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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Sinusoidal Maximal Power Transfer

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Show how maximum power transfer works in AC systems as contrasted to DC systems, and show how to use extra reactive loads for power factor correction.

Previous Lesson

- Showed how power is calculated in AC systems
- Defined the values associated with power triangles and how to use them

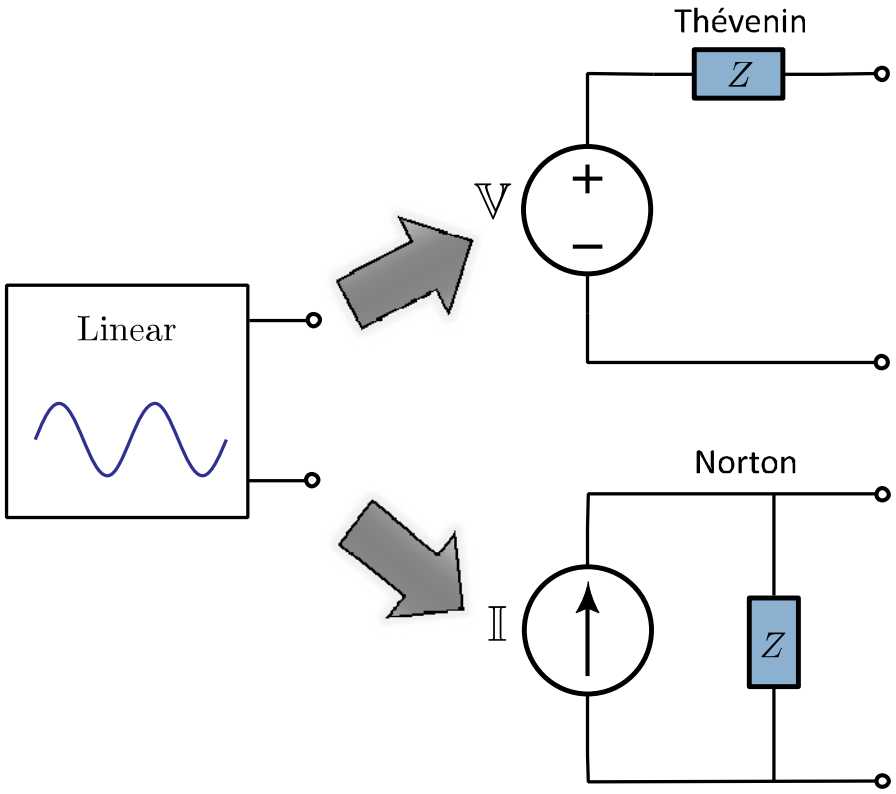
Module 5: Power

- Root-Mean Square
- Power Factor and Power Triangles
- Maximum Power Transfer
- Transformers

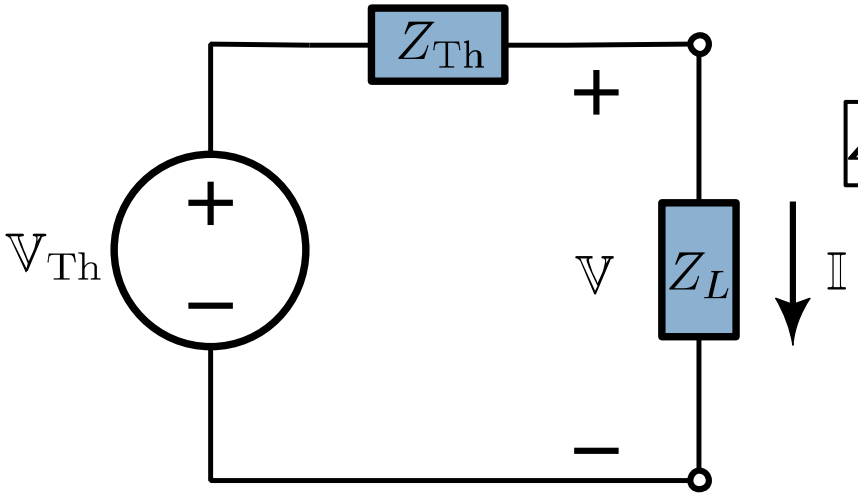
Lesson Objectives

- Be able to find the load impedance that gives maximum power transfer and the average power consumed by this load
- Be able to find the optimal purely resistive impedance that gives largest possible power transfer
- Be able to do power factor correction using additional reactive components
- Power budget

Thévenin and Norton Equivalent



Maximum Power Transfer for AC



$$Z_L = Z_{\mathrm{Th}}^*$$

$$P = \frac{V_{\mathrm{Th}}^2}{8\mathrm{Re}(Z_{\mathrm{Th}})}$$

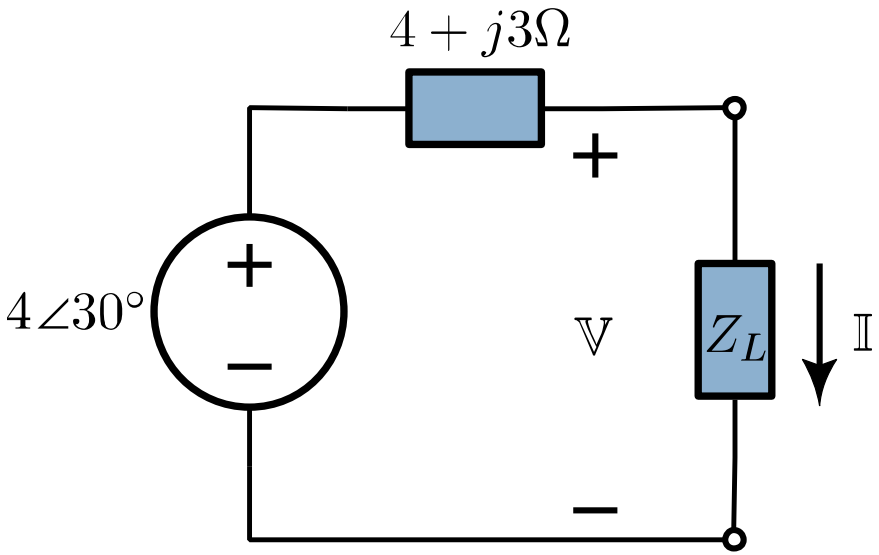
$$Q = -\frac{V_{\mathrm{Th}}^2 \mathrm{Im}(Z_{\mathrm{Th}})}{8[\mathrm{Re}(Z_{\mathrm{Th}})]^2}$$

$$\mathbb{V} = \frac{Z_L}{Z_{\mathrm{Th}}+Z_L}\mathbb{V}_{\mathrm{Th}}$$

$$\mathbb{I} = \frac{\mathbb{V}_{\mathrm{Th}}}{Z_{\mathrm{Th}}+Z_L}$$

$$S = \frac{1}{2}\mathbb{V}\mathbb{I}^*$$

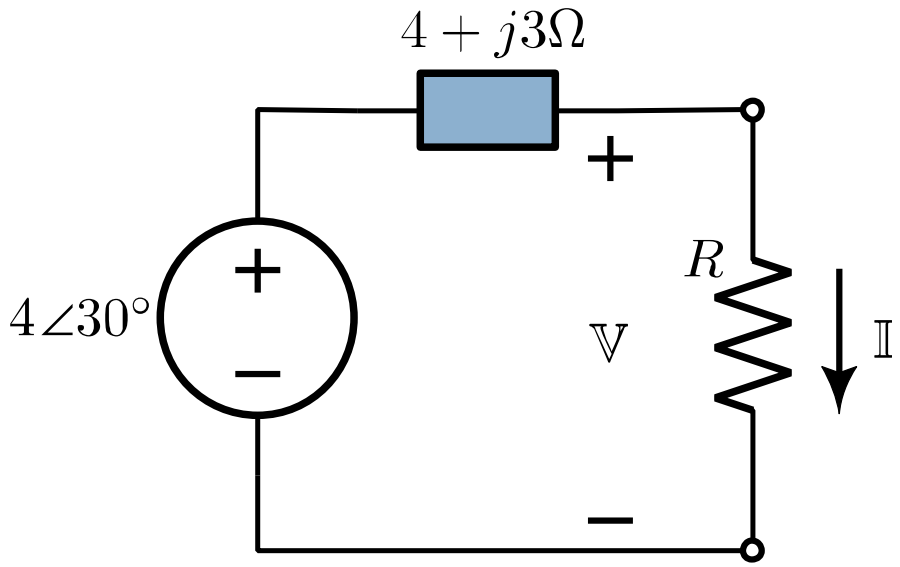
Example 1



$$P = \frac{V_{\text{Th}}^2}{8\text{Re}(Z_{\text{Th}})}$$

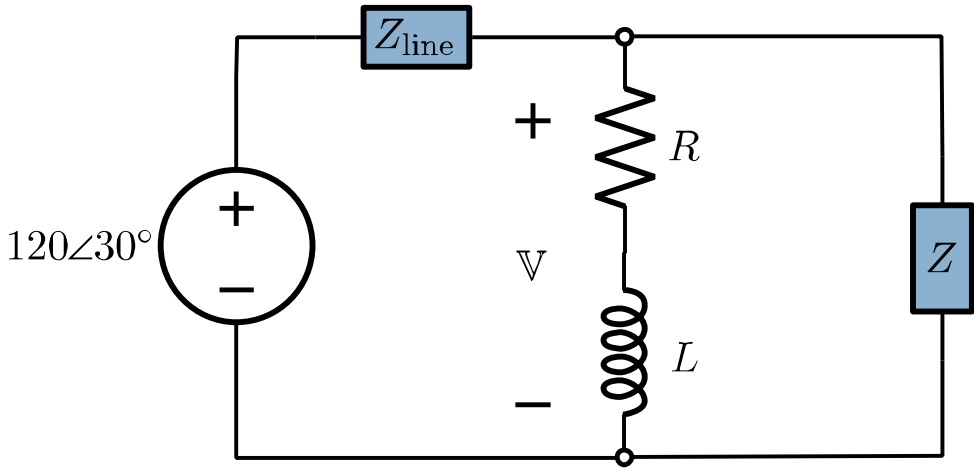
$$Z_L = Z_{\text{Th}}^*$$

Max Transfer with Constrained Load Phase



$$\boxed{|Z_L|} = \boxed{|Z_{\text{Th}}|}$$

Power Factor Correction



$$S = \frac{1}{2}\mathbb{V}\mathbb{I}^* = \frac{|\mathbb{V}|^2}{2Z^*} = \frac{|\mathbb{I}|^2 Z}{2}$$

$$C = \frac{L}{R^2+\omega^2 L^2}$$

Comments on Power Factor Correction

- Purely reactive devices use no power
- May also want to correct for line impedance
- Adding the capacitor changes the voltage and so also the power behavior of the system
- Using capacitors is a common practice in heavy industry to limit reactive power

Summary

- Found impedance that gives maximum power transfer
- Found best impedance given the load must be purely resistive
- Used a capacitor for power factor correction and found the capacitance that gives a particular power factor

Next Lesson

- New device: transformers