RC Circuits

Kirchhoff's loop rule:

- Current oscillates at the same frequency as \( \omega \), but it is out of ___.
- Assume: \( I(t) = \)
  
  then \( Q(t) = \)
  
  where \( I_0 = \)

- Plug these into Kirchhoff's equation:

\[
\begin{align*}
\text{when } t &= \frac{\phi}{\omega} \Rightarrow \\
\text{when } t &= (\phi + \frac{\pi}{2})/\omega \Rightarrow \\
\end{align*}
\]

\[\frac{\Box}{\Box} \Rightarrow \tan \phi = \]

Phase shift is ___ and ___ \(\frac{\pi}{2}\).

\[\text{Voltage } \Box \text{ current.}\]

\[\Box^2 + \Box^2 \Rightarrow \]

Impedance, \( Z \)

\[\text{Solve for } I_0, \text{ then from } \Box \]

\[I(t) = \]

\[\cos \phi = \]
Q. An RC circuit with an AC generator: \( C = 0.82 \mu F, R = 5.6 \Omega, \omega = 5.0 \times 10^2 \text{ rad/s}, V_0 = 15V \) (peak voltage). \( I_0 = ? \quad \phi = ? \)

A.

**LR Circuit**

Kirchhoff's loop rule:

- Expect current of the form \( I(t) = \)
- Following the same procedure as before, find \( I_0 \) and \( \phi \).

\[
\tan \phi = \\
I_0 = \quad \text{with } Z = \\
I(t) = 
\]

In this case, the voltage — the current (\( \phi \) —) by less than \( \pi/2 \).

At low frequencies — dominates impedance
At high frequencies — dominates impedance

Practical use of LR circuits:
Q. The filter of a woofer attenuates signals by a factor of 5.0 at 5 kHz. With $R = 8.0 \Omega$, what is $L$?

A. To attenuate by a factor of 5, $Z$ (with $L$) must be $Z$ (without $L$); i.e. $Z = \ldots$

Analyze:

Power $P(t) =$

$P_{avg} = \langle P(t) \rangle =$

$\langle P(t) \rangle =$

Compare $\begin{cases} \text{DC Circuit: } P = \\ \text{AC Circuit: } \langle P \rangle = \end{cases}$

Q. What power is used in an LR circuit with $L = 10.0 \text{mH}$ and $R = 22 \Omega$ when a 60Hz, 120V power supply is applied?

A. $\langle P(t) \rangle =$

$Z^2 =$

$\langle P(t) \rangle =$

Analyze: If this were a DC circuit,
LC Circuits

Kirchhoff's loop rule:

⇒ Installing capacitors in series ____ the overall reactance.