Georgia Institute of Technology

Linear Circuits

Nathan V. Parrish
PhD Candidate & Graduate Research Assistant
School of Electrical and Computer Engineering

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

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AC Circuit Analysis

Nathan V. Parrish
PhD Candidate & Graduate Research Assistant
School of Electrical and Computer Engineering

Identify how past techniques apply to impedances in AC circuit analysis.

Previous Lesson

- Impedance and its relationship to phasors
- Impedance in reactive circuits changes with frequency

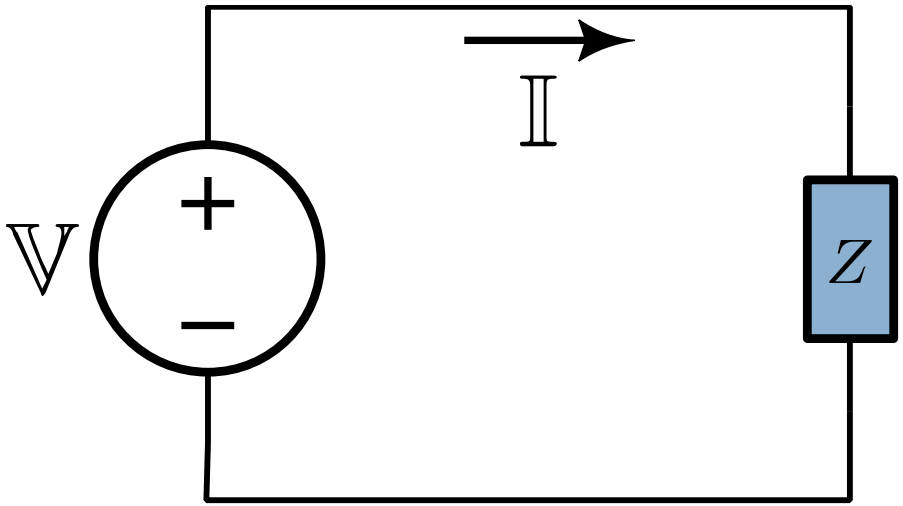
Module 4: Frequency Analysis

- Sinusoids and phasors
- Impedance
- Analysis of sinusoidal systems
- Transfer functions
- Frequency response
- Low-pass and high-pass filters
- Bandpass and notch filters

Lesson Objectives

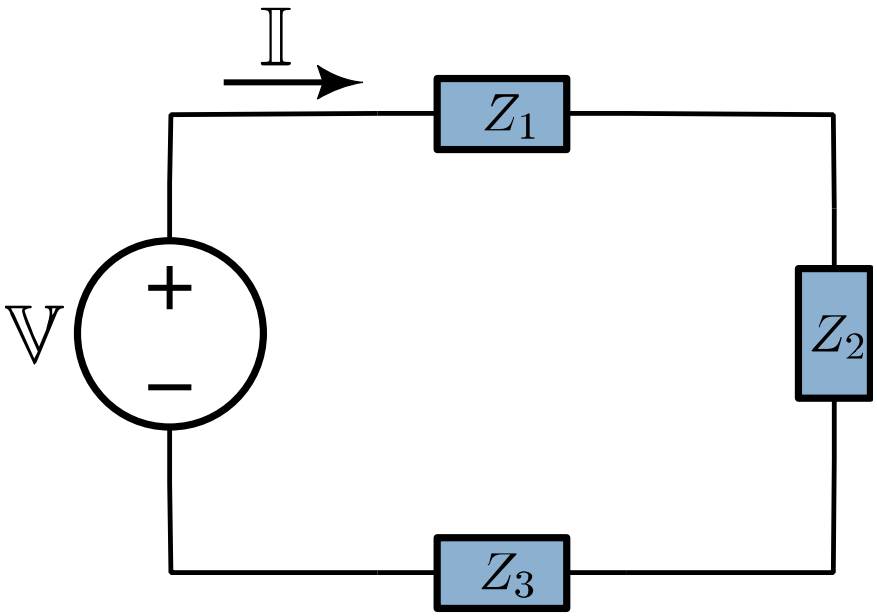
- Apply techniques from DC analysis to sinusoidal systems
- Find equivalent impedances for devices in series/parallel
- Use superposition for analysis: particularly for systems with multiple frequencies
- Be able to analyze a system using these techniques

Impedance is Linear



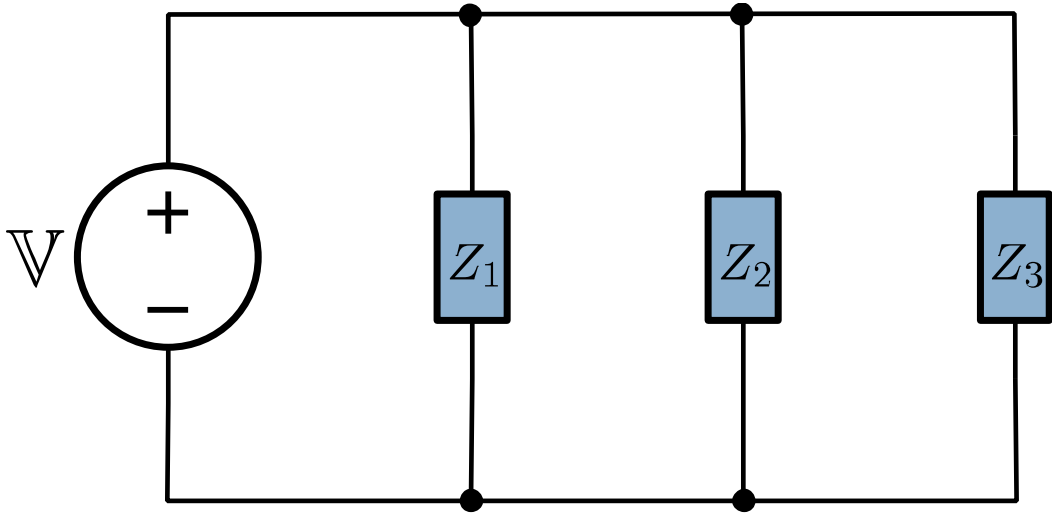
$$\mathbb{V} = \mathbb{I}Z \sim V = IR$$

Impedances in Series



$$Z_{\text{eq}} = \sum_i Z_i$$

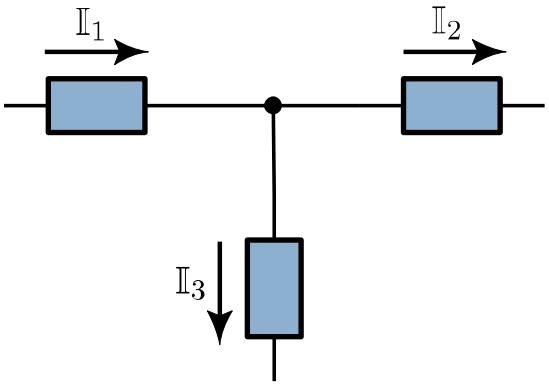
Impedances in Parallel



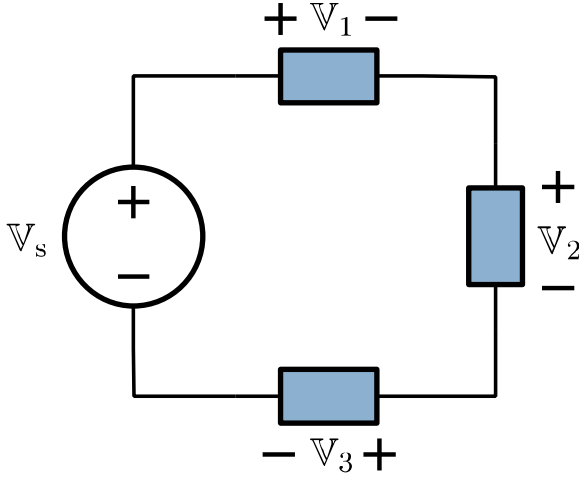
$$Z_{\text{eq}} = \left[\frac{1}{Z_1} + \frac{1}{Z_2} + \frac{1}{Z_3}\right]^{-1}$$

$$Z_{\text{eq}} = \left[\sum_i \frac{1}{Z_i}\right]^{-1}$$

Kirchhoff's Laws

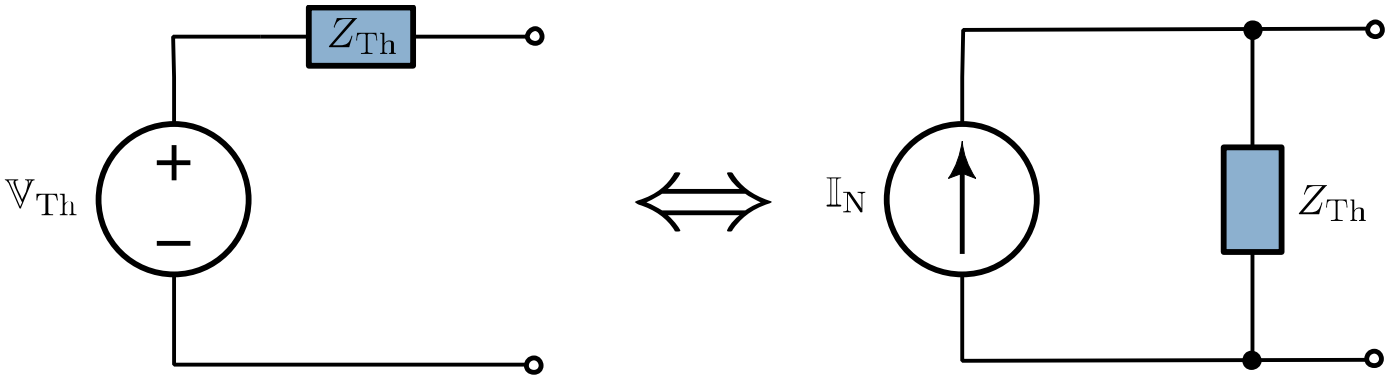


$$\mathbb{I}_1 = \mathbb{I}_2 + \mathbb{I}_3$$



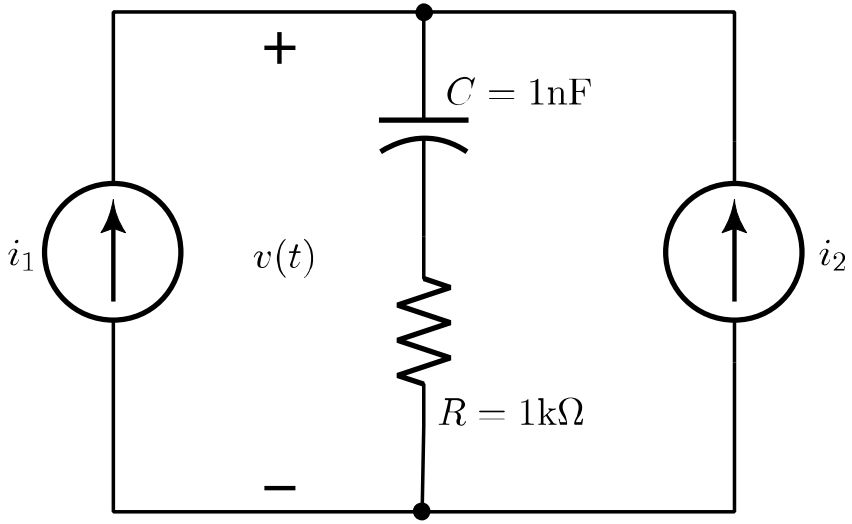
$$\mathbb{V}_s = \mathbb{V}_1 + \mathbb{V}_2 + \mathbb{V}_3$$

Source Transformations



$$\mathbb{V}_{\mathrm{Th}} = \mathbb{I}_{\mathrm{N}} Z_{\mathrm{Th}}$$

Superposition



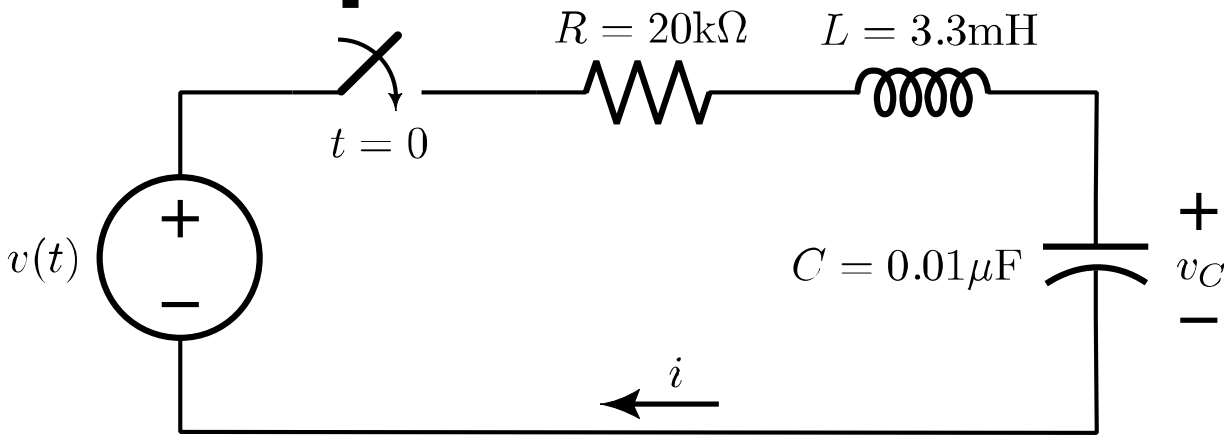
$$i_1(t) = \sqrt{2}\cos\left(10^6 t\right)\text{A}$$

$$i_2(t) = 3\sin\left(\frac{1}{\sqrt{3}} \cdot 10^6 t\right)\text{A}$$

Valid Impedance Techniques

- Kirchhoff's Laws
- Superposition
- Node-voltage
- Mesh-current
- Thévenin and Norton Equivalent Circuits
- Source Transformations

Example



$$v(t) = \cos\left(2\pi(780)t\right)$$

Summary

- Showed how DC analysis techniques are applied in sinusoidal systems
- Used superposition to analyze a system with multiple frequencies
- Solved an example system using these techniques

Next Lesson

- Demo showing sinusoidal response
- Transfer functions – how systems react across different frequencies