Review of AC-circuit

Keys to deal with R, L, and C in an AC-circuit

- Across R, voltage and current are in-phase
- Across L, the current lags behind voltage by 90°
- Across C, the current leads voltage by 90°

Also,

- When two elements are in series → the same current passing through them
- When two elements are in parallel → the same voltage across them
Basics

I and V are in-phase

\[ i = \Delta V \sin \omega t \]

**Figure 33.1** A circuit consisting of a resistor R

I lags V by 90 degrees

\[ \Delta v_L = \Delta V_{\text{max}} \sin \omega t \]

**Figure 33.2** (a) Plots of the instantaneous current \( i_L \) and instantaneous voltage \( \Delta v_L \) across a

I leads V by 90 degrees

\[ \Delta v_C = \Delta V_{\text{max}} \sin \omega t \]

**Figure 33.7** A circuit consisting of a capacitor C
RLC in series

Key: \( I_R, I_L, \) and \( I_C \) are all in phase

\[
\Delta V_R \sim R \\
\Delta V_L \sim X_L \\
\Delta V_C \sim X_C \\
\Delta V_{\text{max}} \sim Z
\]

\[
Z = \sqrt{R^2 + (X_L - X_C)^2} \\
\phi = \tan^{-1}\left(\frac{X_L - X_C}{R}\right)
\]
What if RLC are not in series?

Which of the following is true

(a) $\Delta V_c = \Delta V_L$, $I_C = I_L$

(b) $\Delta V_c = \Delta V_L$, $I_R = I_L$

(c) $\Delta V_c = \Delta V_R$, $I_R = I_L$

(d) $\Delta V_L = \Delta V_R$, $I_R = I_L$

(e) $\Delta V_c = \Delta V_L + \Delta V_R$, $I_C = I_L$

(f) $\Delta V_c = \Delta V_L + \Delta V_R$, $I_R = I_L$

How do you draw the phasor diagram?
Power dissipation

- Only R dissipates power

\[ P = I \ast \Delta V, \text{ always} \]

For L and C, I and \( \Delta V \) are 90\(^o\) out of phase \( \rightarrow P_L = 0, P_C = 0 \)
For R, I and \( \Delta V \) are in-phase \( \rightarrow P_R = I\Delta V = I_{\text{rms}}^2 R \)
Resonance in RLC circuit in series

\[ Z = \sqrt{R^2 + (X_L - X_C)^2} \]

\[ \phi = \tan^{-1}\left( \frac{X_L - X_C}{R} \right) \]

\[ P_R = I\Delta V = I_{\text{rms}}^2 R \]

Where \( I_{\text{rms}} = \frac{V_{\text{rms}}}{Z} \)

For a fixed AC voltage source, maximum power dissipation occurs when \( X_L = X_C \), ie. When \( Z = R \)

\[ \text{i.e. } \omega = \frac{1}{\sqrt{LC}} \]