Resonance:

Occurs when a system responds extra strongly to a periodic driving force because the total impedence becomes purely real. At this frequency, the inductor and capacitor exchange energy back and forth perfectly, and their reactive impedances exactly cancel.

$$\text{total impedence} = Z = Z_{real} + i\cancel{Z_{imag}}^{\,0 \text{ (at resonance)}}$$

$$= R + i\cancel{X}^{\,0 \text{ (at resonance)}}$$

so

$$|Z| = \sqrt{R^2 + 0^2} = R$$

$$\phi_z = \tan^{-1}\left(\frac{0}{R}\right) = 0$$

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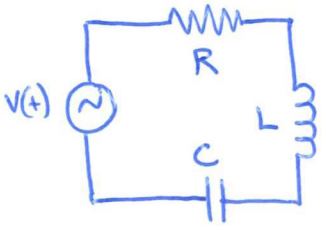
example:

For a series RLC



$$Z_{total} = R + i\underbrace{\left(\omega L - \frac{1}{\omega C}\right)}_{\text{must be zero for resonance}}$$

set:

$$\omega L - \frac{1}{\omega C} = 0$$

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

$$\omega^2 LC = 1$$

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

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

resonance Frequency