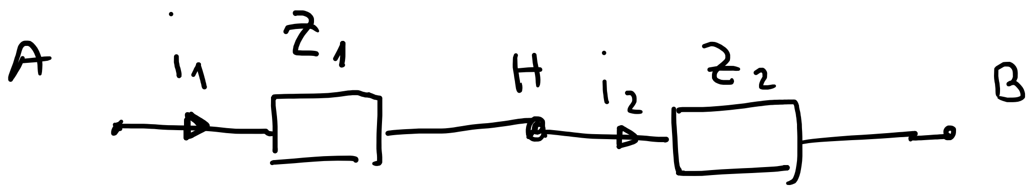
$$Z = \frac{\underline{V}}{\underline{I}} \Rightarrow \underline{V} = Z\, \underline{I}$$ IMPEDENZA

$$Z = R + jX$$

R = RESISTENZA (Ω)

X = REATTANZA (Ω)

IMPEDENTE COLLEGATE IN SERIE



$$-\underline{I}_1 + \underline{I}_2 = 0$$

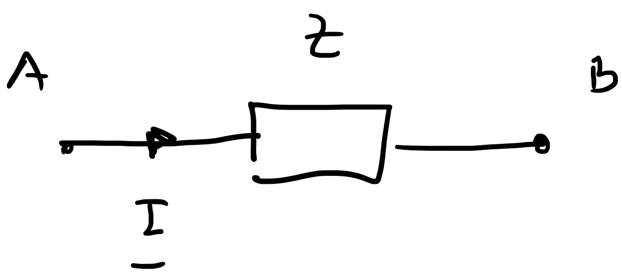
$$\underline{I}_2 = \underline{I}_1 = \underline{I}$$

$$\underline{V}_{AB} = \underline{V}_{AH} + \underline{V}_{HB}$$

$$\underline{V}_{AH} = \underline{V}_1 = Z_1 \underline{I}$$

$$V_{AB} = Z_1 \underline{I} + Z_2 \underline{I} = (Z_1 + Z_2)\,\underline{I}$$

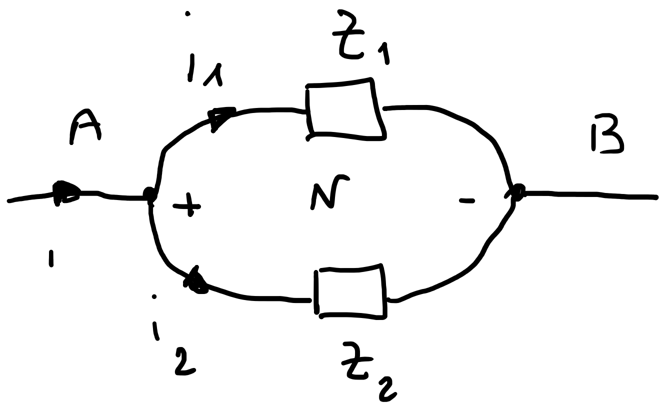
$$\underline{V}_{HB} = \underline{V}_2 = Z_2 \underline{I}$$



$$\underline{V}_{AB} = Z\,\underline{I}$$

$$Z = Z_1 + Z_2$$

IMPEDENTE COLLEGATE IN PARALLELO



$$\underline{V} = Z_1 \underline{I}_1$$

$$\underline{V} = Z_2 \underline{I}_2$$

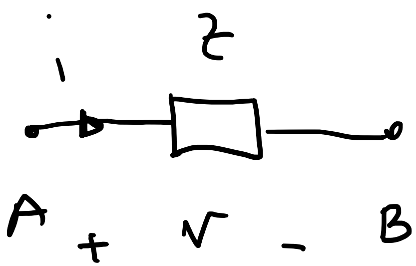
$$\underline{I} = \underline{I}_1 + \underline{I}_2$$

$$Z = \frac{Z_1 Z_2}{Z_1 + Z_2}$$

$$Z_1, Z_2 \neq 0$$

$$\underline{I}_1 = \frac{\underline{V}}{Z_1}, \quad \underline{I}_2 = \frac{\underline{V}}{Z_2}$$

$$\underline{I} = \frac{\underline{V}}{Z_1} + \frac{\underline{V}}{Z_2} = \underline{V}\left(\frac{1}{Z_1} + \frac{1}{Z_2}\right)$$



$$\underline{V} = Z \underline{I}$$

$$Z \neq 0$$

$$\underline{I} = \frac{\underline{V}}{Z}$$

$$\frac{1}{Z} = \frac{1}{Z_1} + \frac{1}{Z_2}$$