Georgia Institute of Technology

Linear Circuits

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An introduction to linear electric circuit elements and a study of circuits containing such devices.

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Sinusoids and Phasors

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Review sinusoid properties and describe phasors and how to use them.

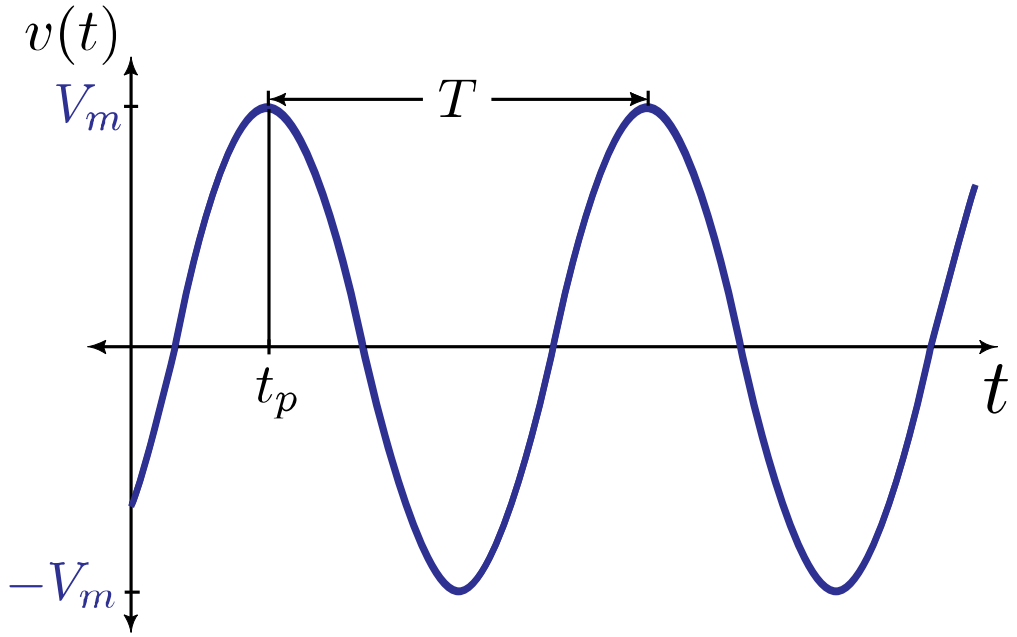
Module 4: Frequency Analysis

- Sinusoids and phasors
- Impedance
- Circuit analysis in AC
- Transfer functions
- Frequency response
- High/low-pass filters
- Bandpass/notch filters

Lesson Objectives

- Identify sinusoid properties (amplitude, frequency, angular frequency, period, phase)
- Describe the properties of sinusoids in capacitors and inductors
- Find phasors of sinusoidal functions
- Add sinusoids using phasors

Sinusoidal Currents and Voltages



$v(t) = V_m \cos(\omega t + \theta)$

Peak value: V_m

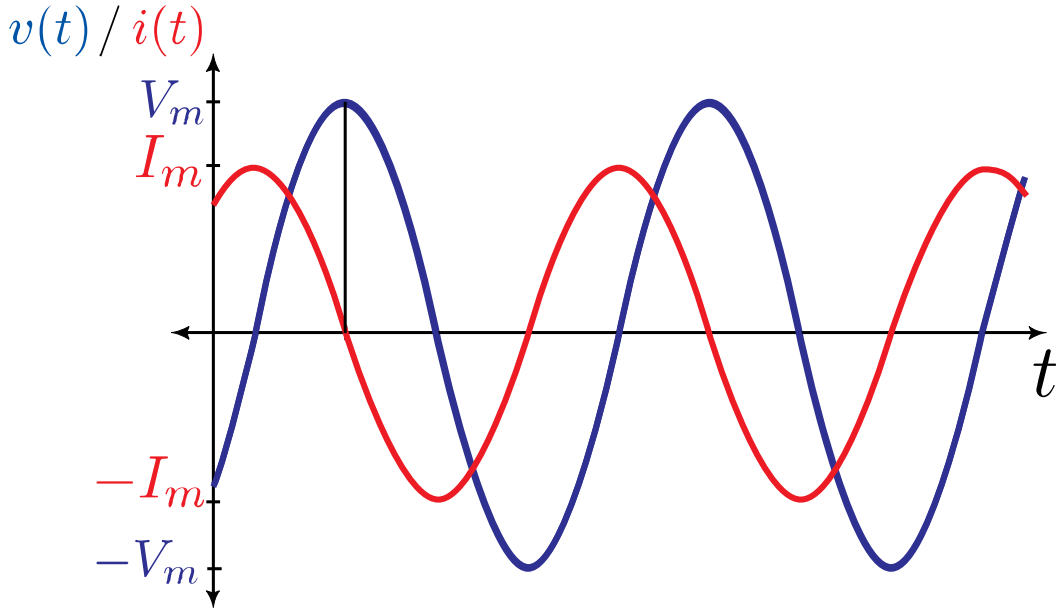
Period: T (s)

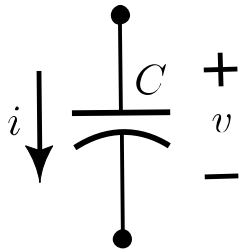
Frequency: $f = \frac{1}{T}$ (Hz)

Angular frequency: $\omega = 2\pi f$ (rad/s)

Phase angle: $\theta = -2\pi \frac{t_p}{T}$

Sinusoids and Capacitors



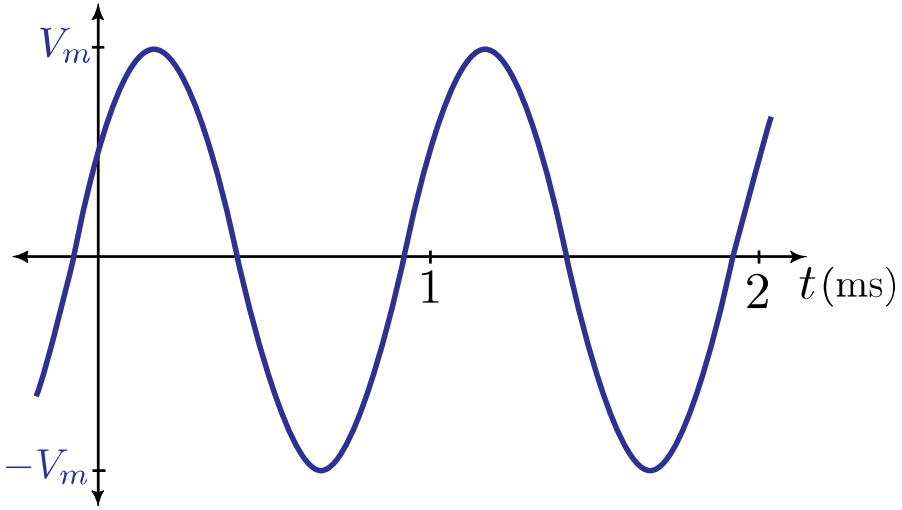


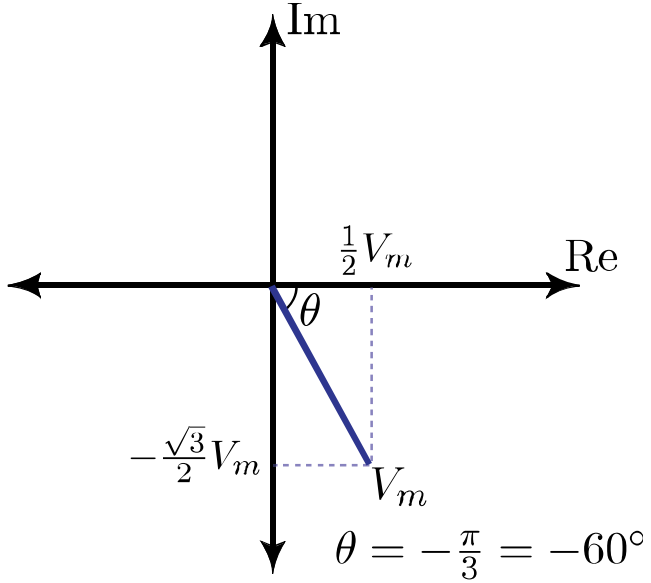
$$i_c = C\frac{dv_c}{dt} \qquad v_c(t) = V_m \cos(\omega t + \theta)$$

$$i_c(t) = CV_m\omega \cos\left(\omega t + \theta + \tfrac{\pi}{2}\right)$$

Phasors

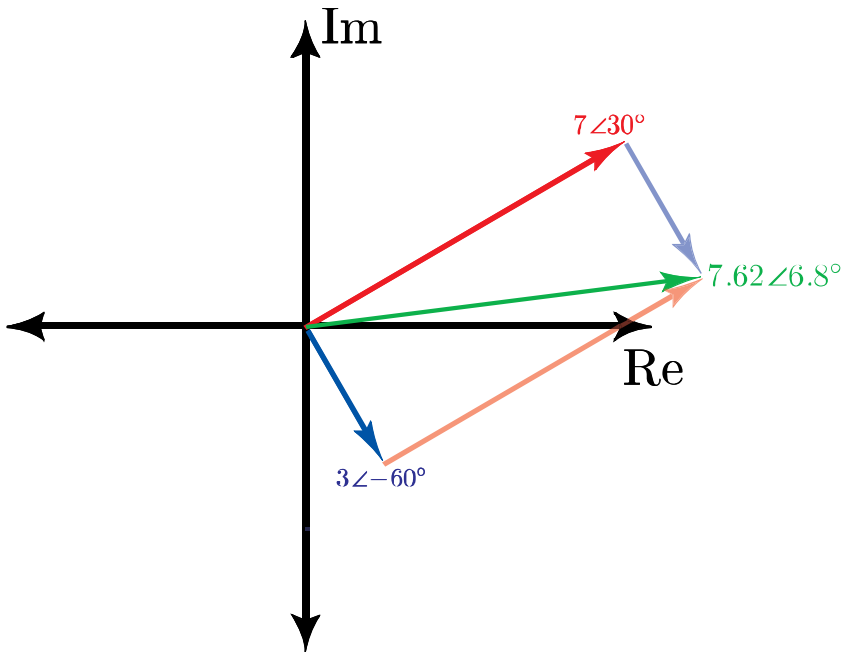
Phasor has an **implied** frequency.





$$v(t) = V_m \cos(2000\pi - \tfrac{\pi}{3}) \quad \Leftrightarrow \quad \mathbb{V} = V_m \angle -\tfrac{\pi}{3} = \tfrac{1}{2}V_m - j\tfrac{\sqrt{3}}{2}V_m$$

Adding Sinusoids with Phasors



$$v_1 = 7\cos(120\pi t + 30°) \quad \Leftrightarrow \quad 7\angle 30°$$

$$v_2 = 3\cos(120\pi t - 60\,°) \quad \Leftrightarrow \quad 3\angle -60°$$

$$7\angle 30° + 3\angle -60° = 7.62\angle 6.8°$$

$$v_1 + v_2 = 7.62\cos(120\pi t + 6.8°)$$

Comments on Phasors

- Cannot compare phasors with different frequencies
- Multiplying phasors does not equate to multiplying functions

Summary

- Reviewed sinusoid properties
- Identified sinusoid behavior in linear devices
- Found phasors and used them to add sinusoids

Next Lesson

- Define impedance – a property describing the sinusoidal behavior of linear devices.