Lecture 7
Linear AC circuits

\[ V(t) = V_0 \cos(\omega t + \phi) \]

Q: why study AC (sine) response?

1)

Q: if you have ______ network, what shape on input remains the same on the output?

2)

3) superposition:

Complex notation
Euler formula
\[ e^{j\alpha} = \cos \alpha + j \sin \alpha \]
\[ j^2 = -1 \]

Usually simply write \( V(t) = \)

Time vs. freq. domain analysis

Time domain: \( V(t), I(t) \)

KVL & KCL \( \Rightarrow \)

Freq. domain: \( V(\omega), I(\omega) \)

\[ \frac{d}{dt}(e^{j\omega t}) \rightarrow \]

\[ \int e^{j\omega t} \, dt \rightarrow \]
KVC & KCL =>

- Time domain
- Frequency domain
- Two ways to look
- Fourier analysis:

Complex impedance

\[ V(\omega) = \]

Admittance = generalized conductance

Let \( i(t) = I_0 e^{j\omega t} \), \( v(t) = V_0 e^{j(\omega t + \phi)} \)

\[ Z(\omega) = \]
Impedance can change both
\[ Z = R + jX = Z_0 e^{j\phi}, \Rightarrow \]

Capacitance
\[ \frac{di}{dt} = \frac{i}{C} \]

\[ Z_C = \frac{v(t)}{i(t)} = \]

voltage \[\underline{\text{leads}}\] current by \(90^\circ\)

Inductance
\[ v = L \frac{di}{dt} \]

\[ Z_L = \frac{v(t)}{i(t)} = \]

voltage \[\underline{\text{lags}}\] current by \(90^\circ\)

\[ \begin{array}{c|c|c}
\hline
\omega \to 0 & \omega \to \infty \\
\hline
Z_R & \hline
Z_L & \hline
Z_C & \\
\hline
\end{array} \]