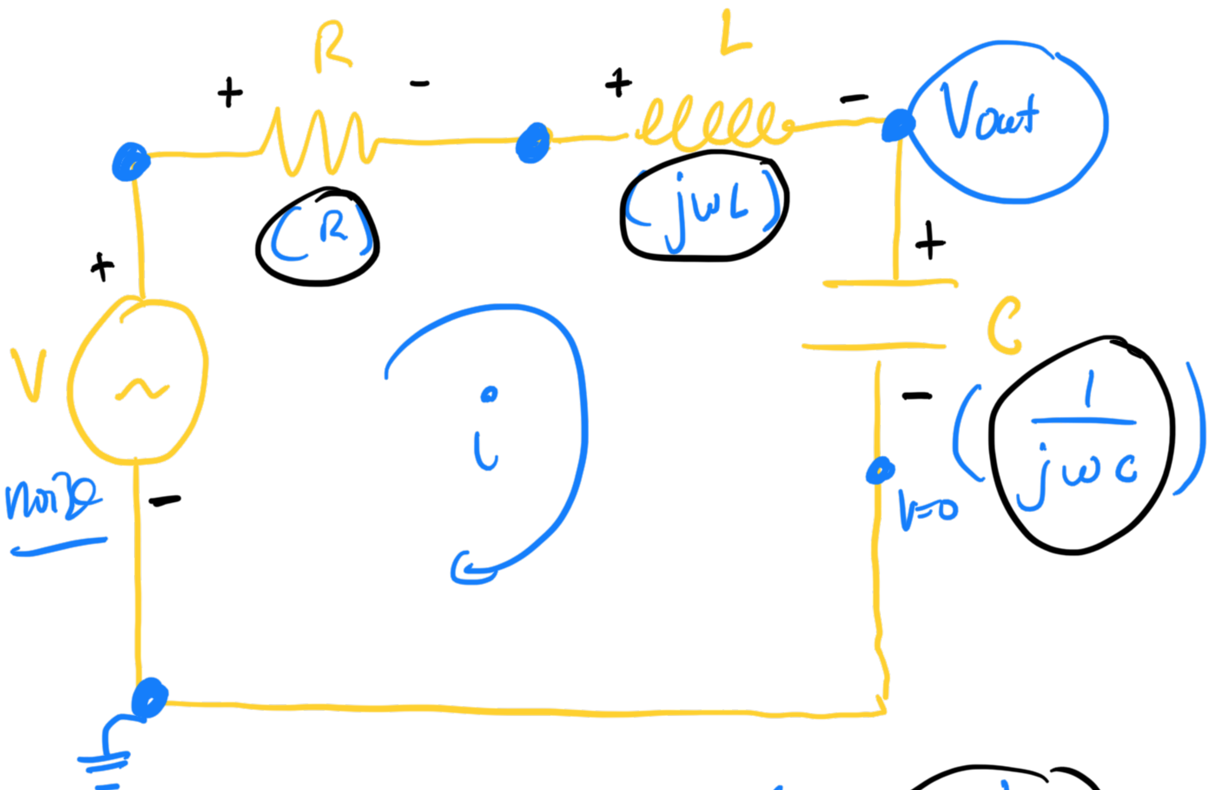
Physics 421 -
Lecture 30

RLC circuits



$$V_{out} = V_{in}\left(\frac{\frac{1}{j\omega C}}{\frac{1}{j\omega C} + j\omega L + R}\right)$$

(Voltage Divider)

$$V_{out} = V_{in}\left(\frac{\frac{1}{\cancel{j\omega C}}}{\frac{1-\omega^2 LC + j\omega RC}{\cancel{j\omega C}}}\right)$$

$$V_{out} = V_{in}\left(\frac{1}{\underbrace{(1-\omega^2 LC)}_{\substack{\text{Real} \\ \cos\phi}} + j\underbrace{\omega RC}_{\substack{\text{complex} \\ \sin\phi}}}\right)$$

$$\boxed{\tan\phi = \frac{-\omega RC}{(1-\omega^2 LC)}} \neq 0$$

$$|V_{out}| = |V_{in}| \left(\frac{1}{} \right.$$

$$\sqrt{(1-\omega^2 LC)^2 + (\omega^2 R^2 C^2)}$$

Frequency Dependent!

$$\omega = 2\pi f \qquad V_{in} = V_0 \sin(\omega t)$$

$$1 - \omega^2 LC = 0$$

$$\omega^2 LC = 1$$

$$\omega^2 = \frac{1}{LC}$$

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

resonant **frequency**.

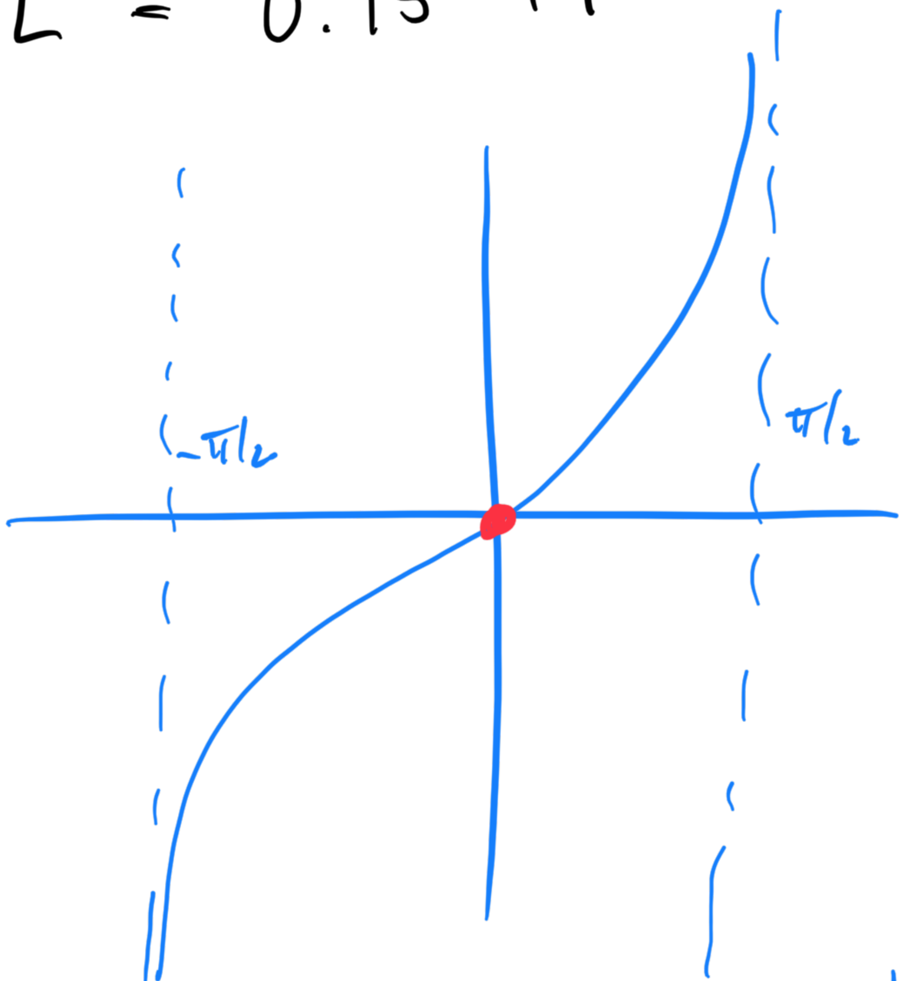
$$f = \frac{1}{2\pi}\sqrt{\frac{1}{LC}}$$

max. output voltage.

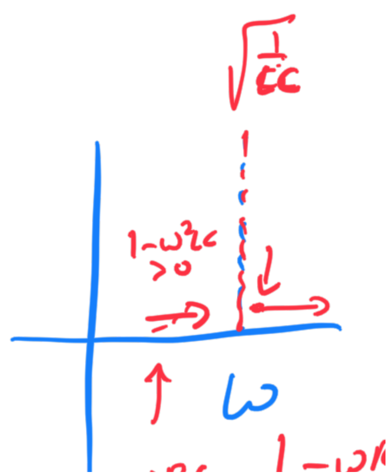
$R = 12\ \Omega$

$C = 100\ \mu F$

$L = 0.15\ H$



$-\omega RC$



$$(1 - \omega^2 LC)$$

$\to -\infty$

$1-\omega^2 LC$ $\to -\infty$ | $1-\omega$ $\to +$

If $|V_{out}| > |V_{in}|$

$\boxed{\text{Amplifier}}$

$L = 0.015 \text{ H}$

$C = 100 \times 10^{-6} \text{ F}$

$$\omega_{res} = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(\cancel{.015})(100 \times 10^{-6})}}$$

.015

$$= 816.5 \text{ rad/s}$$

$$f = \frac{\omega}{2\pi} = \cancel{129.9\ Hz}$$

$$41.1\ Hz$$