Topic 3

Voltage Dividers, Loaded Voltage Dividers, and Equivalent Circuits

3.1 Voltage Dividers

Simple application of Kirchoff's Laws to resistors in series (or resistors that are effectively in series) with one end grounded:

$$V_{\text{out}} = \frac{R_1}{R_1 + R_2} V_{\text{in}}.$$

3.2 Non-Ideal Voltage Sources

When a load resistor is connected across the output terminals of a voltage divider, DC circuit analysis shows that the output voltage decreases. The smaller the value of the load resistance, the larger the *droop*. Droop is a property of all non-ideal voltage sources, i.e., real-world sources, whenever current is drawn from the source.

3.3 Equivalent Circuits

Thévenin's Theorem: Any two-terminal network of resistors and voltage sources is equivalent to a single resistor (R_{Th}) in series with a single ideal voltage source (V_{Th}).

$$V_{\text{Th}} = \text{Open circuit voltage}$$

$$R_{\text{Th}} = \frac{\text{Open circuit voltage}}{\text{Short circuit current}}$$

or

$R_{\text{Th}} =$ Resistance between terminals with all voltage sources "shorted out"

3.3.1 Thévinen Equivalent for a Voltage Divider (special case)

For a voltage divider:

$$V_{\text{Th}} = \frac{R_1}{R_1 + R_2} V_{\text{in}}.$$

$$R_{\text{Th}} = R_{\text{parallel}} = \frac{R_1 R_2}{R_1 + R_2}$$