EE251
Lectures

Electronic Measurements

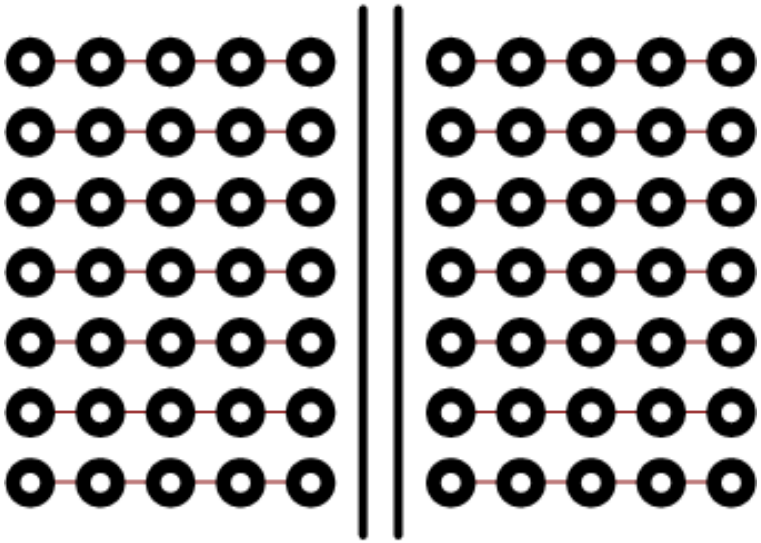
Section 05

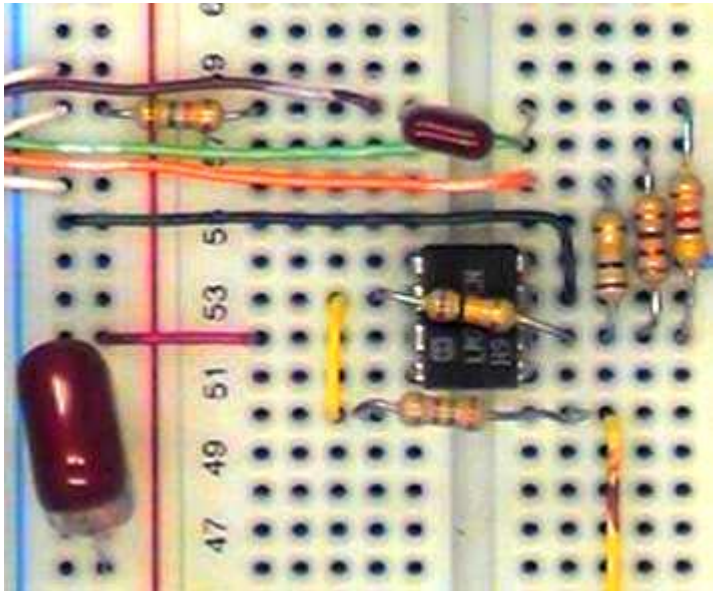
Measurements

- How to measure voltage?
- How to measure current?
- How to measure resistance?
- How to view a signal?

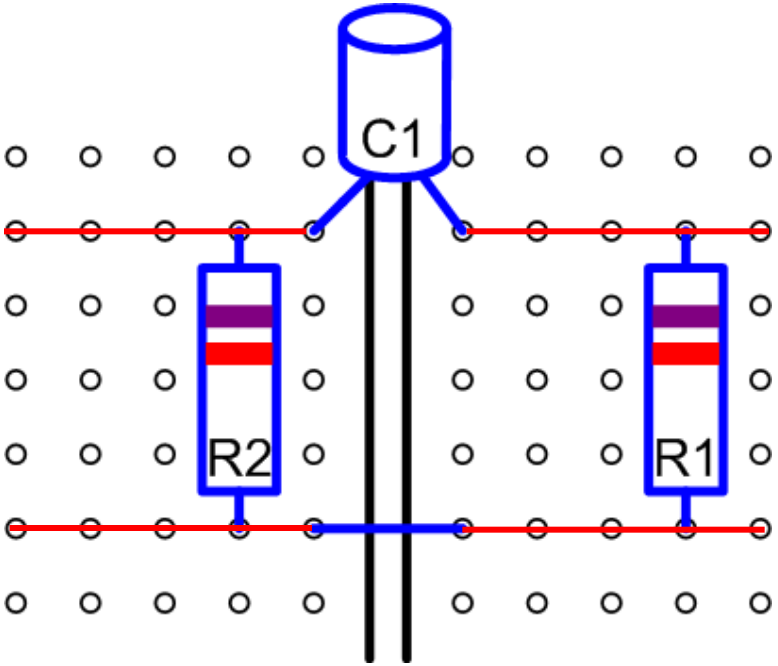
Bread Boards

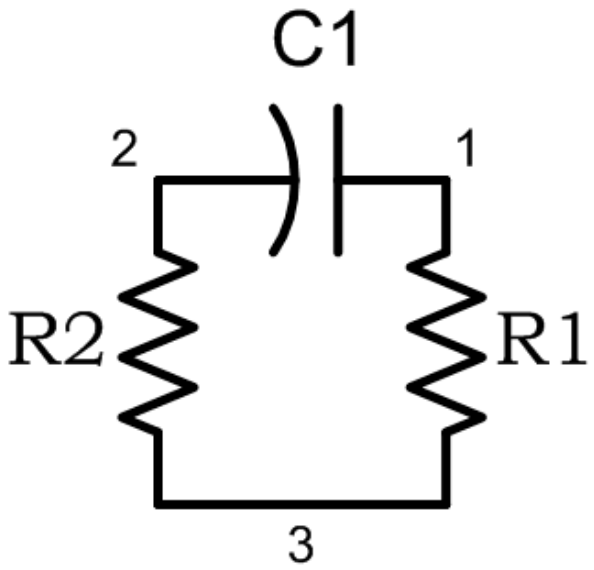
- A board with spring contact holes to hold components; no soldering is required
- Holes of each row are internally connected



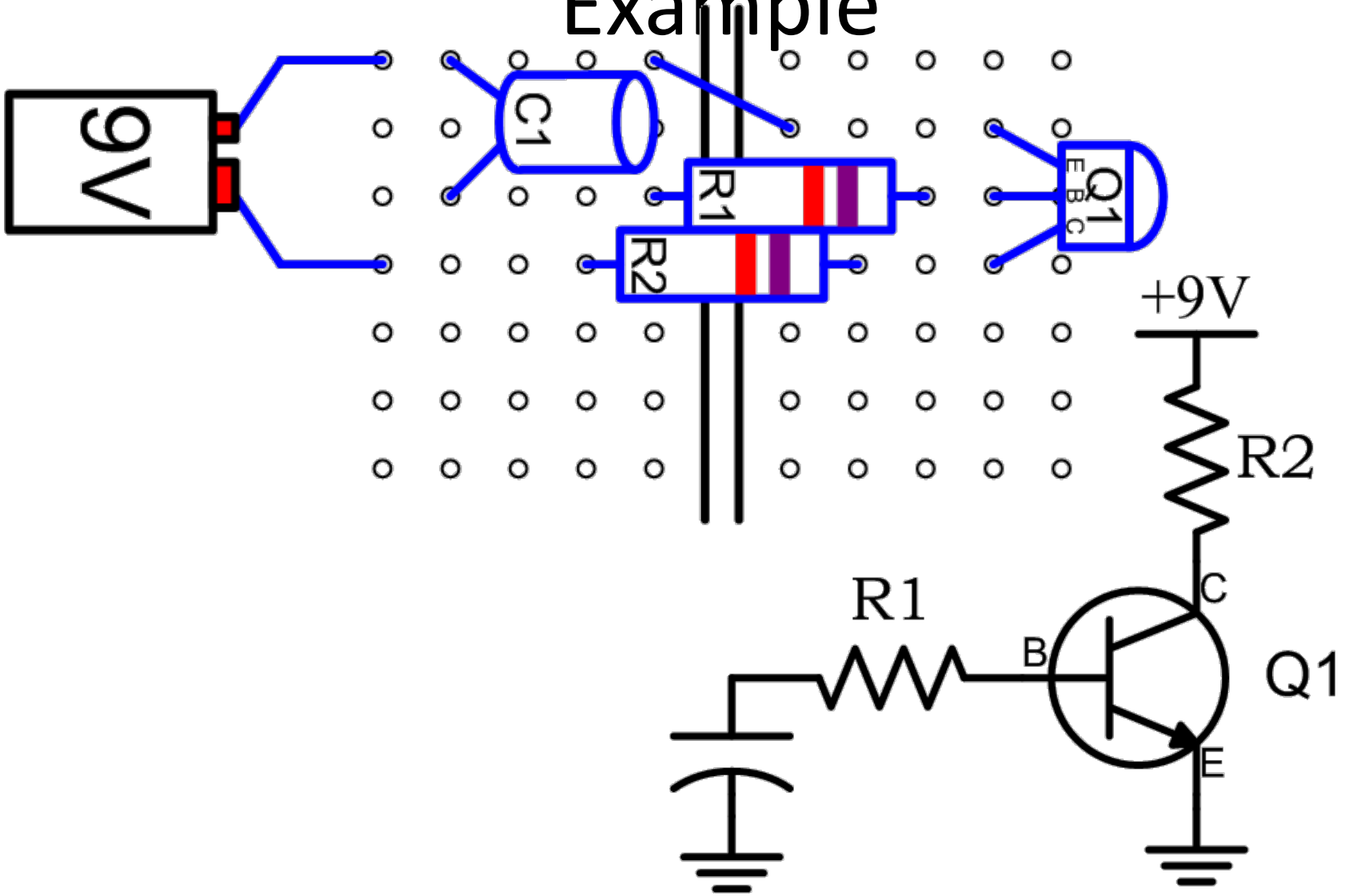


Example





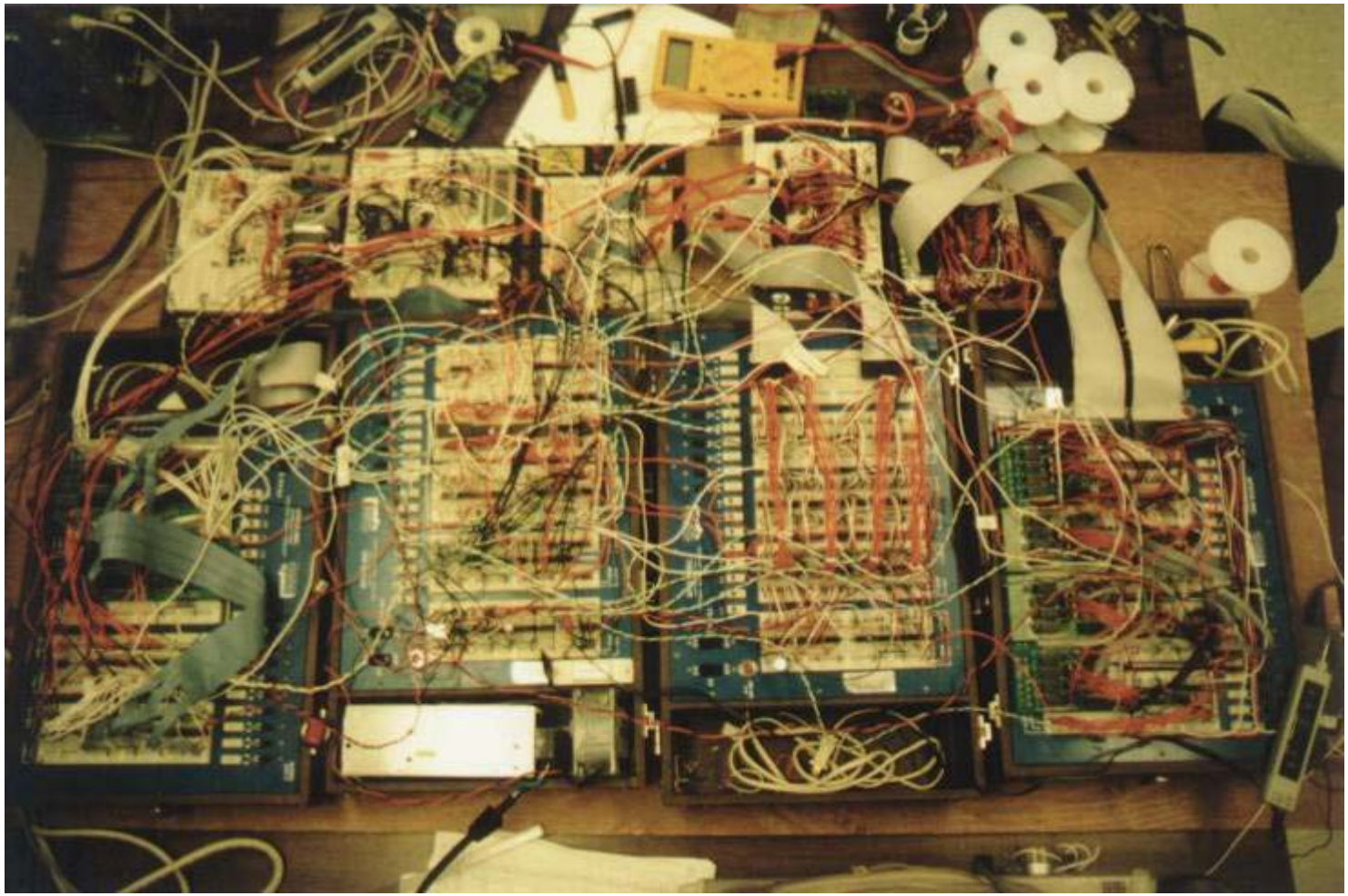
Example



Rules

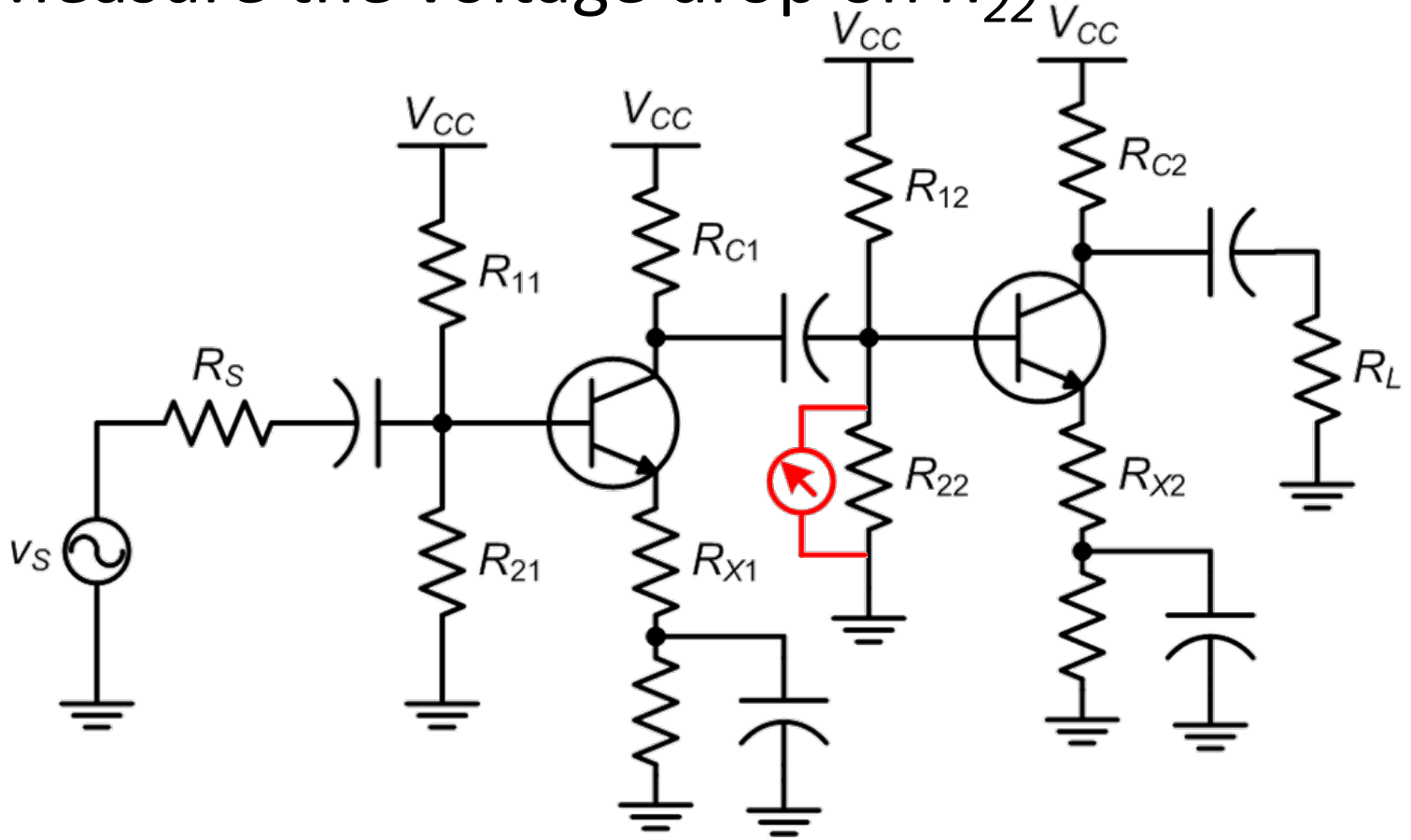
- Study Circuit
- Collect all components
- Start at the middle
- Power must be off
- Careful with sensitive components
- Nice wiring

Bad Example



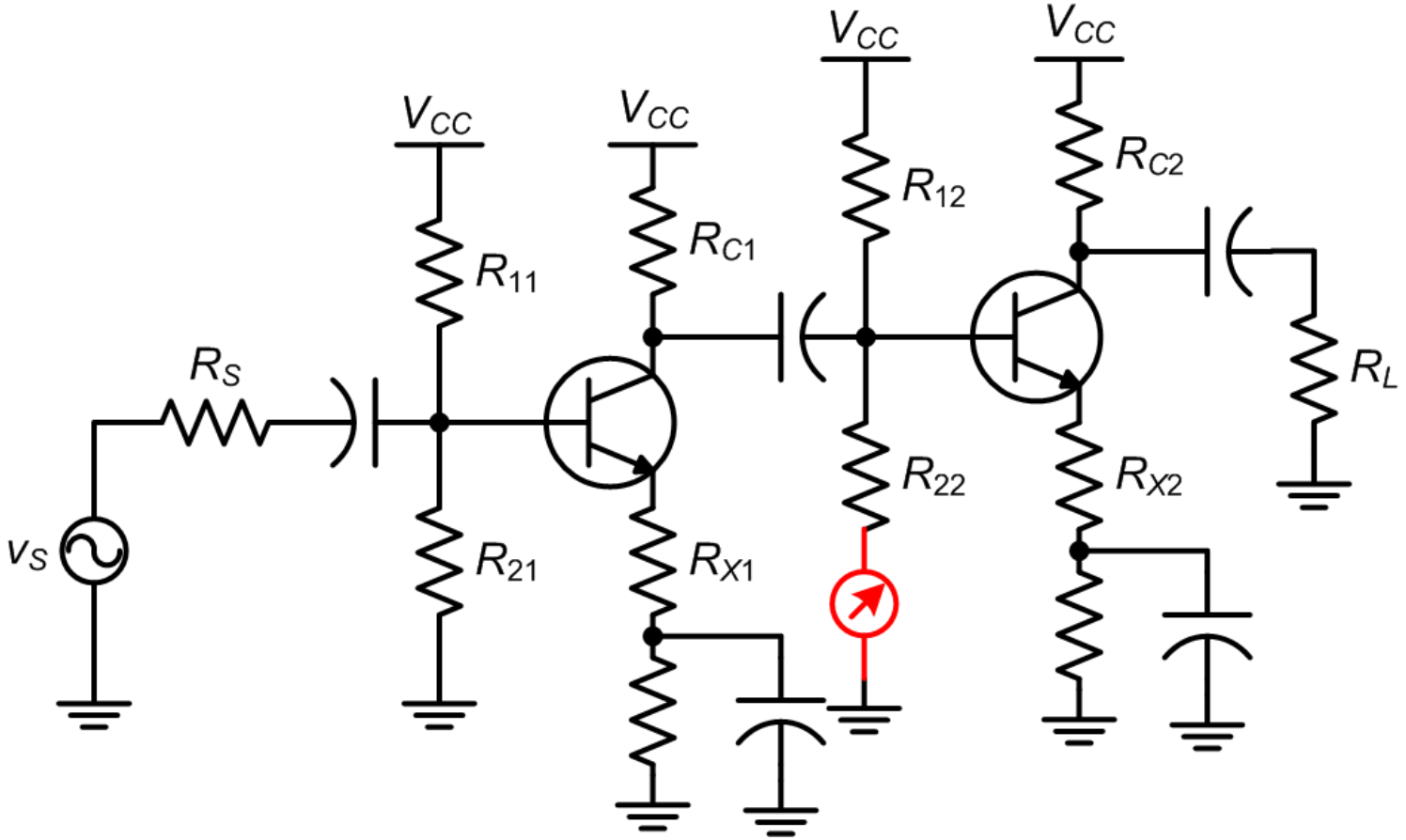
Measuring Volt

- Measure the voltage drop on R_{22}



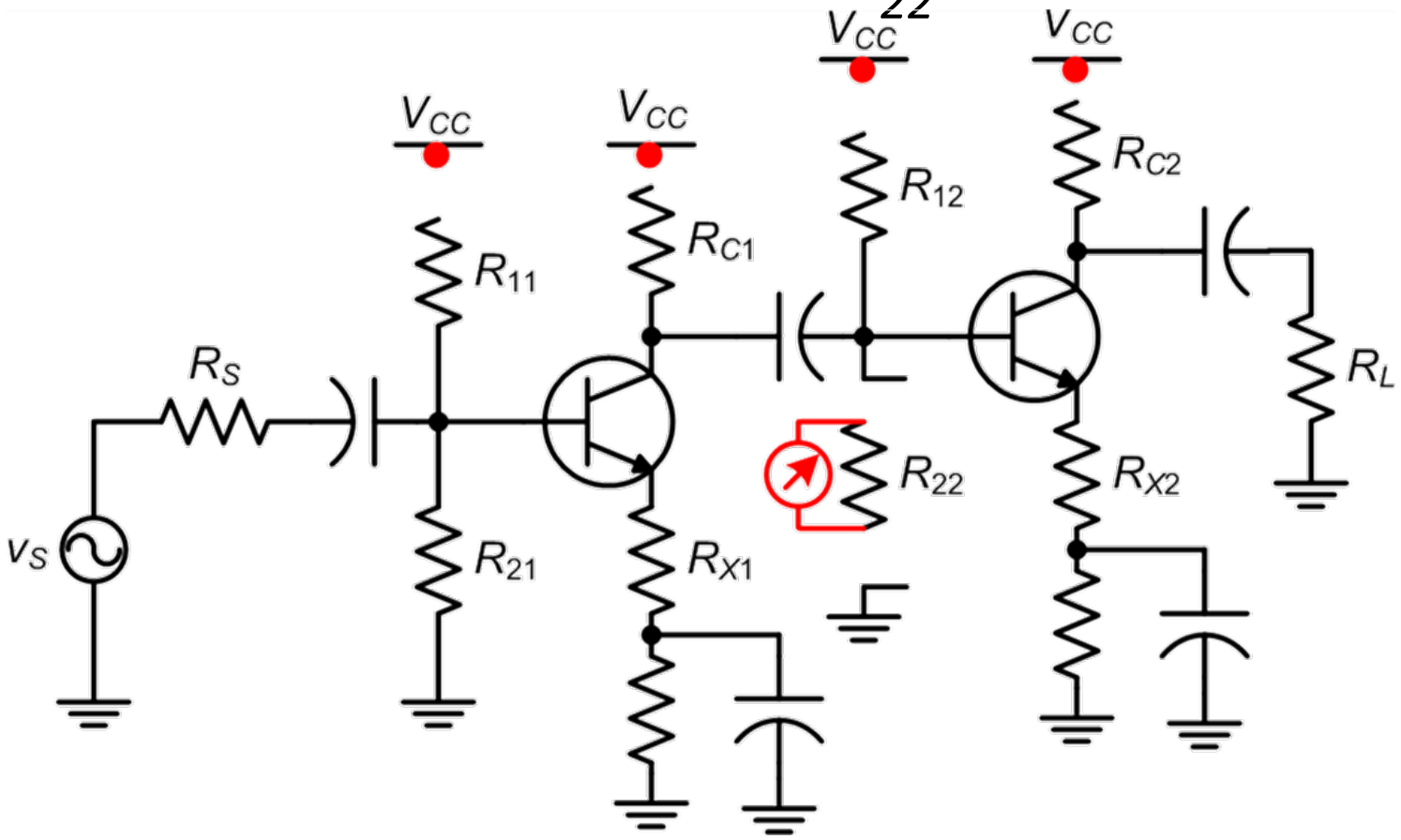
Measuring Current

- Measure the current through R_{22}



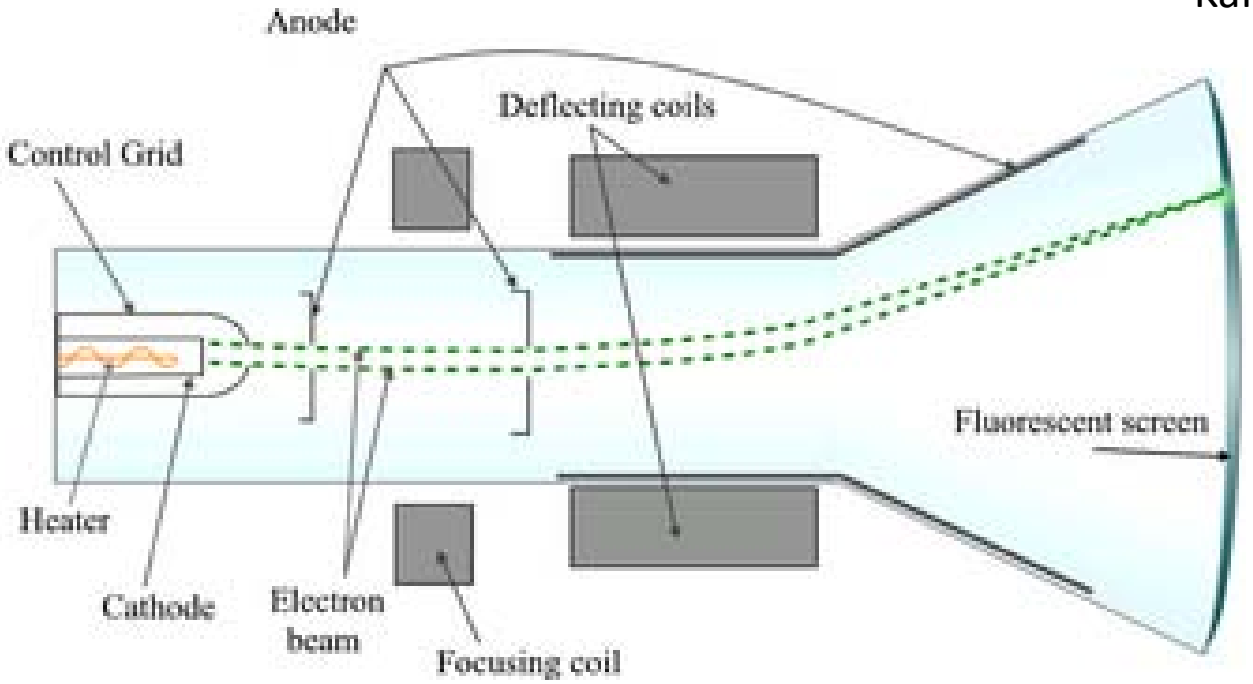
Measuring Resistance

- Measure the resistance of R_{22}



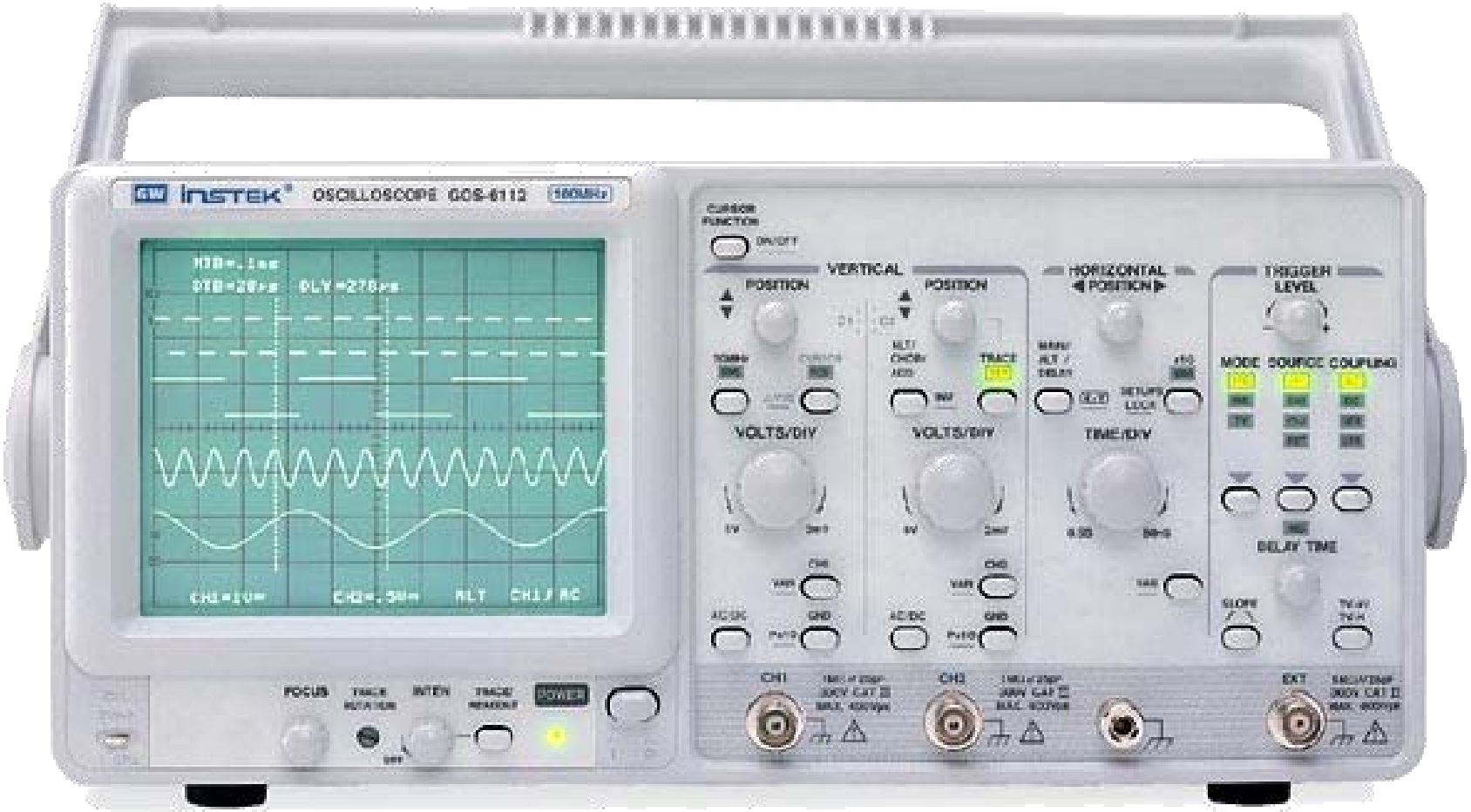
Oscilloscopes

Karl Ferdinand Braun
(1897)



Cathode Ray Tube

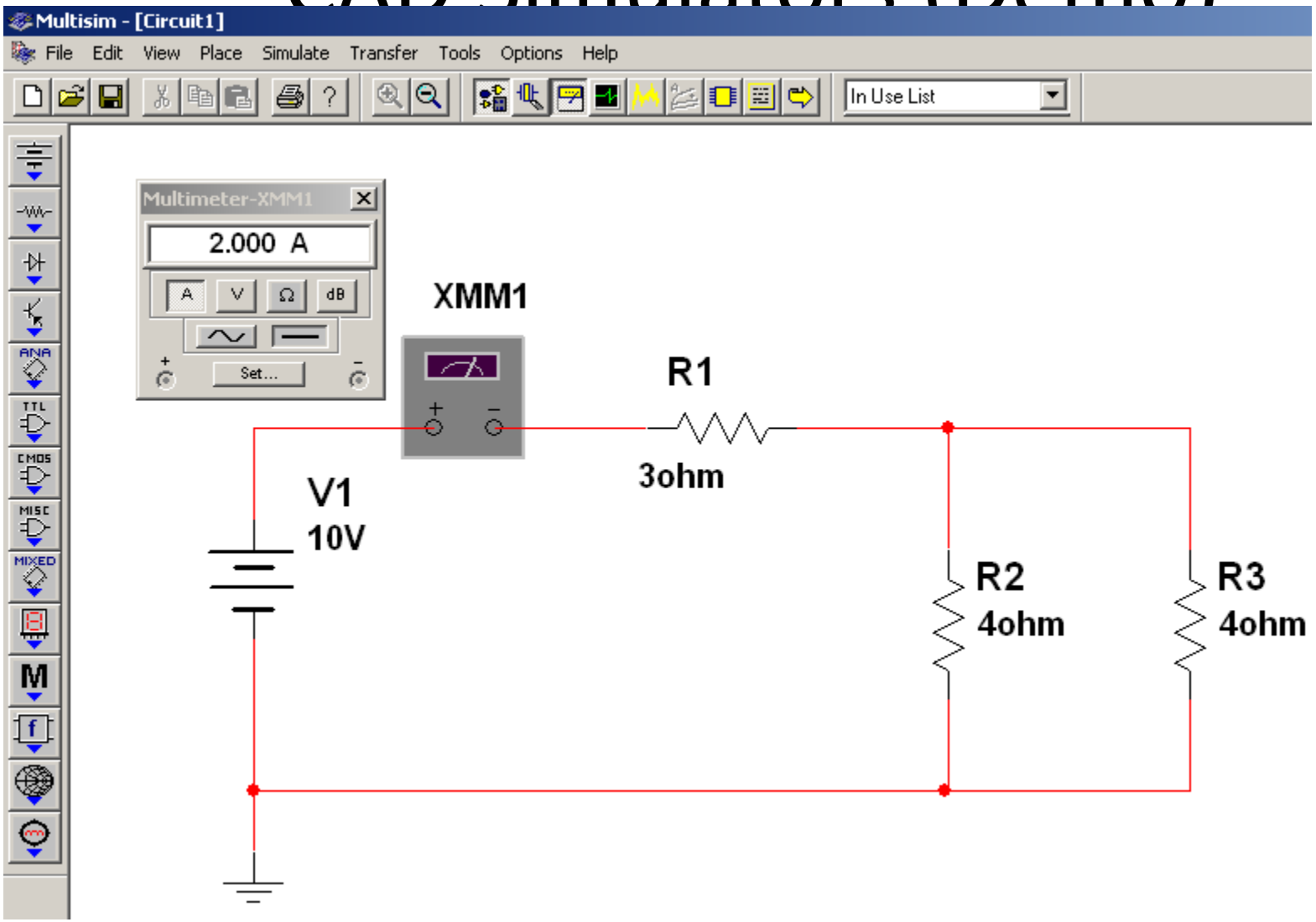
Oscilloscopes



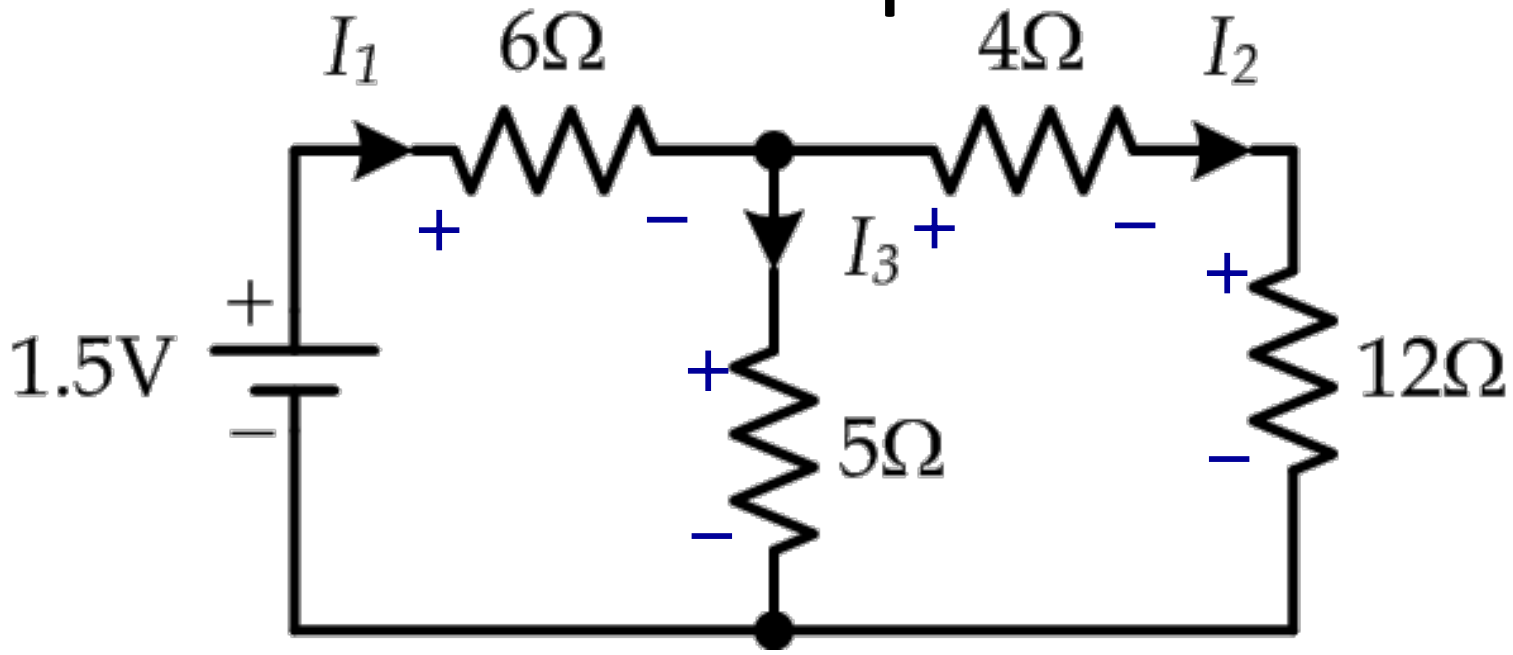
Selection Criteria

- Analog vs. Digital
  - Digital: Sample and Hold
- Bandwidth, Sampling Rate, Resolution (Accuracy)
  - 5x the maximum signal frequency
- Number of Channels
  - 2-4 for correlations
- Memory Depth
  - Recording Time
- Triggering Capability
  - Display Signal after Trigger
- Display Capability
  - phase shift, rise time, fall time
  - delay, pulse width, duty cycle, frequency and period
- Analysis Capabilities
  - Math, FFT

CAD Simulators (Demo)



Example

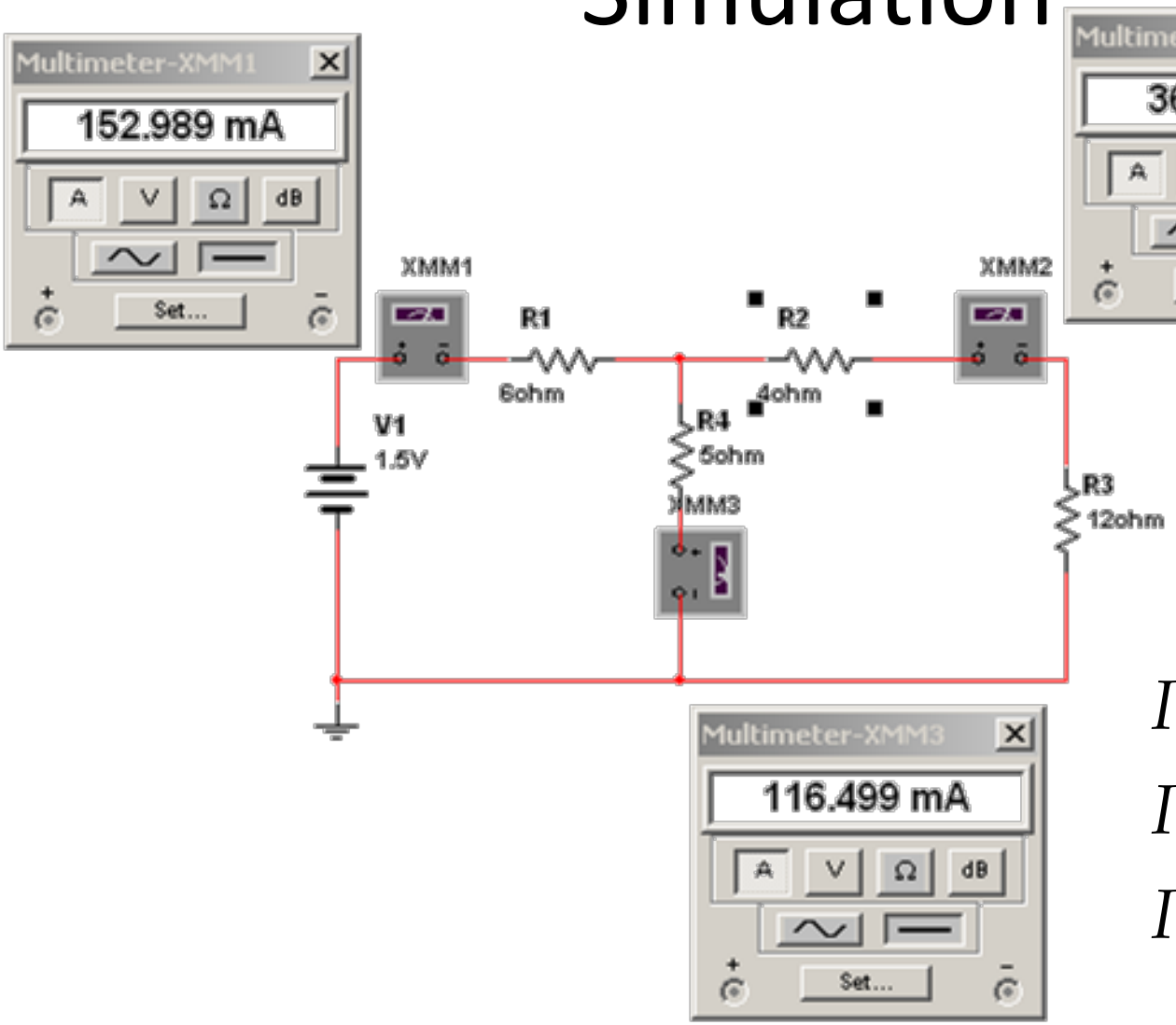


$$KCL: \quad I_1 = I_2 + I_3$$

$$KVL: \begin{aligned} -1.5 + 6I_1 + 5I_3 &= 0 \\ -5I_3 + 4I_2 + 12I_2 &= 0 \end{aligned}$$

$$\begin{aligned} I_1 &= 152.9 \quad mA \\ \Rightarrow I_2 &= 36.4 \quad mA \\ I_3 &= 116.5 \quad mA \end{aligned}$$

Simulation

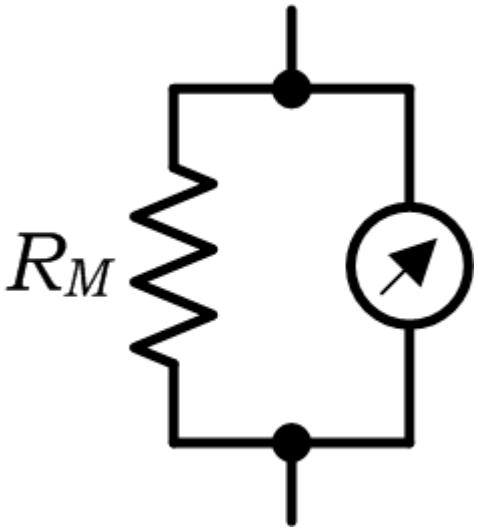


$$I_1 = 152.9 \quad mA$$

$$I_2 = 36.4 \quad mA$$

$$I_3 = 116.5 \quad mA$$

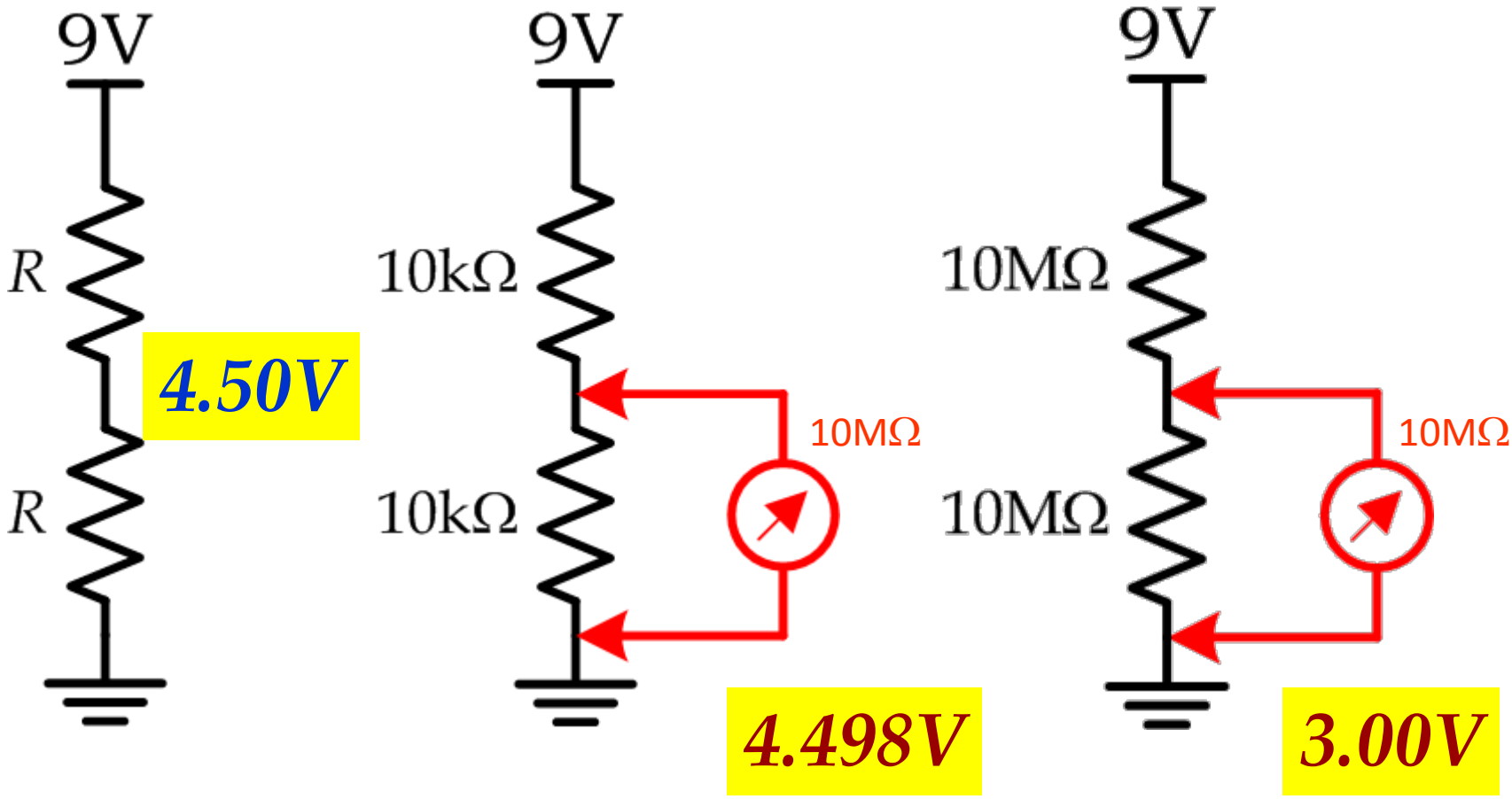
Non-Ideal Instruments



voltmeter ***ammeter***

$$R_M >> R_L \qquad r_m << R_L$$

Measurement Error



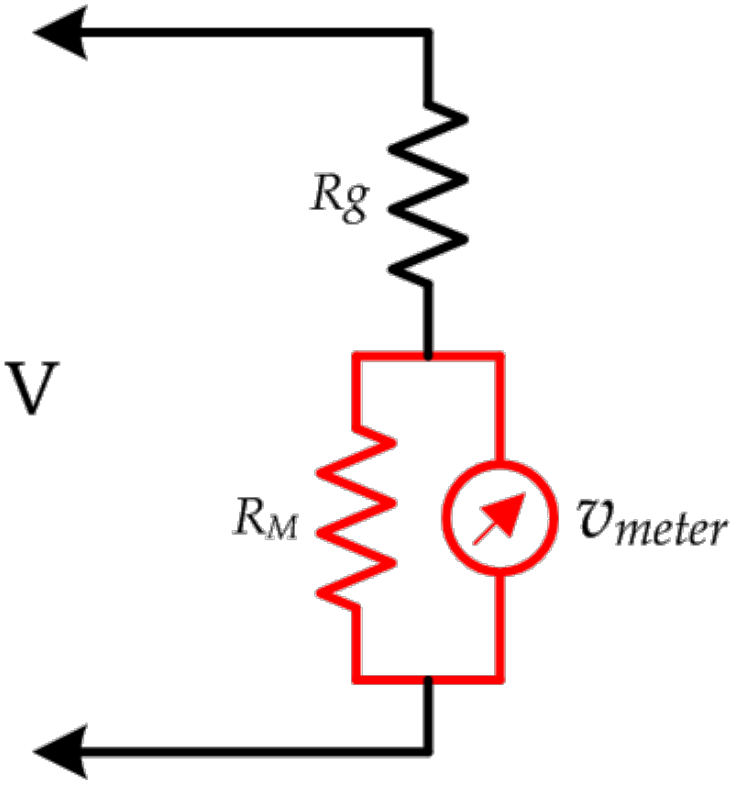
Range Extension

- A voltmeter of maximum range of 50V
  - Can it read 100V safely?

- Voltage Divider

$$V = v_{meter} \times \left(1 + \frac{R_g}{R_M}\right)$$

$$er = er_{meter} \times \left(1 + \frac{R_g}{R_M}\right)$$



Non-Ideal OSX (Harmonics)