Recap

- Ohm's law and resistance V=IR
- Voltage sources
- Current sources
- Kirchoff's laws

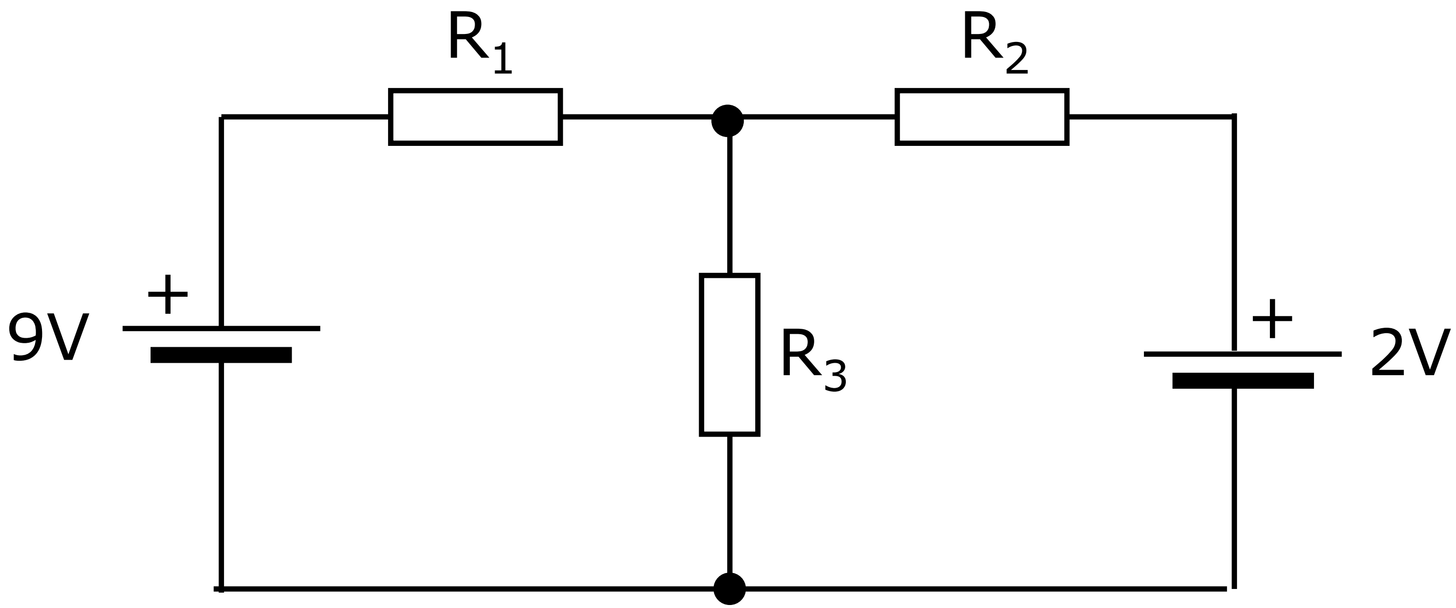
$$\sum_{\text{node}} I_n = 0 \quad \text{KCL}$$

$$\sum_{\text{loop}} V_n = 0 \quad \text{KVL}$$

- Passive sign convention

Example

$R_1 = 3k\Omega$
$R_2 = 2k\Omega$
$R_3 = 6k\Omega$



This lecture

Methods/tricks for solving circuits

- Mesh currents
- Node voltages
- Superposition
- Thevenin’s theorem
- Norton’s theorem

Measurements and power extraction

- Measuring voltage
- Measuring current
- Power extraction and impedance matching

Mesh currents

1. Label loop currents in all interior loops

2. Apply KVL around each loop

   Using **passive sign convention** and using KCL to get currents in shared sections

3. Solve for loop currents and use these to obtain everything else.

Node voltages

1. Choose a ground node and label all other nodes.

2. Apply KCL to each node.

   The currents can usually be directly written down as a $\Delta V/R$.

3. Solve for node voltages and use these to obtain everything else.

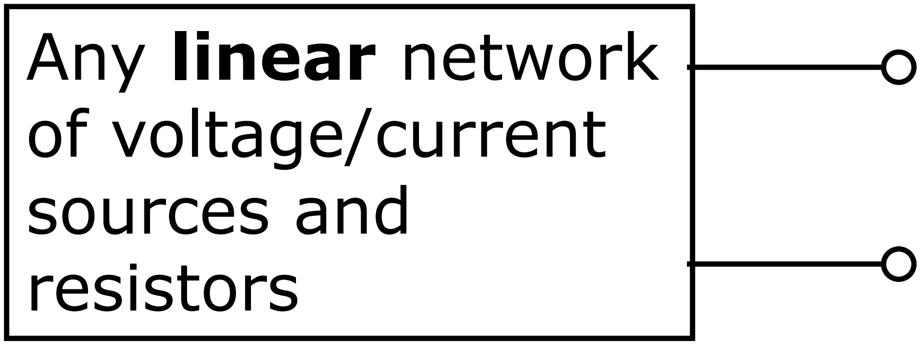
Superposition

1. A linear circuit with more than one current/voltage source can be analysed by considering one source at a time.

2. When analysing just one source replace other
    - Current sources with a break
    - Voltages sources with a wire

3. The total response of the circuit will be the sum of the individual responses.
    - Make sure you label everything with the same directions

Thevenin’s theorem



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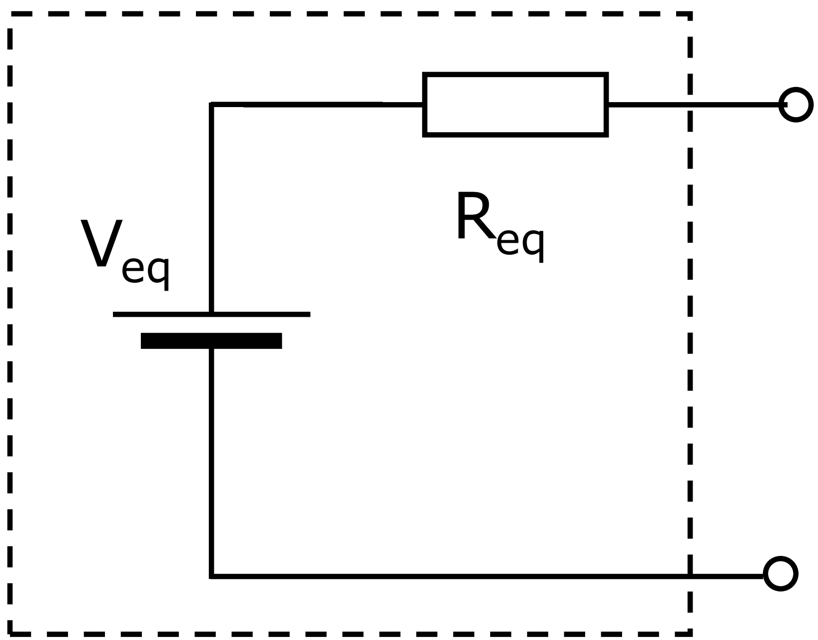
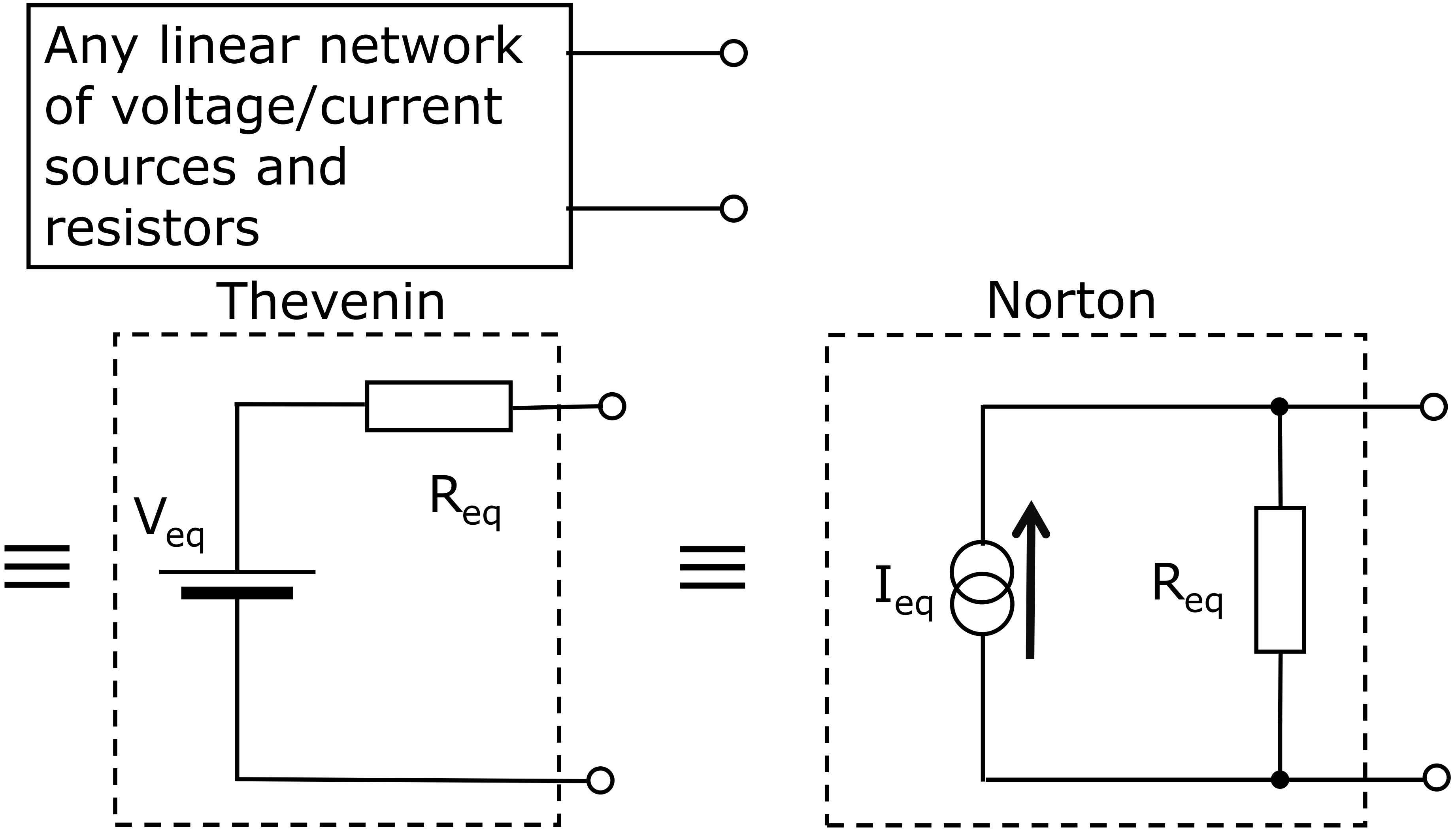


Equivalent circuit

$$V_{\mathrm{eq}} = V_{\text{open-circuit}}$$

$$R_{\mathrm{eq}} = \frac{V_{\mathrm{eq}}}{I_{\text{short-circuit}}}$$

Norton’s theorem

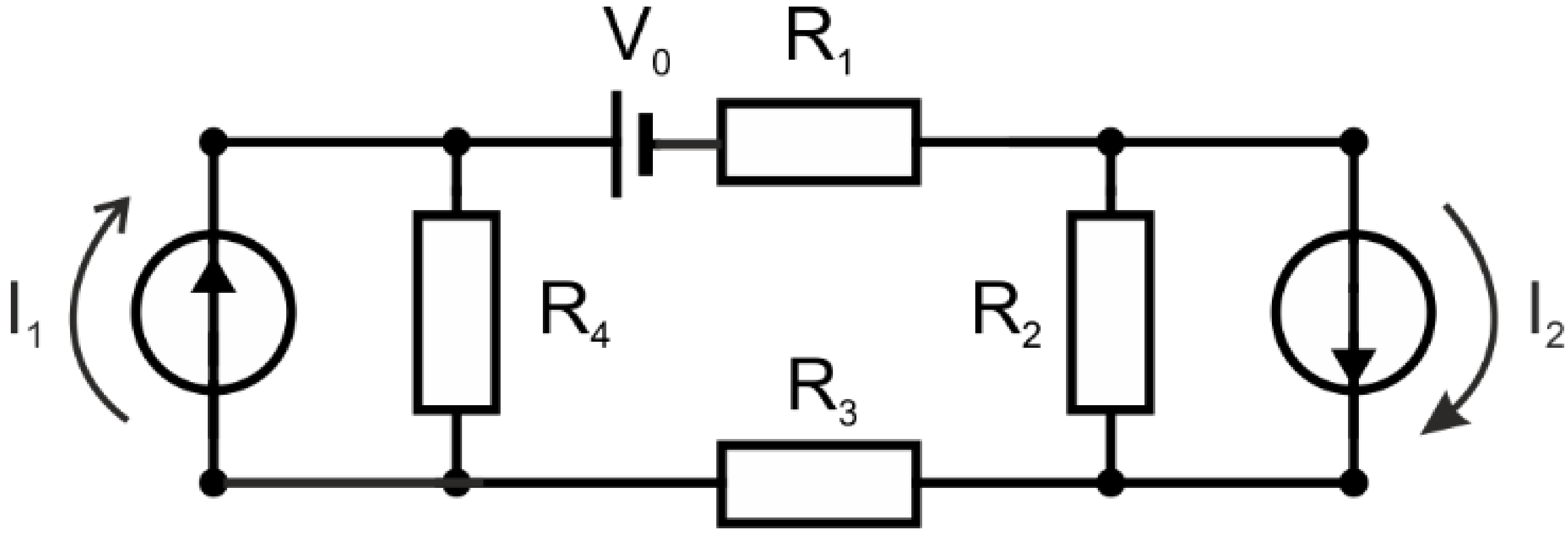


$$I_{eq} = \frac{V_{eq}}{R_{eq}}$$

Methods/tricks for solving circuits

- Mesh currents
- Node voltages
- Superposition
- Thevenin's theorem
- Norton's theorem

Which trick to use?

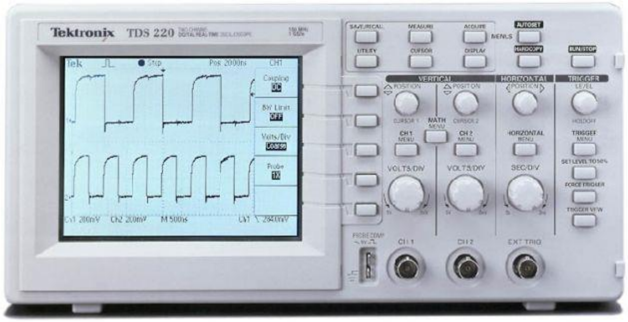


Measuring circuit voltages and currents

Voltage measurements: need $R_{in} >> R_{eq}$

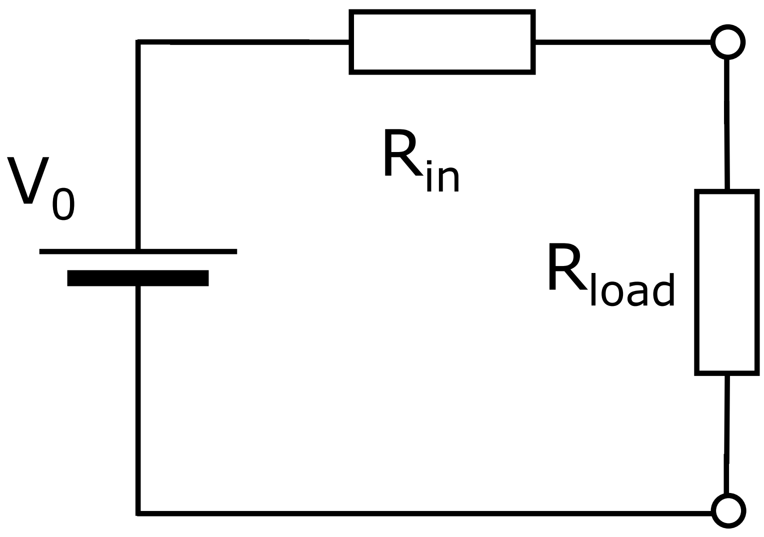
10MΩ

1MΩ



Current measurement: need $R_{in} << R_{eq}$

Matching: maximum power transfer



Find R_L to give maximum power in load

$$P = \frac{V_L^2}{R_L} = V_0^2 \frac{R_L^2}{\left(R_{in} + R_L\right)^2} \frac{1}{R_L}$$

Max when $\frac{dP}{dR_L} = 0 \quad \Rightarrow R_L = R_{in}$

Maximum power transfer when $R_L = R_{in}$

Note – power dissipated half in R_L and half in R_{in}

Circuits have Consequences

- Problem:
  - My old speakers are 60W speakers.
  - Special 2-4-1 deal at El-Cheap-0 Acoustics on 120W speakers!!
    - ("Offer not seen on TV!")
  - Do I buy them?
- Depends! 4W, 8W, or 16W speakers?
- **Why does this matter?**