Resistive Circuits

Series resistances:
\[ V = V_1 + V_2 = iR_1 + iR_2 = i(R_1 + R_2) \]
\[ \frac{V}{R} = \frac{V}{R_1 + R_2} \]

Parallel resistances:
\[ \frac{1}{i} = \frac{1}{i_1} + \frac{1}{i_2} = \frac{V}{R_1} + \frac{V}{R_2} = V\left(\frac{1}{R_1} + \frac{1}{R_2}\right) \]
\[ \frac{1}{i} = \frac{1}{R} = \frac{1}{R_1 + R_2} \]

Example:

Voltage division in series connection:
\[ \frac{V_1}{V} = \frac{R_1}{R_1 + R_2} \]
\[ V_1 = iR_1 = V\left(\frac{R_1}{R_1 + R_2}\right) \]
\[ V_2 = iR_2 = V\left(\frac{R_2}{R_1 + R_2}\right) \]

Example:

Current division in parallel connection:
\[ \frac{i_1}{i} = \frac{R_1}{R_1 + R_2} = i\left(\frac{R_1}{R_1 + R_2}\right) \]
\[ i_2 = i\left(\frac{R_2}{R_1 + R_2}\right) \]

Example:

Position Transducer:

Voltage division based angle measurement
Node - Voltage Analysis

- Select a reference node and set its voltage to zero (also called ground).
- Label other nodes with known/unknown voltage variables.
- Use KCL to write equation at each node with unknown voltage.

Example:

$V_2 = V_3 - V_1$
$V_2 = V_1 - 0.5(V_3 - V_1) = 0.5V_1 - 0.5V_3$

$V_3 = V_1 - (0.5V_1 - 0.5V_3) = 0.5V_1 + 0.5V_3$

Two equations with two unknowns.

Mesh - Current Analysis

- Partition the circuit into independent loops, called meshes.
- Label each mesh with known/unknown current.
- Use KVL to write equation for each unknown mesh current.

Example:

Note: $V_2 = i_2 - i_1$

$V_2 = R_3i_2$

$V = i_1R_1 + i_2R_2 + i_2R_3$

Two equations with two unknowns.