EE 2015

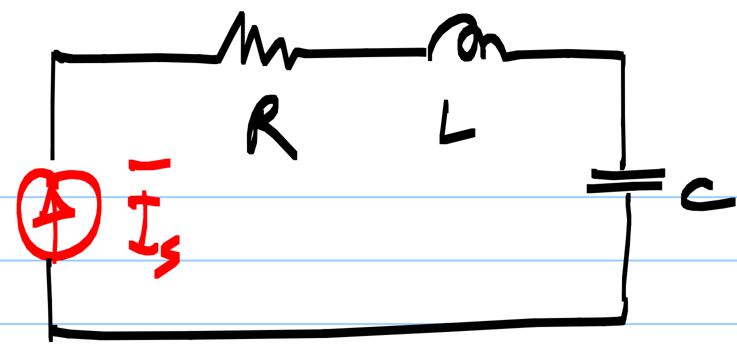
24/10/2017

Power factor correction

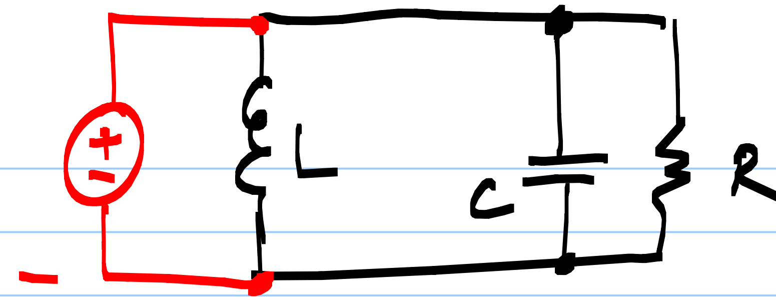
Conjugate matching for max. power transfer

ω

$\frac{2\pi}{\omega}$



Series RLC



Parallel RLC

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}}$$

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

$$\frac{[E_L + E_C]}{E_R}$$

E_R \ Energy dissipated in one cycle

Series RLC:

$$i_s = I_p \cos \omega t$$

$$E_L = \frac{1}{2} L i_s^2 = \frac{1}{2} L I_p^2 (\cos^2 \omega t)$$

$$v_c = \frac{I_p}{\omega C} \sin \omega t$$

$$E_c = \frac{1}{2} \cdot \frac{I_p^2}{\omega^2 C} \sin^2(\omega t)$$

$$E_R = \frac{I_p^2 R}{2} \cdot \frac{2\pi}{\omega}$$

Parallel RLC

$$v_s = V_p \cos \omega t$$

$$E_c = \frac{1}{2} C V_p^2 \cos^2 \omega t$$

$$i_L = \frac{V_p}{\omega L} \cdot \sin \omega t$$

$$E_L = \frac{1}{2} \frac{V_p^2}{\omega^2 L} \cdot \sin^2 \omega t$$

$$E_R = \frac{V_p^2}{2R} \cdot \frac{2\pi}{\omega}$$

$$2\pi \frac{\text{Max}\left[E_L + E_c\right]}{E_R}$$

@ $\omega = \frac{1}{\sqrt{LC}}$

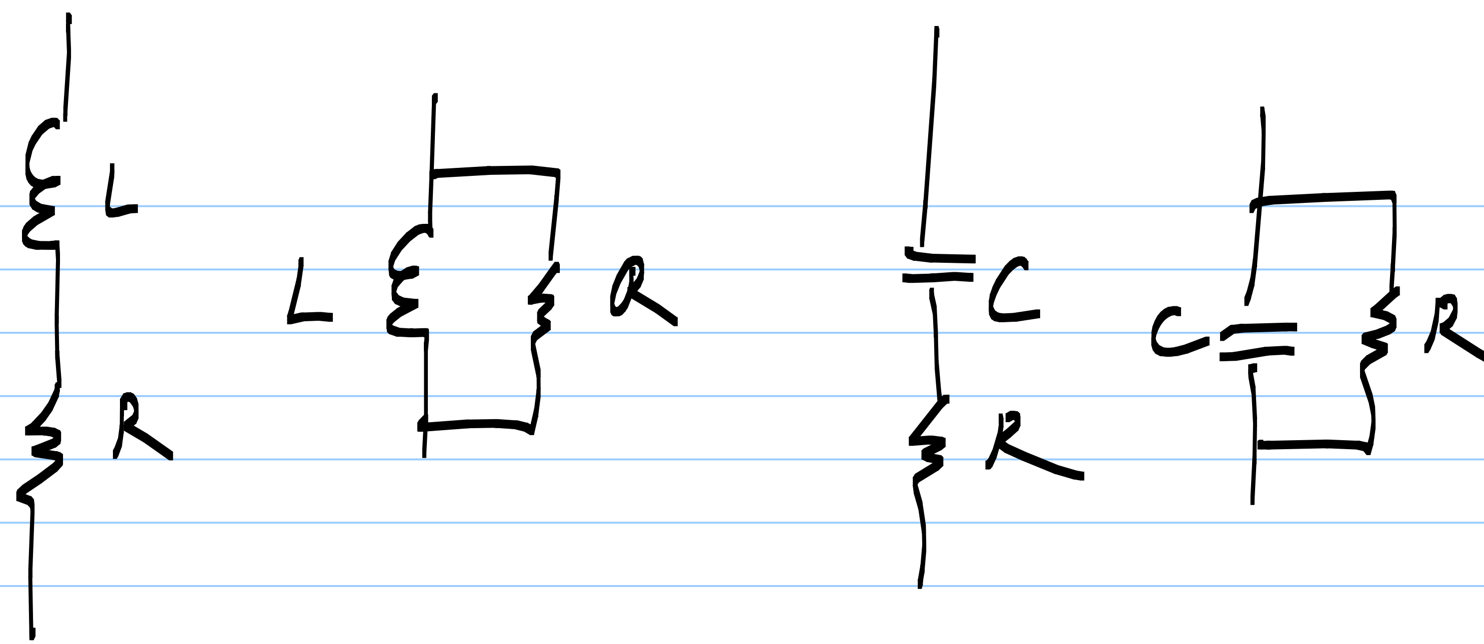
$$\frac{1}{\omega^2 C} = L$$

Series RLC

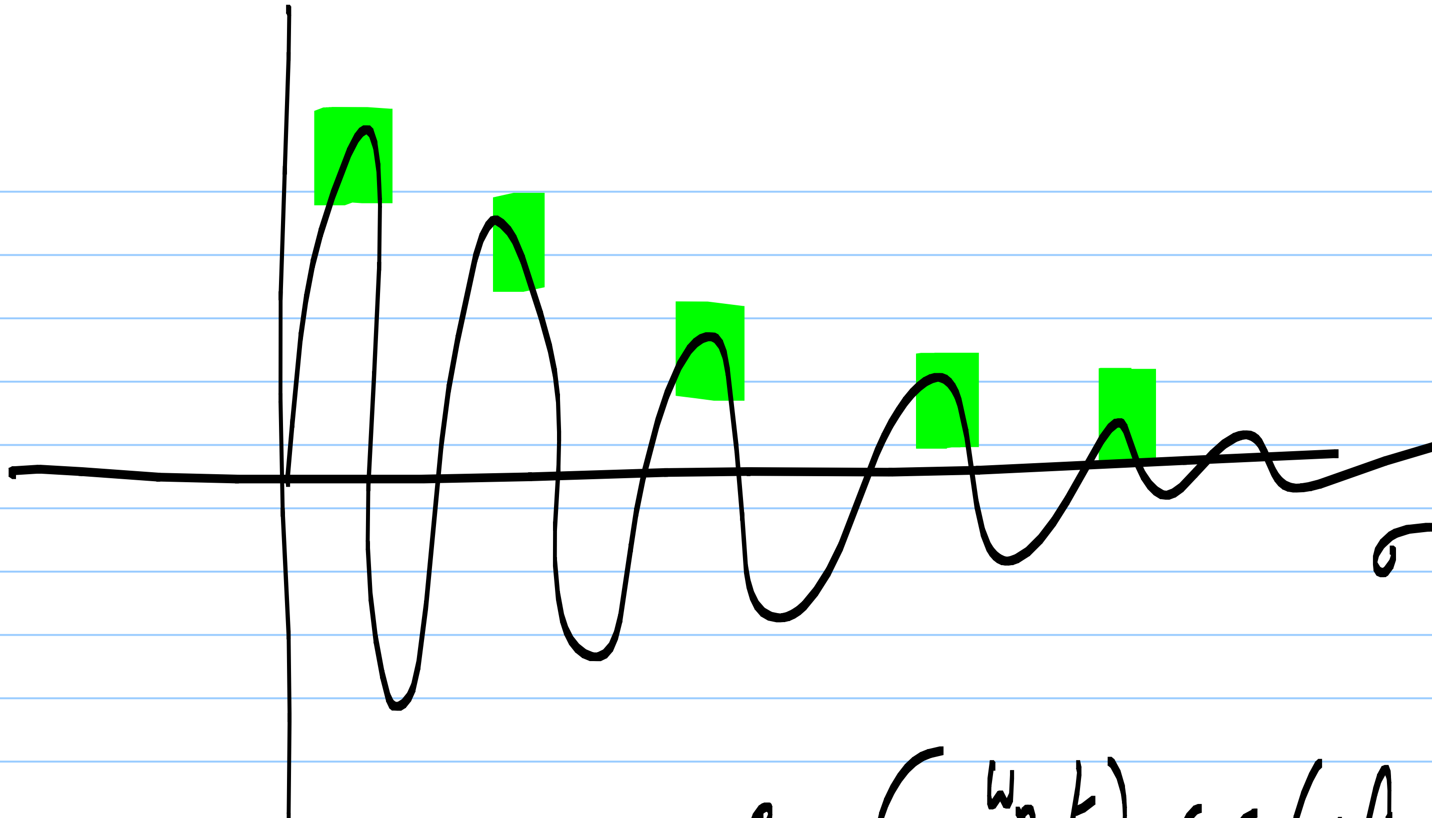
$$\frac{\frac{1}{2} L I_p^2 \cos^2\omega t + \frac{1}{2} \text{[illegible]} \sin^2\omega t}{\frac{I_p^2 R}{2} \cdot \frac{2\pi}{\omega}}$$

$$\frac{\frac{1}{2} L \cdot I_p^2}{\frac{1}{2} \cdot I_p^2 R \frac{2\pi}{\omega}} = \frac{1}{2\pi} \frac{\omega L}{R}$$

$$= \frac{Q}{2\pi}$$



$$2\pi \cdot \frac{\text{Peak energy stored}}{\text{Energy dissipated in each cycle}} \triangleq Q(\omega)$$



$\sigma = -\frac{\omega_n}{2Q}$

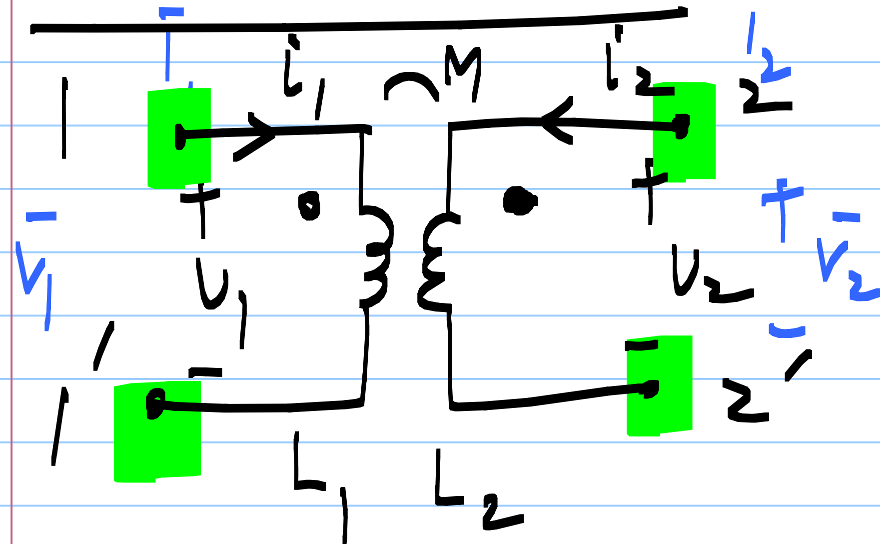
$t \div 0 \quad T_1 \quad Q \cdot \frac{2\pi}{\omega_n}$

$\underbrace{\exp\left(-\frac{\omega_n}{2Q} t\right)}\ \underbrace{\cos(\omega t + \phi)}$

$\underline{\exp(-T_1)} \quad \exp\left(-Q \cdot \frac{2\pi}{\omega_n} \cdot \frac{\omega_n}{2Q}\right)$

Mutual inductor:

$M = k\sqrt{L_1 L_2}$



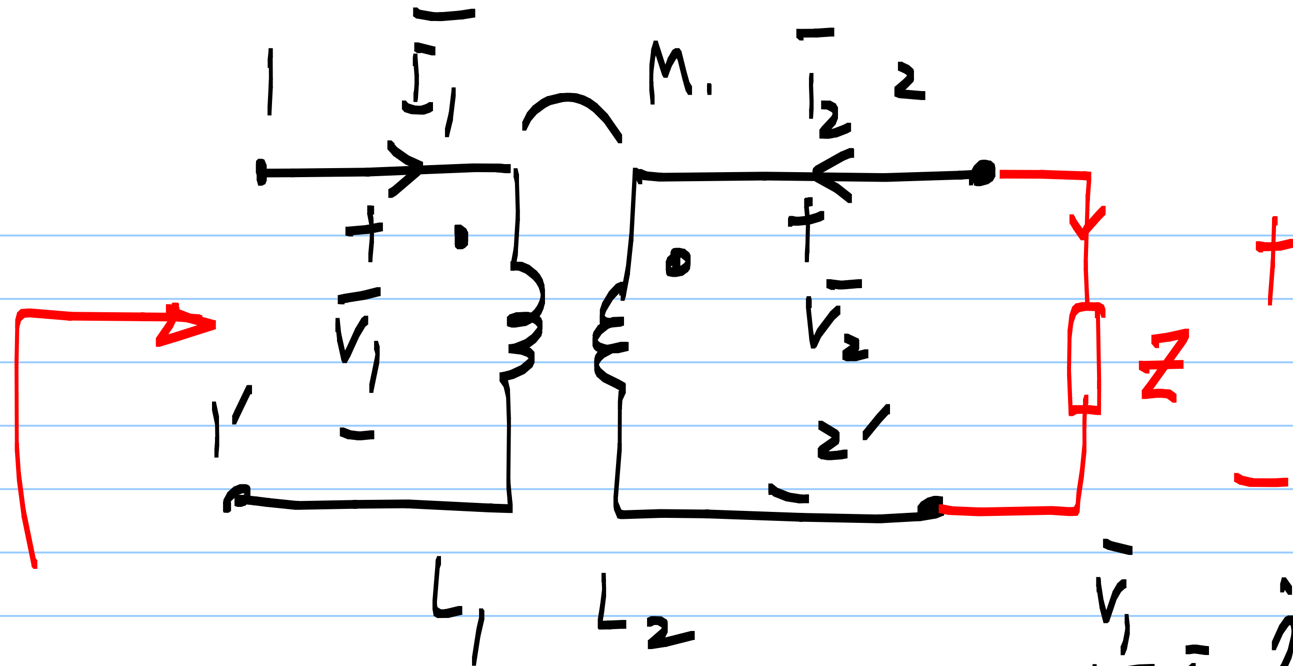
$$v_1 = L_1 \cdot \frac{di_1}{dt} + M \cdot \frac{di_2}{dt}$$

$$v_2 = M \cdot \frac{di_1}{dt} + L_2 \cdot \frac{di_2}{dt}$$

@ ω, sinusoidal steady state

$$\begin{bmatrix} \bar{V}_1 \\ \bar{V}_2 \end{bmatrix} = \begin{bmatrix} j\omega L_1 & j\omega M \\ j\omega M & j\omega L_2 \end{bmatrix} \begin{bmatrix} \bar{I}_1 \\ \bar{I}_2 \end{bmatrix}$$

Z- Parameters of the mutual inductor



$$\bar{V}_2 = -Z \cdot \bar{I}_2$$

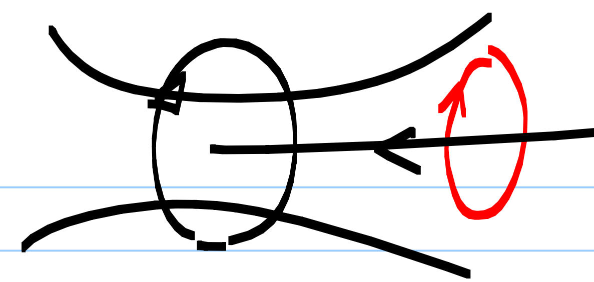
$$\frac{\bar{V}_1}{\bar{I}_1} = j\omega L_1 + j\omega M \frac{(-j\omega M)}{Z + j\omega L_2}$$

$$\bar{V}_1 = j\omega L_1 \cdot \bar{I}_1 + j\omega M \cdot \bar{I}_2$$

$$-Z \cdot \bar{I}_2 = j\omega M \cdot \bar{I}_1 + j\omega L_2 \cdot \bar{I}_2$$

$$\bar{I}_2 = \frac{-j\omega M \bar{I}_1}{Z + j\omega L_2} \cdot I_1$$

$$\frac{\bar{V}_1}{\bar{I}_1} = j\omega L_1 + j\omega M \frac{(-j\omega M)}{Z + j\omega L_2}$$



$$Z_{eq} = \frac{\bar{V}_1}{\bar{I}_1} = \frac{j\omega L_1 \cdot Z + \omega^2 (M^2 - L_1 L_2)}{Z + j\omega L_2}$$

$k \rightarrow 1$ $\quad M \rightarrow \sqrt{L_1 L_2}$: $\left\{ \frac{j\omega L_1 \cdot Z}{Z + j\omega L_2} \right.$

$L_1, L_2 \rightarrow \infty$ → $Z_{eq} \simeq \frac{L_1}{L_2} \cdot Z$ } Transformer

$\bar{V}_2, \bar{I}_2$ in term of $\bar{V}_1$ & $\bar{I}_1$