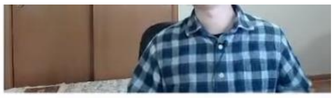
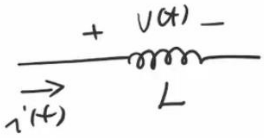


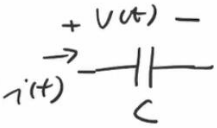
L. C.



passive components

Cannot generate energy

Store energy



Store/release energy in the form of "i", mag. field.

i cannot jump

______ energy in the form of "v", elec. field.

v cannot jump.

time domain:

$$v(t) = L \cdot \frac{di(t)}{dt}$$

$$i(t) = \frac{1}{L}\int_0^t v(x)\,dx + i(0)$$

$$i(t) = C\frac{dv(t)}{dt}$$

$$v(t) = \frac{1}{C}\int_0^t i(x)\,dx + v(0)$$

freq. domain.

✓ $Z_L = j\underset{2\pi f}{\underbrace{\omega}} L.$

✓ $Z_C = \frac{1}{j\omega C} = -\frac{j}{\underset{2\pi f}{\underbrace{\omega}} C}$

DC: $f=0$, short

AC: $f \to \infty$, open

$f \to 0$, open.

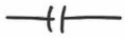
$f \to \infty$,

→ RL, RC, RLC step response with DC source.

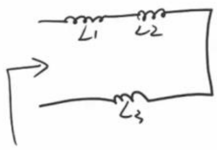
→ ∿ AC analysis, "ω", "f"

AC analysis:

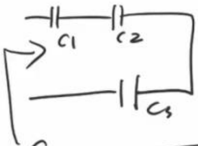
$i(t)$ lags $v(t)$ by $90°/\frac{\pi}{2}$.



$i(t)$ leads $v(t)$ by $90°/\frac{\pi}{2}$.

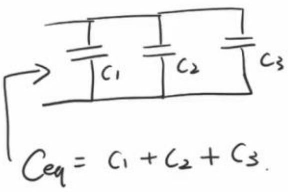


$L_{eq} = L_1+L_2+L_3$



$$C_{eq} = \frac{1}{\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}}$$

$$L_{eq} = \frac{1}{\frac{1}{L_1}+\frac{1}{L_2}+\frac{1}{L_3}}$$



$C_{eq} = C_1 + C_2 + C_3.$

RL $\Uparrow$ $i(t)$ RC $\Uparrow$ $v(t)$

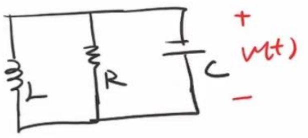
$$x(t) = x_F + (x_0 - x_F)\cdot e^{-\frac{t}{\tau}}$$

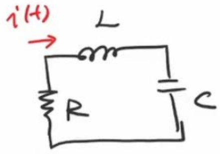
Step / Natural Response.

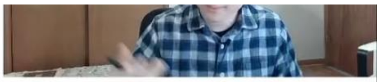
$\Uparrow$ x_F, x_0 $\Uparrow$ $\boxed{\text{DC steady-state.}}$

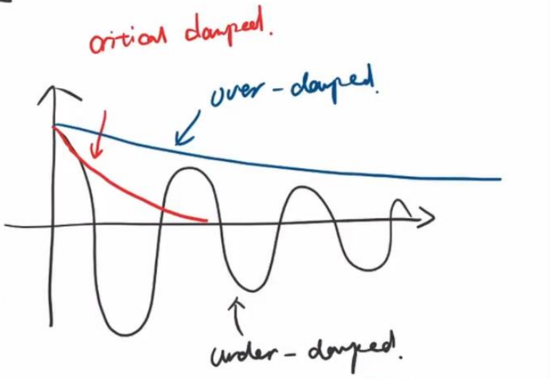
$\tau = \frac{L}{R}$ $\tau = RC$

RLC









Natural:

$\alpha^2 > \omega_0^2$, over damped condition

$\alpha^2 = \omega_0^2$, critical damped ——.

$\alpha^2 < \omega_0^2$, under damped —

$\boxed{\alpha} = \frac{1}{2RC}$ $\alpha = \frac{R}{2L}$

$\omega_0 = \frac{1}{\sqrt{LC}}$ $\omega_0 = \frac{1}{\sqrt{LC}}$

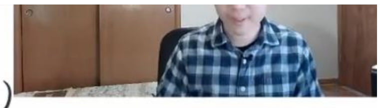
$x(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$, $t \geq 0$. $s_1 = -\alpha + \sqrt{\alpha^2 - \omega_0^2}$, $s_2 = -\alpha - \sqrt{\alpha^2 - \omega_0^2}$, $x(0) = A_1 + A_2$, $\frac{dx(0)}{dt} = A_1 s_1 + A_2 s_2$

$x(t) = D_1 t e^{-\alpha t} + D_2 e^{-\alpha t}$, $t \geq 0$. $x(0) = D_2$, $\frac{dx(0)}{dt} = D_1 - \alpha D_2$.

$x(t) = e^{-\alpha t}(B_1 \cos \omega_d t + B_2 \sin \omega_d t)$, $\omega_d = \sqrt{\omega_0^2 - \alpha^2}$

$x(0) = B_1$, $\frac{dx(0)}{dt} = -\alpha B_1 + \omega_d B_2$.

Step: $x(t) = x_F + \{$ Natural Response $\}$



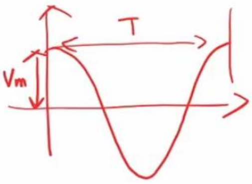
Sinusoidal Response.

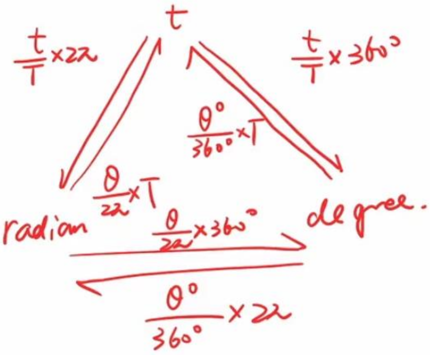
$v(t) = V_m \cos(\omega t + \theta_v)$, $\quad i(t) = I_m \cos(\omega t + \theta_i)$

V_m ⇑ Amplitude, ω ⇑ freq., θ_v ⇑ initial phase

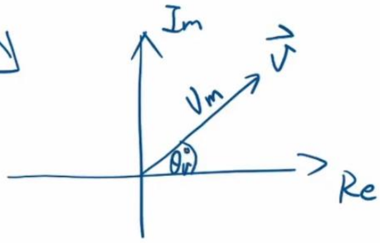
$\omega = 2\pi f$ (ω: rad/s, f: Hz)

$f = \frac{1}{T}$





P



$$P\{v(t)\} = V_m \angle \theta_v^\circ = V_m \angle \theta_v = V_m e^{j\theta_v} = \vec{V}$$

$V_{rms} = \frac{V_m}{\sqrt{2}}$, $\quad I_{rms} = \frac{I_m}{\sqrt{2}}$, (for sinusoidal signals)

$$V_{rms} = \sqrt{\frac{1}{nT}\int_0^{nT} v^2(t)\, dt}.$$

$$Z_L = j\omega L, \quad Z_C = \frac{1}{j\omega C} = -\frac{j}{\omega C}.$$

$$Z = R + jX$$

do AC Analysis with what we learned in DC Analysis:

KCL, KVL, Node-voltage, Mesh-current, Source-transformation.

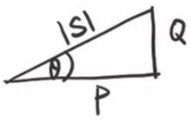
Thevenin / Norton eqv.

$$\underline{\underline{S}} = P + jQ$$

App. Real React

$$P = \frac{V_m I_m}{2}\cos(\theta_v - \theta_i), \quad Q = \frac{V_m I_m}{2}\sin(\theta_v - \theta_i)$$

$$= V_{rms} \cdot I_{rms}\cos(\theta_v - \theta_i) \qquad = V_{rms} I_{rms}\sin(\theta_v - \theta_i)$$



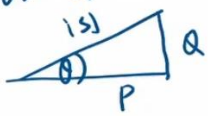
$$V_{rms} = \frac{V_m}{\sqrt{2}} = V_{eff}.$$

$$I_{rms} = \frac{I_m}{\sqrt{2}} = I_{eff}.$$

$\theta_v - \theta_i$: PF Angle., $\cos(\theta_v - \theta_i) = PF$. $\boxed{PF \rightarrow 1, \text{ better}}$

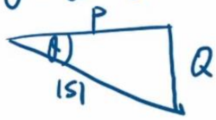
lagging PF

$\theta = \theta_v - \theta_i > 0$. inductive load



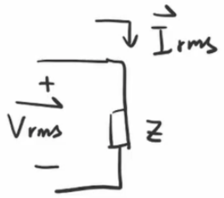
leading PF.

$\theta = \theta_v - \theta_i < 0$



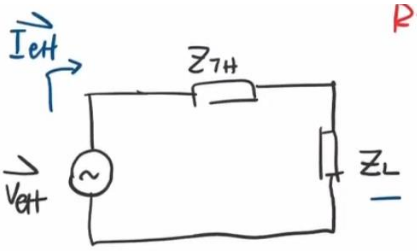
$$\vec{S} \neq \vec{V} \times \vec{I}, \quad \vec{S} = \frac{\vec{V} \times \vec{I}^{*}}{2}, \quad \vec{S} = \overrightarrow{V_{rms}} \cdot \overrightarrow{I_{rms}^{*}}$$

$$= \overrightarrow{V_{eff}} \cdot \overrightarrow{I_{eff}^{*}}$$



$$\overrightarrow{S_Z} = \overrightarrow{V_{rms}} \cdot \overrightarrow{I_{rms}^{*}} = |\overrightarrow{I_{rms}}|^2 \cdot Z = \frac{|\overrightarrow{V_{rms}}|^2}{Z^{*}}$$

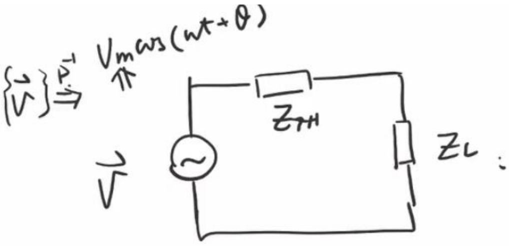
$R_{TH} = R_L.$



$$Z_{TH} = R_{TH} + jX_{TH}$$

$$Z_L = Z_{TH}^{*}, \quad Z_L = R_{TH} - jX_{TH}.$$

$$P_{max-L} = |\overrightarrow{I_{eff}}|^2 \cdot R_L = \left(\frac{|\overrightarrow{V_{eff}}|}{2R_{TH}}\right)^2 \cdot R_L = \frac{|\overrightarrow{V_{eff}}|^2}{4R_{TH}} = \frac{|\overrightarrow{V_{eff}}|^2}{4R_L}$$



$$|\overrightarrow{V_{eff}}| = \frac{V_m}{\sqrt{2}}$$

$$P_{max-L} = \frac{V_m^2}{8R_L} = \frac{V_m^2}{8R_{TH}}$$