IMPEDENZA E AMMETTENZA

$$\frac{\bar{V}}{\bar{I}} = Z \in \mathbb{C} \qquad \frac{\bar{I}}{\bar{V}} = Y \in \mathbb{C}$$

$$\frac{v(t)}{i(t)} = R \in \mathbb{R} \quad = \quad \frac{i(t)}{v(t)} = G \in \mathbb{R}$$

CONDENSATORE

$$Z_C = \frac{1}{j\omega C} \qquad Y_C = j\omega C$$

$$\lim_{\omega/f \to 0} \quad |Z_C| \to +\infty \quad |Y_C| \to 0$$ circuito aperto

$$\frac{|\bar{I}|}{|\bar{V}|} = |Y_C|$$

$$\lim_{\omega/f \to +\infty} \quad |Z_C| \to 0 \quad |Y_C| \to +\infty$$

$$|V| = |Z_C||I| \Rightarrow$$ corto circuito

INDUTTORE

$$Z_L = j\omega L \qquad Y_L = \frac{1}{j\omega L}$$

$$\lim_{\omega/f \to 0} |Z_L| \to 0 \Rightarrow \text{corto circuito}$$

$$\lim_{\omega/f \to \infty} |Y_L| \to 0 \Rightarrow \text{circuito aperto}$$

LEGGI DI KIRCHHOFF PER I FASORI

$$\sum_{\alpha} \pm V_\alpha(t) = 0 \qquad \sum_{\beta} \pm i_\beta(t) = 0$$

$$\left[\begin{aligned} V_\alpha(t) &= Re\left\{ \bar{V}_\alpha e^{j\omega_0 t} \right\} \\ &= \frac{\bar{V}_\alpha e^{j\omega_0 t} + \bar{V}_\alpha^{*} e^{-j\omega_0 t}}{2} \end{aligned}\right]$$

$$\cos(\varphi) = \frac{e^{j\varphi} + e^{-j\varphi}}{2}$$

$$\sum_{\alpha} \pm V_\alpha(t) = \sum_{\alpha} \pm Re\left\{ \bar{V}_\alpha e^{j\omega_0 t} \right\} = 0$$

$$\forall t = \sum_{\alpha} \pm Re\left\{ \bar{V}_\alpha \right\} = 0$$

$$\sum_{\alpha} \pm \overline{V}_{\alpha} = 0$$

$$A_1 \cos(\omega_0 t + \varphi_1) + A_2 \cos(\omega_0 t + \varphi_2) =$$

$$A_3 \cos(\omega_0 t + \varphi_3) \overset{\circ}{=}$$

$$\underbrace{A_1 e^{j\varphi_1} + A_2 e^{j\varphi_2}}_{\text{SOMMA DEI FASORI}} = A_3 e^{j\varphi_3}$$

FASORE DELLA SOMMA

$$\sum \pm V_{\alpha}(t) = 0$$

$$\sum \pm \overline{V}_{\alpha} = 0$$

FASORE DELLA SOMMA

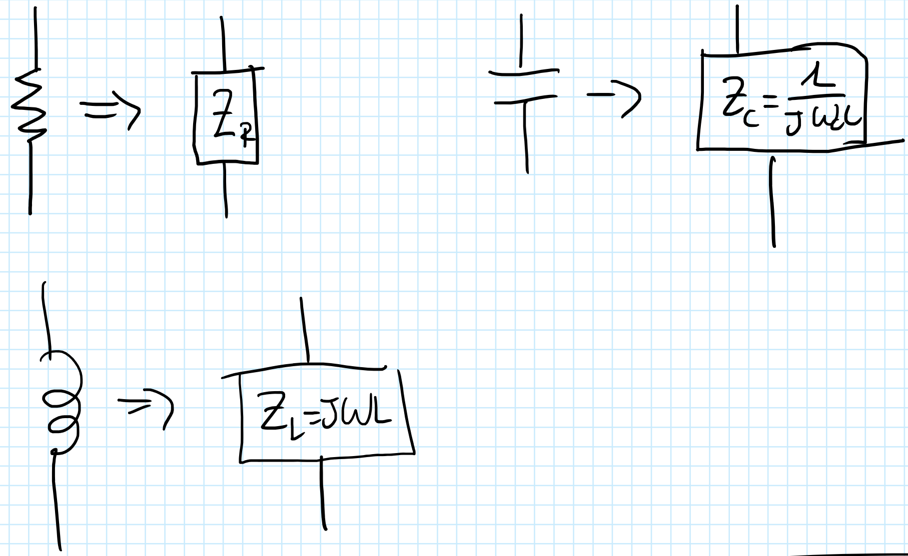
CIRCUITO SIMBOLICO NEL DOMINIO DEI FASORI

1) sostituisco i generatori sinusoidali con generatori costanti a valori complessi pari al fasore dei generatori

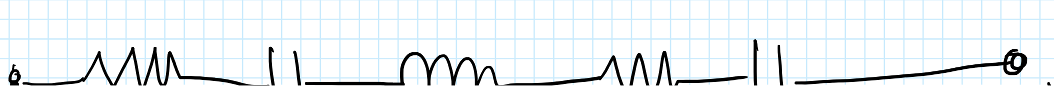
V_g $V_g = A\cos(\omega_0 t + \varphi_{V_g}) \Longleftrightarrow \overline{V}_g$

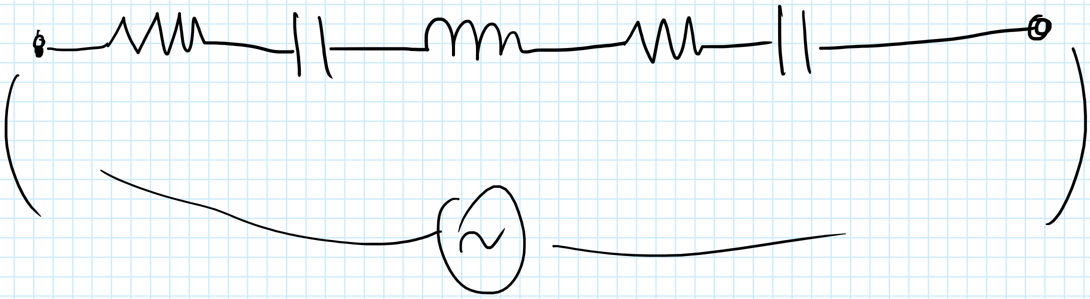
I_g $I_g = B\cos(\omega_0 t + \varphi_{I_g}) \Rightarrow \overline{I}$

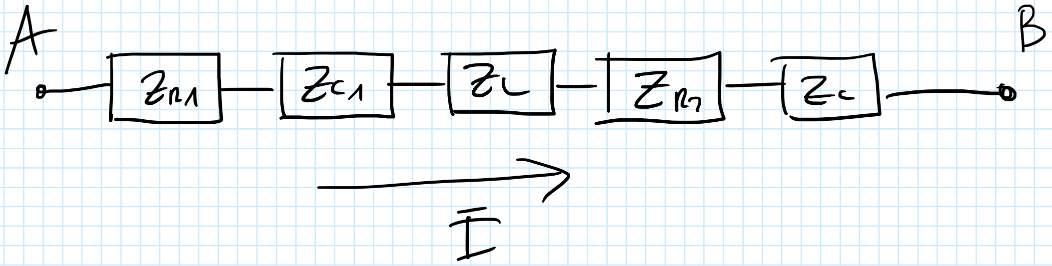
2) sostituiamo i bipoli con le rispettive impedenze/ammettenze



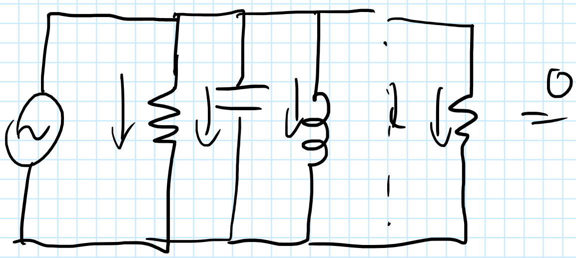
PER IL CIRCUITO SIMBOLICO VALGONO TUTTI I METODI DI ANALISI E TUTTI I TEOREMI (THEVENIN, NORTON, MILLMAN, SOSTITUZIONE, SOV, PSE, EQUIVALENZA DEI GEN. REALI)

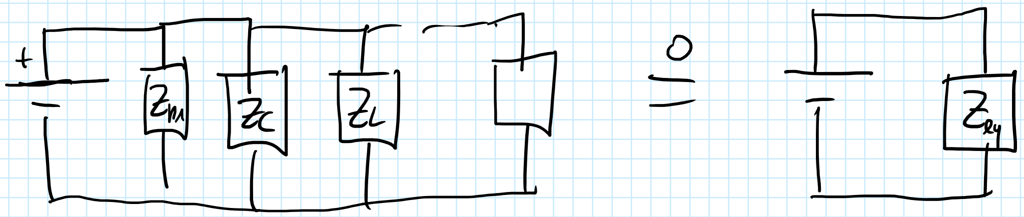






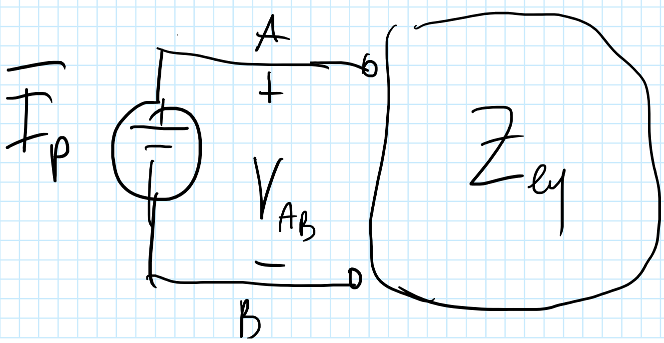
$$\bar{V} = \bar{I} \left(\sum_\alpha Z_\alpha \right)$$



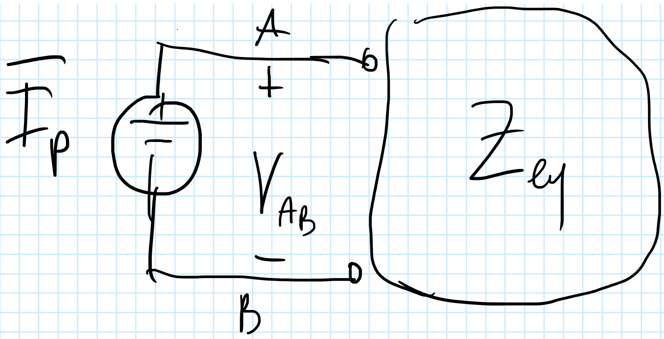


$$Y_{eq} = \sum_\alpha Y_\alpha \Rightarrow Z_{eq} = \left(\sum_\alpha \frac{1}{Z_\alpha} \right)^{-1}$$

$$Z = [\Omega] \qquad Y = [\Omega^{-1}]$$

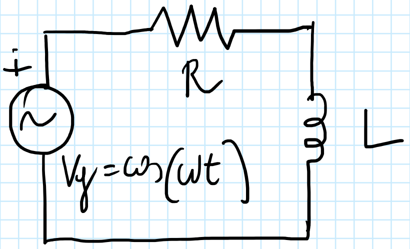


$$Z_{eq} = \frac{\bar{V}_{AB}}{\bar{I}_p}$$



$$Z_{eq} = \frac{\overline{V}_{AB}}{\overline{I}_p}$$

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



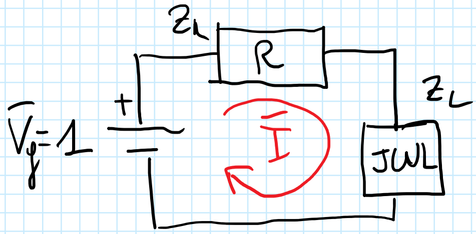
DISEGNARE IL CIRCUITO SIMBOLICO

→ SOSTITUIRE I GEN. CON I FASORI

→ SOSTITUIRE I BIPOLI CON LE RISPETTIVE IMPEDENZE

$$V_g = \cos(\omega t) \Rightarrow \bar{V}_g = 1$$

$$R \rightarrow Z_R \doteq R \qquad L \rightarrow Z_L = j\omega L$$



$$\bar{I} = \frac{\bar{V}_g}{Z_R + Z_L} = \frac{\bar{V}_g}{R + j\omega L}$$

$$\bar{I} = \frac{1}{R + j\omega L} \xrightarrow{\text{TEMPO}} i(t) = I_0 \cos(\omega t + \varphi_I)$$

$$I_0 = |\bar{I}| \qquad \varphi_I = \mathrm{Arg}(\bar{I})$$

$$\frac{a + jb}{c + jd} = \bar{X} = \frac{A_1 e^{j\varphi_1}}{A_2 e^{j\varphi_2}}$$

$$I_0 = \frac{1}{\sqrt{R^2 + \omega^2 L^2}}$$

$$|\bar{X}| = \frac{A_1}{A_2} = \frac{\sqrt{a^2 + b^2}}{\sqrt{c^2 + d^2}}$$

$$\varphi_I = \mathrm{Arg}(1) - \mathrm{Arg}(R + j\omega L)$$

$$\mathrm{Arg}(\bar{X}) = \varphi_1 - \varphi_2$$

$$\varphi_I = Arg(1) - Arg(R + j\omega L) \qquad Arg(\bar{X}) = \varphi_1 - \varphi_2$$

$$\varphi_I = 0 - tg^{-1}\left(\frac{\omega L}{R}\right)$$

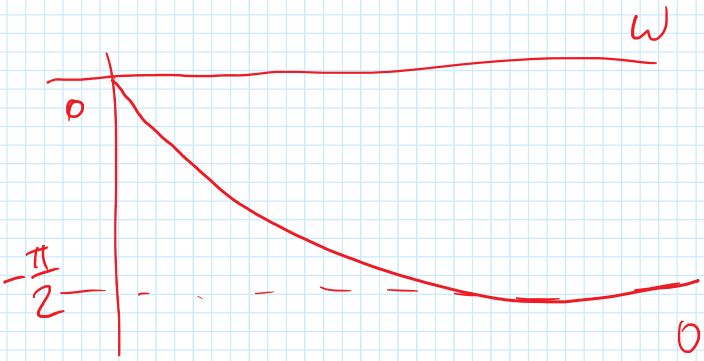
$$i(t) = \frac{1}{\sqrt{R^2+\omega^2 L^2}} \cos\left(\omega t - tg^{-1}\left(\frac{\omega L}{R}\right)\right) \quad [A]$$

$$i(t) = \underbrace{\frac{1}{\sqrt{R^2+\omega^2 L^2}}}_{A} \cos\Big(\underbrace{\omega_0}_{\omega_0} t + \underbrace{arctg\left(-\frac{\omega L}{R}\right)}_{\varphi}\Big)$$

$$\varphi = -tg^{-1}\left(\frac{\omega L}{R}\right)$$

$$|i(t)| = \frac{1}{\sqrt{R^2+\omega^2 L^2}} \qquad \omega \to \infty \to |i(t)| \to 0$$

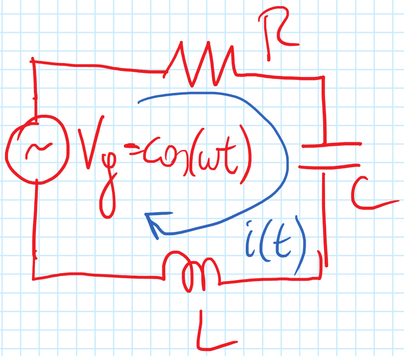
$$\varphi_I = -tg^{-1}\left(\frac{\omega L}{R}\right)$$



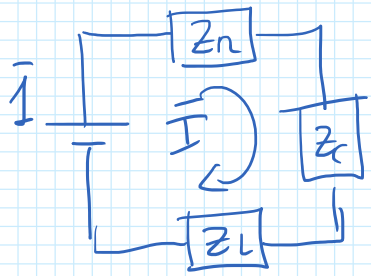
$$\omega \to 0 \qquad |i(t)| = \frac{1}{R}$$

$$|Z_R| = R = |Z_L| \qquad \omega ?$$

$$R = \omega L \qquad \omega^* = \frac{R}{L} = \frac{1}{\tau}$$



$\Longleftrightarrow$



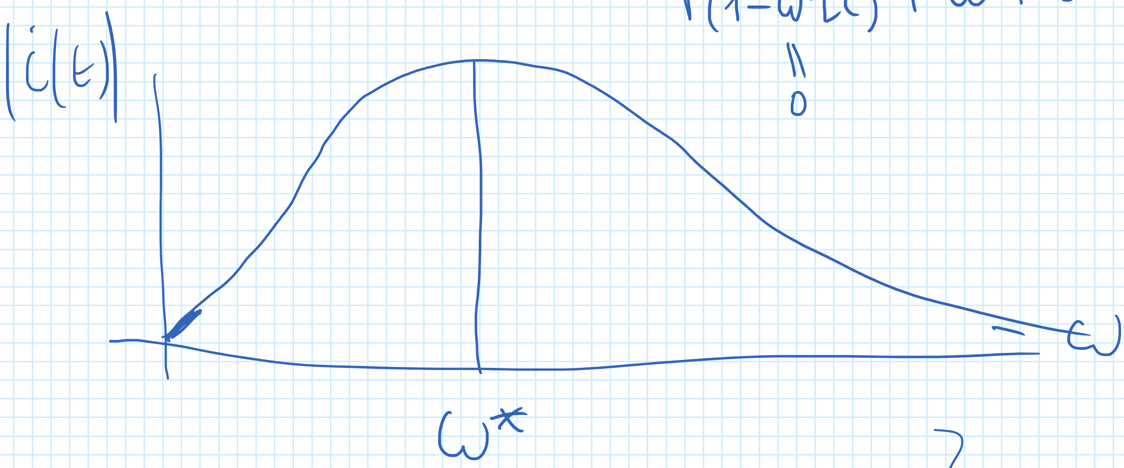
$$\frac{1}{j\omega C} = \frac{-j}{\omega C}$$

$$\bar{I} = \frac{\bar{V_g}}{Z_R + Z_L + Z_C} = \frac{\bar{V_g}}{R + j\omega L - \frac{j}{\omega C}}$$

$$\bar{I} = \frac{\omega C \bar{V_g}}{\omega RC + j\omega^2 LC - j} \cdot \frac{j}{j} = \frac{j\omega C}{1 + j\omega RC - \omega^2 LC} \bar{V_g}$$

$$\bar{I} = \bar{V_g} \cdot \frac{j\omega C}{(1-\omega^2 LC) + j\omega RC}$$

$$|i(t)| = |\bar{I}| = |V_g| \cdot \frac{\omega C}{\sqrt{\underbrace{(1-\omega^2 LC)^2}_{=0} + \omega^2 R^2 C^2}}$$



$$1 - \omega^{*2} LC = 0 \qquad \omega^{*2} LC = 1 \Big\} \; \omega^* = \frac{1}{\sqrt{LC}}$$

$$|i(t)|\,|\bar{I}| = |V_g| \cdot \frac{\omega C}{\ } = \frac{|V_g|}{\ }$$

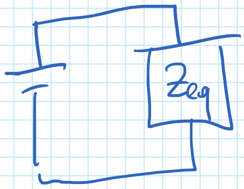
$$|i(t)| = |\bar{I}| = |V_g| \cdot \frac{\omega C}{\omega R C} = \frac{|V_g|}{R}$$

per $\omega = \omega^* = \frac{1}{\sqrt{LC}}$ $\quad Z_L = -Z_C$

$$j\omega^* L = \frac{j}{\omega^* C}$$

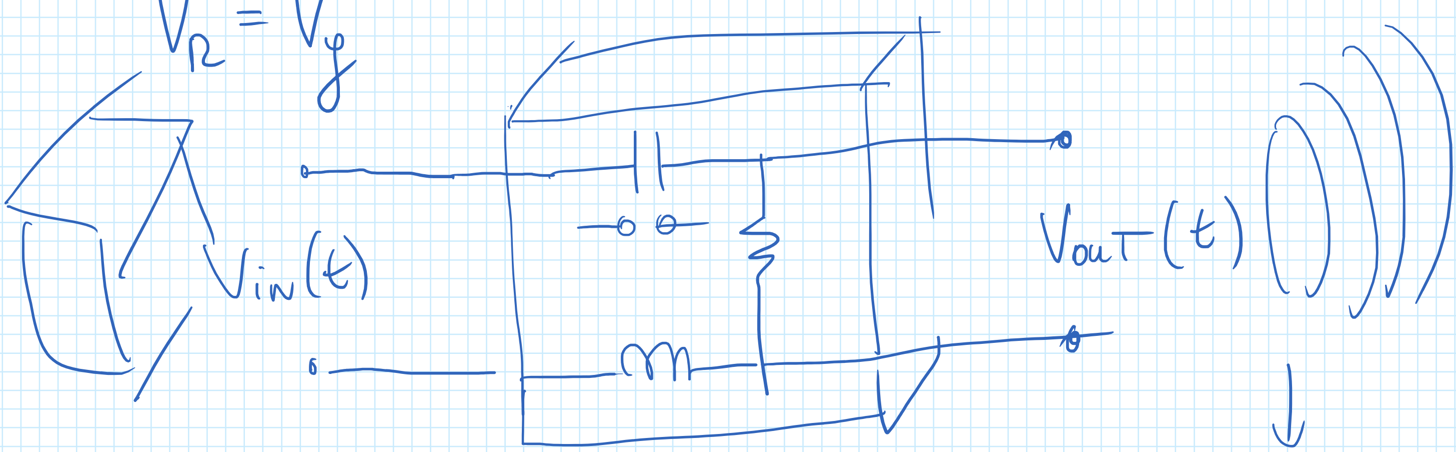
$$\frac{L}{\sqrt{LC}} = \frac{\sqrt{LC}}{C}$$

$$\sqrt{\frac{L}{C}} = \sqrt{\frac{L}{C}}$$



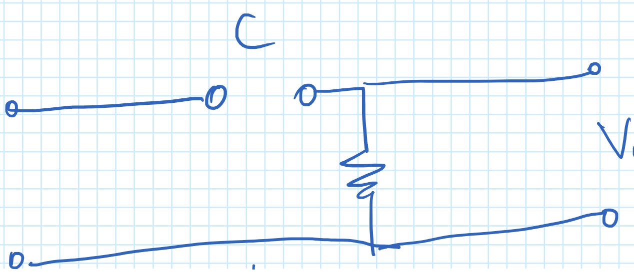
$$= Z_R + Z_L + Z_C = Z_R \qquad \omega = \left(\sqrt{LC}\right)^{-1}$$

$$\bar{V}_R = \bar{V}_g$$

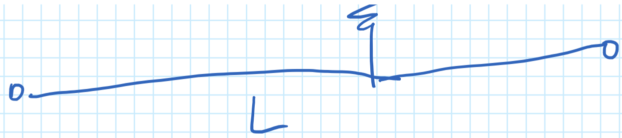


$$V_R(\omega) = I(t,\omega) \cdot R$$

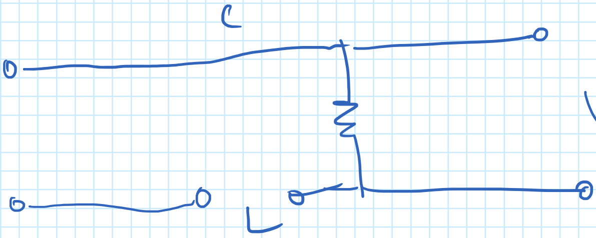
$\omega \to 0$



$V_{out} = 0$

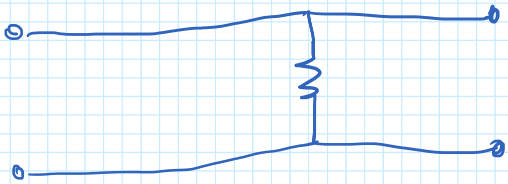


$\omega \to \infty$



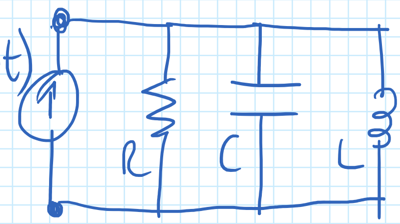
$V_{out} = 0$

$\omega = \omega^* = \frac{1}{\sqrt{LC}}$

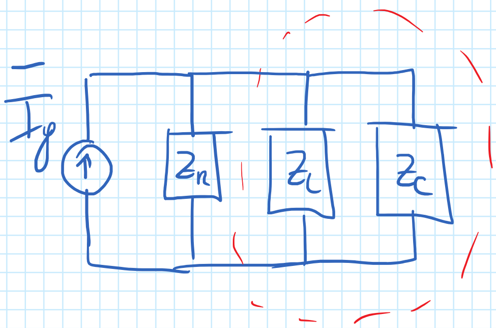


$V_{out} = V_{in}$

$I_g = \cos(\omega t)$



$\Rightarrow$



$$Z_{LC} = \frac{Z_L Z_C}{Z_L + Z_C}$$

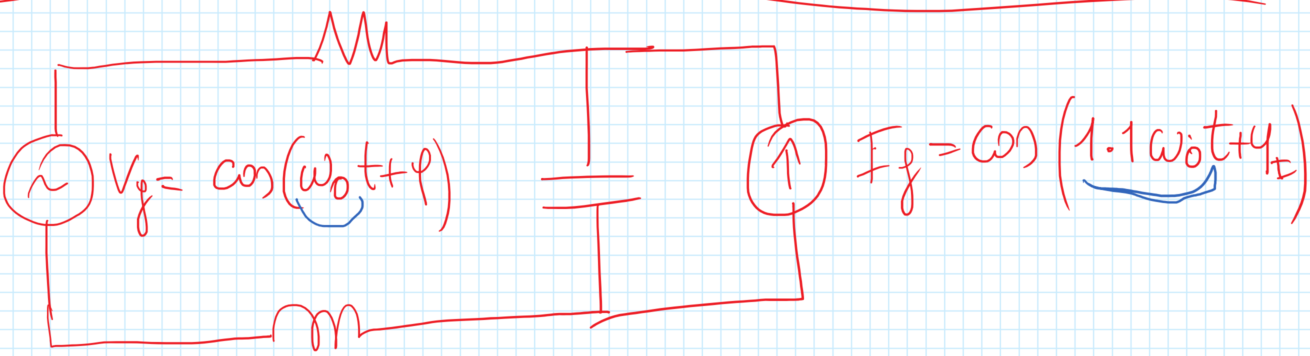
$$\omega = \omega^* = \frac{1}{\sqrt{LC}}$$

$$Z_L + Z_C = 0$$

$$Y_{eq} = Y_R + Y_L + Y_C$$

$$Z_{LC} \to +\infty$$

$$Y_C + Y_L = 0$$



IN PRESENZA DI ECCITAZIONI SINUSOIDALI A FREQ DIFFERENTI APPLICO IL PSE

→ SPENGO TUTTI I GEN. TRANNE QUELLI AD UNA STESSA FREQ f_0

→ APPLICO IL METODO DEI FASORI ALLA FREQ f_0

→ CALCOLO LE GRANDEZZE TEMPORALI ALLA FREQ f_0

→ RIPETO I PASSAGGI SOPRA $\forall f_K$

→ SOMMO LE GRANDEZZE TEMPORALI ALLE VARIE FREQUENZE