AC Circuit Analysis Using Phasors

If we were to analyzed a circuit that is being driven by an AC source, we would expect to see a differential equation something like:

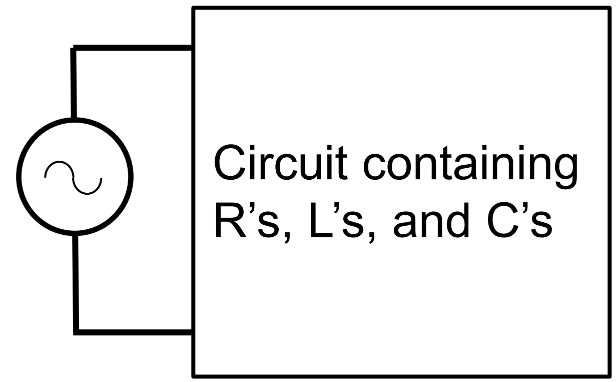
$$a\frac{d^2y}{dt^2} + b\frac{dy}{dt} + cy(t) = dcos(\omega t + \theta)$$

where $y(t)$ might be a voltage or a current.

The solution will consist of:

- ❑ Homogeneous part
  - Either underdamped, overdamped or critically damped.
  - Transient → Will decay to 0 over time.

- ❑ Particular part
  - Something like $Acos(\omega t + \theta) + Bsin(\omega t + \theta)$
  - Persistent → does not decay over time.
  - Sinusoidal (with same frequency as source)



With typical component values we use, the transient part will become insignificant after only small fractions of a second.

As a result, we are often interested in only the "steady state" part of the solution which is sinusoidal in nature.

We will use phasors/impedances to help us find the *sinusoidal steady state* solution to AC circuits.

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All of the techniques we use for the analysis of resistive circuits apply to circuits with Rs and Ls and Cs when we use phasors and complex impedances.

KVL: $v_1(t) + v_2(t) + \cdots + v_n(t) = 0$ $\Longleftrightarrow$ $\boldsymbol{V}_1 + \boldsymbol{V}_2 + \cdots + \boldsymbol{V}_n$=0

KCL: $i_1(t) + i_2(t) + \cdots + i_n(t) = 0$ $\Longleftrightarrow$ $\boldsymbol{I}_1 + \boldsymbol{I}_2 + \cdots + \boldsymbol{I}_n$=0

Series combinations of impedances: $Z_{eq} = Z_1 + Z_2 + \cdots + Z_n$.

Parallel combinations of impedances: $\frac{1}{Z_{eq}} = \frac{1}{Z_1} + \frac{1}{Z_2} + \cdots + \frac{1}{Z_n}$.

Voltage/current dividers, Δ-Y transformations, source transformations, Thevenin/Norton equivalents, node-voltage, mesh-current, etc.

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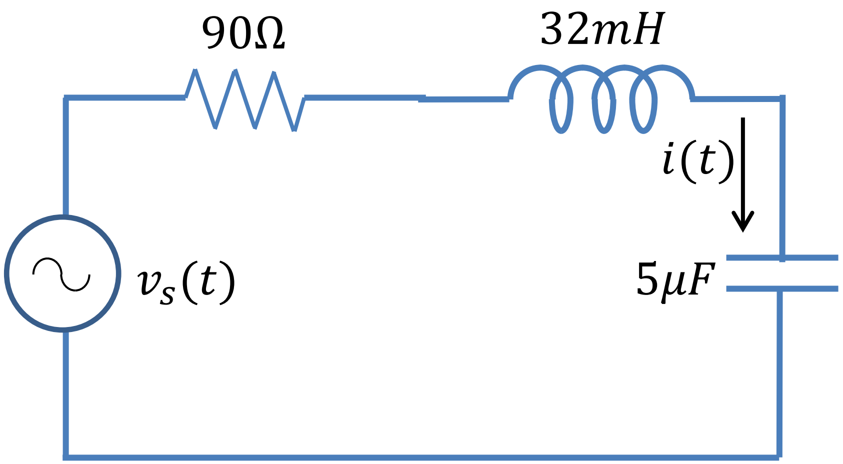
Example:
Assuming
$v_s(t) = 750\cos(5000t + 30°)$ volts,
find $i(t)$ in the circuit shown using phasors.



AC Circuit Analysis Using Phasors

Example

Assuming $i_g(t) = 500\cos(2000t)$ mA, find $v_L(t)$ in the circuit shown using phasors.