Electronics for IoT

Resistance
Electronic Circuits

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Last Time

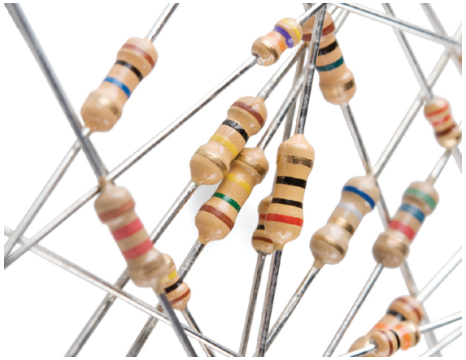
- Solar powered “noise maker”
- What else could we power with the solar cell?

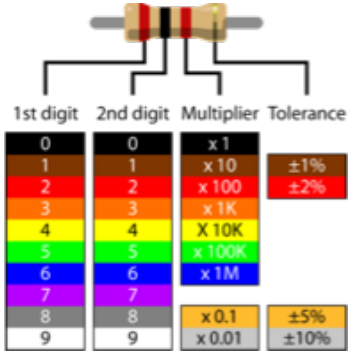
Outline

- Resistors
  - Electrical characteristics
  - Symbol
  - Ohm's law
- Solar cell power optimization
- Circuit analysis
  - Kirchhoff's laws
- Application:
  - LED

Resistors

- Electrical circuit component (device)





Characteristics

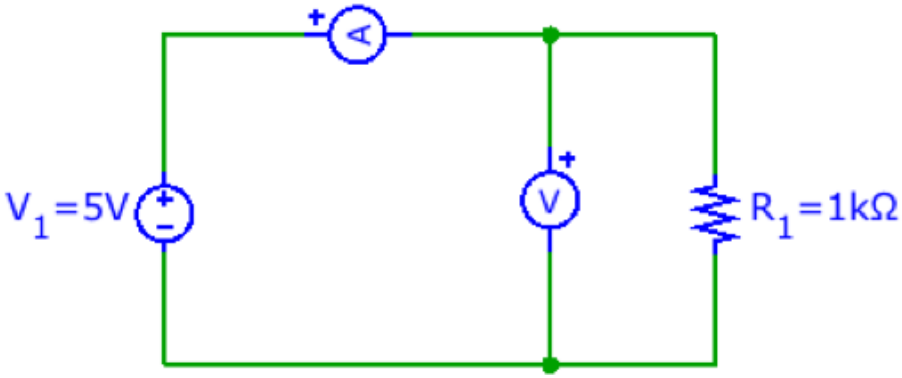
Ohm – Meter


VoltAlert
FLUKE 117 TRUE RMS MULTIMETER
LoZ
600.0
V AC
0 Auto Volts 6 00
Lo / Hi
HOLD
MINMAX
RANGE
AUTO-V LoZ
OFF
Hz
mV
Ω
Volt Alert
A
Hz
A
COM
V Ω
10 A FUSED
CAT III 600 V

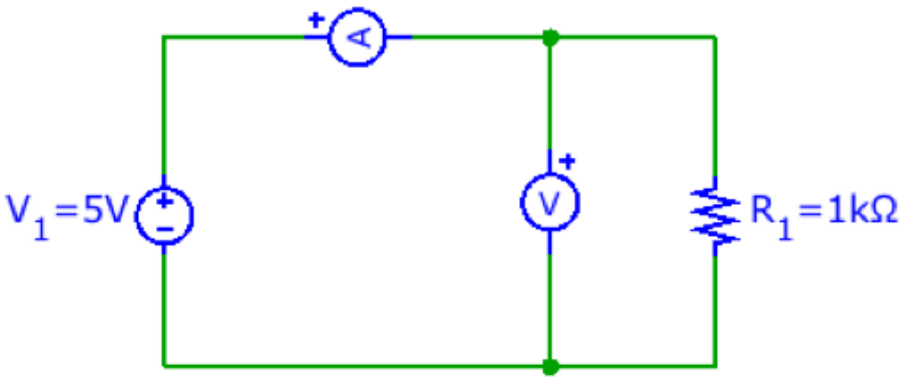
Continuity Test

Resistor I/V Relationship

Resistor Circuit Example

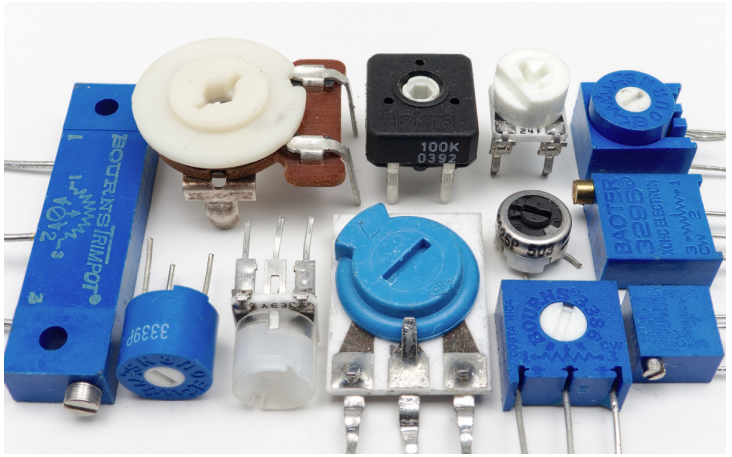


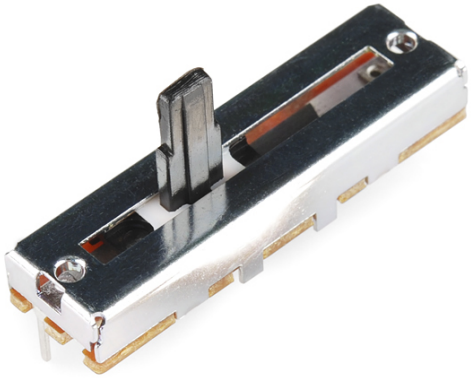
Solar Cell Power



Potentiometer

- Variable resistor



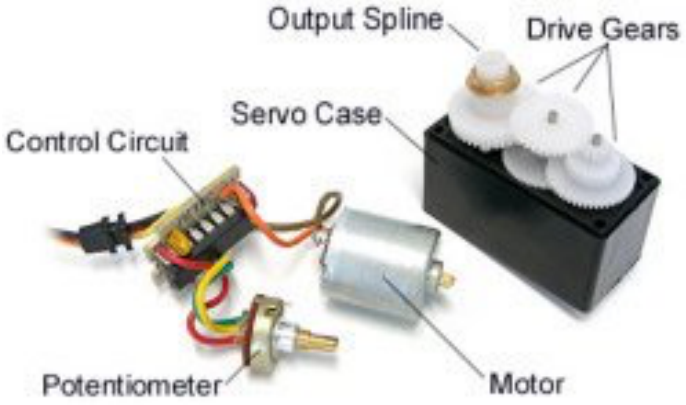


Potentiometer – How does it work?

Potentiometer – Resistance

Application: Encoder

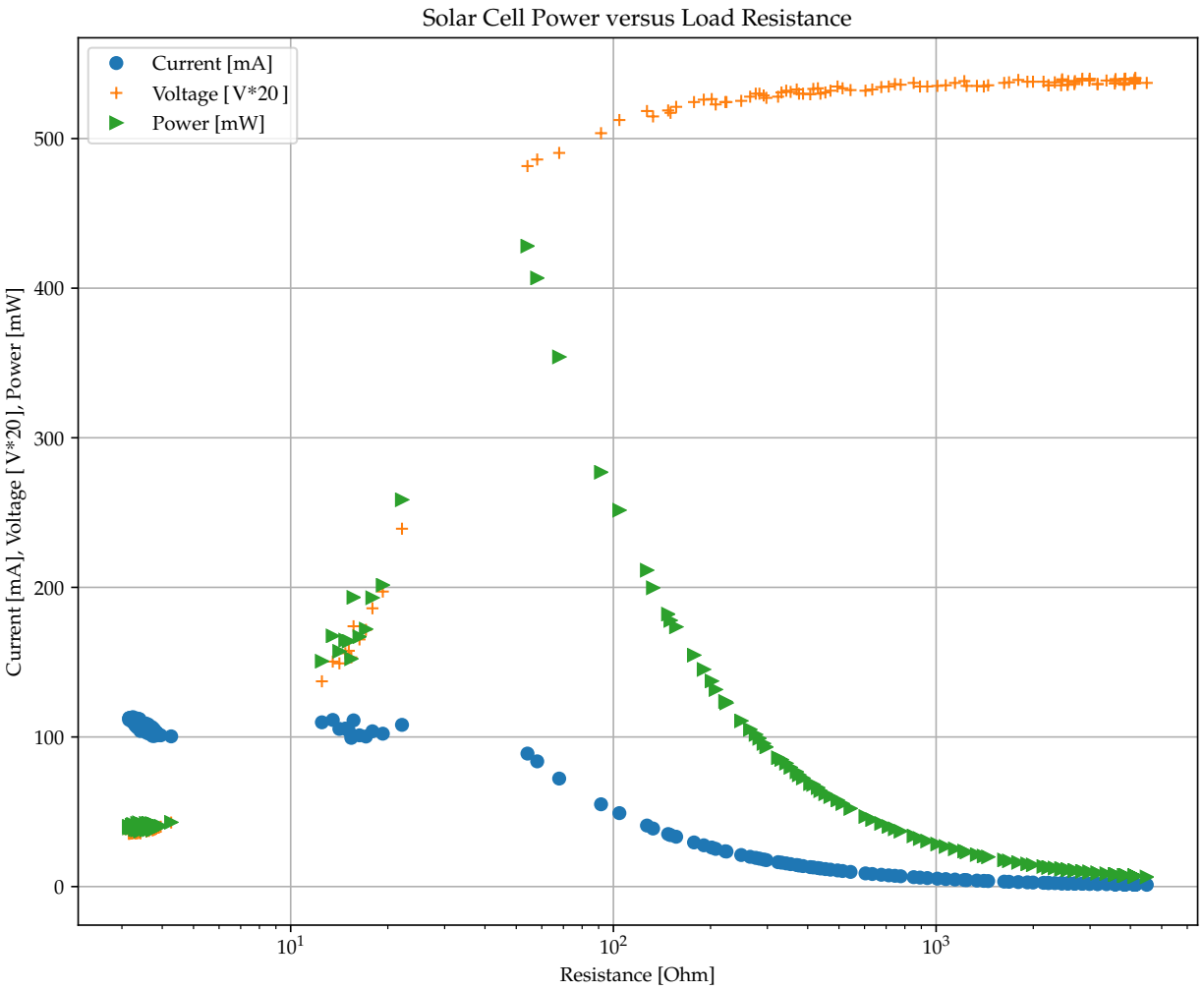
Example: Servo



Potentiometer Symbol

Solar Power

After a little bit of work …



Maximum Power

- P_{max} = 450 mW
- R = 45 Ohm
- V = 5 V
- I = ?

Efficiency

- Solar power (sun overhead): ~ 1 kW/m^2

Outline

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  - Ohm's law
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  - Kirchhoff's laws
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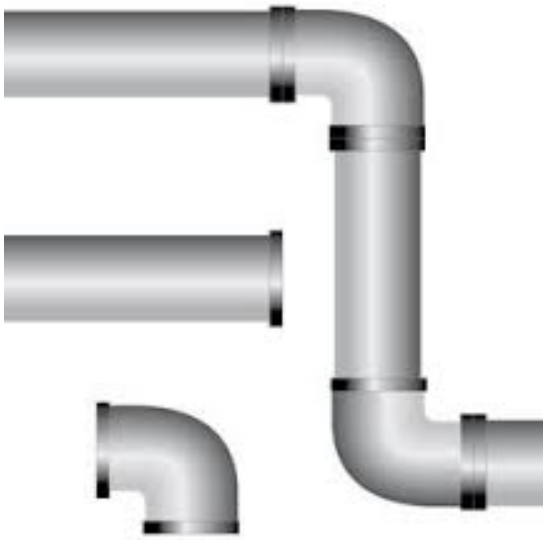
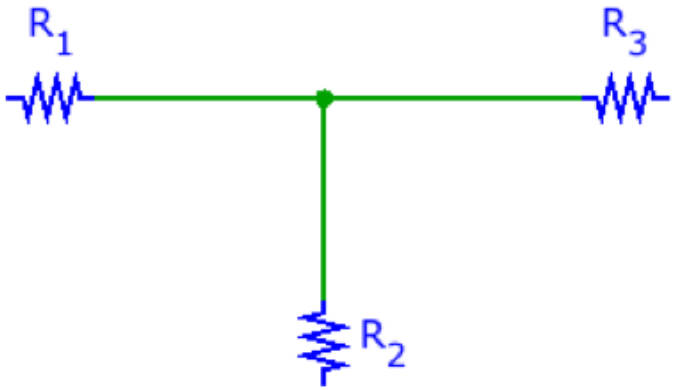
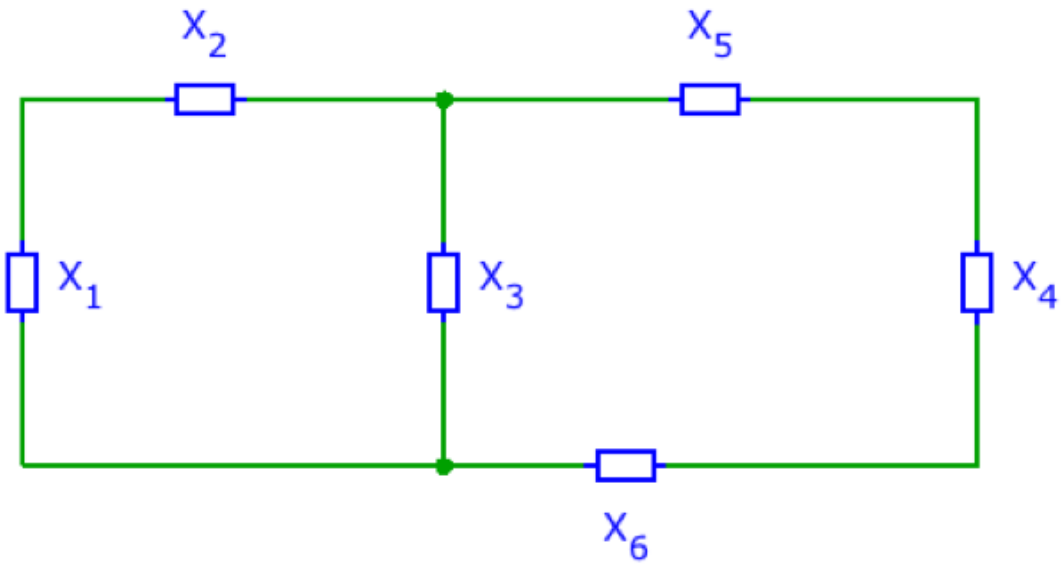
Kirchhoff's Laws …



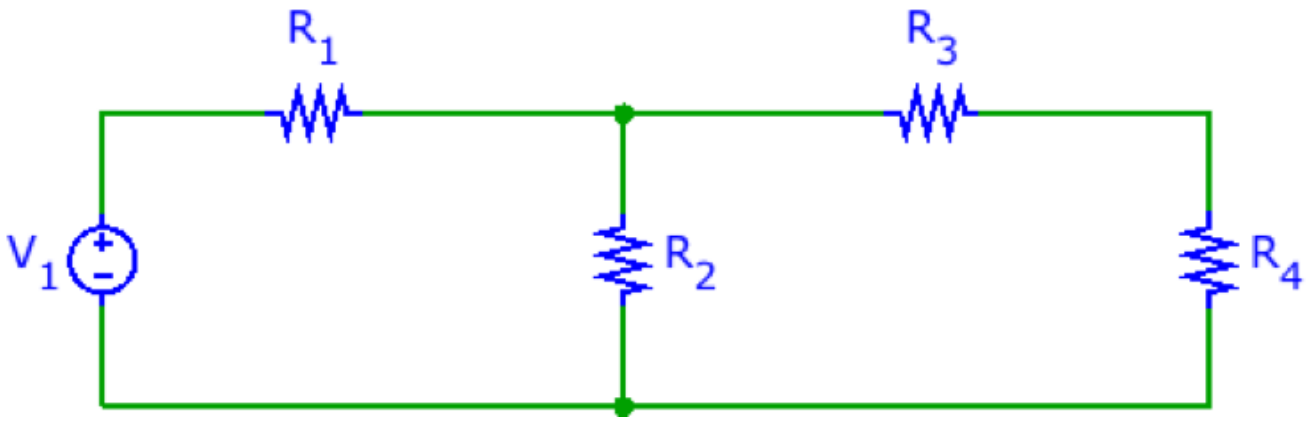
Branches



Kirchhoff's Current Law (KCL)



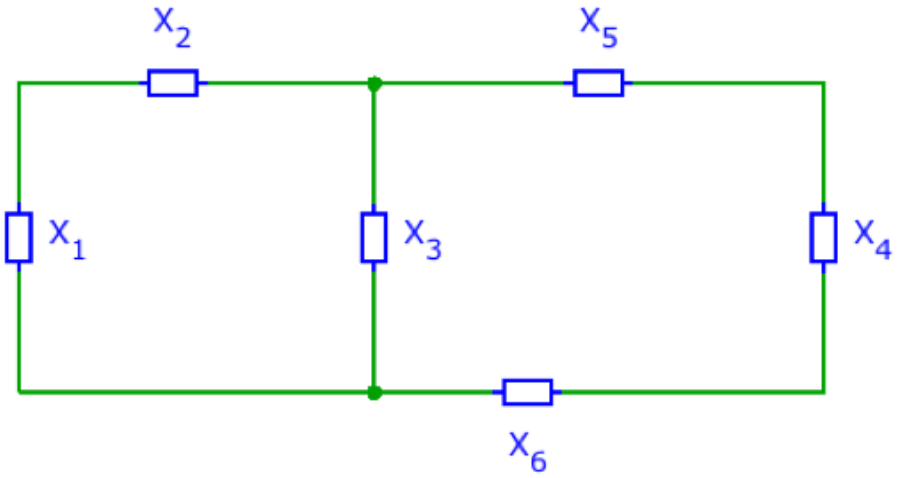
KCL Example



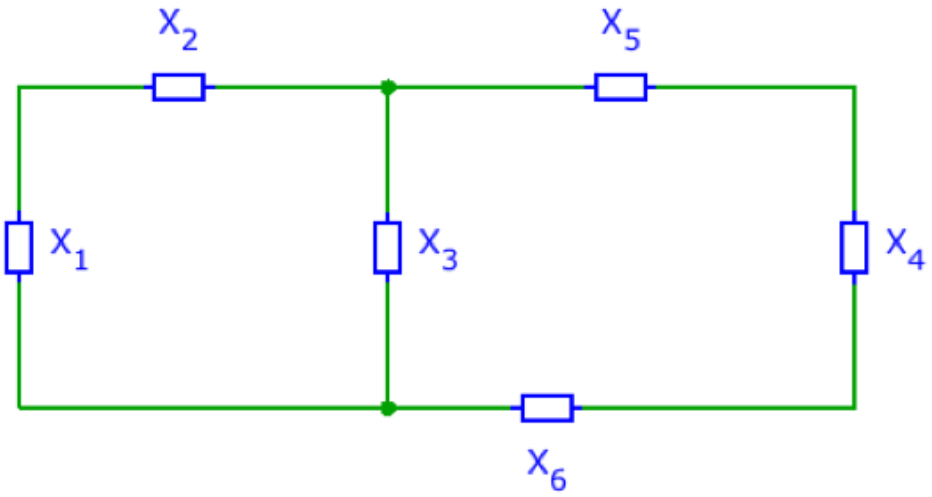
Kirchhoff's Voltage Law (KVL)

Hiking Loop

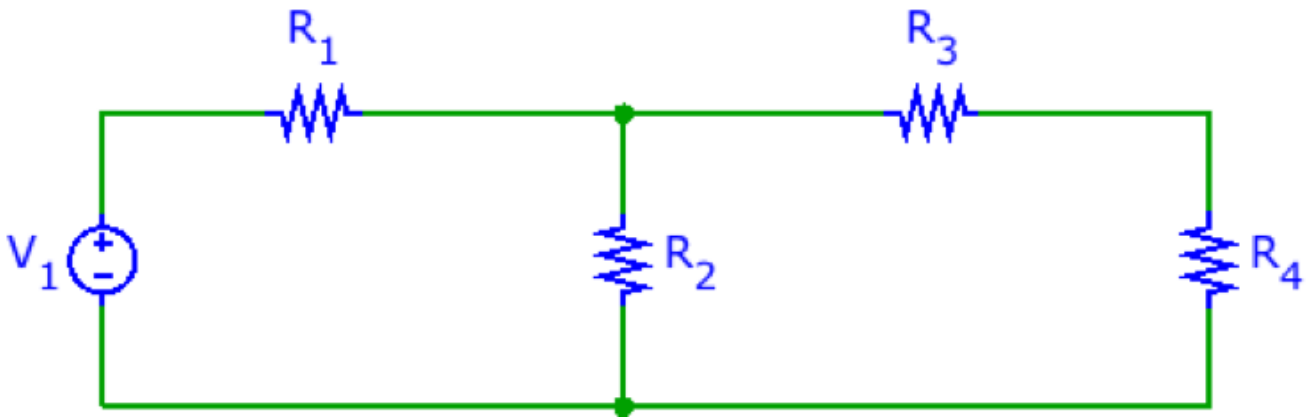
Voltage Loop



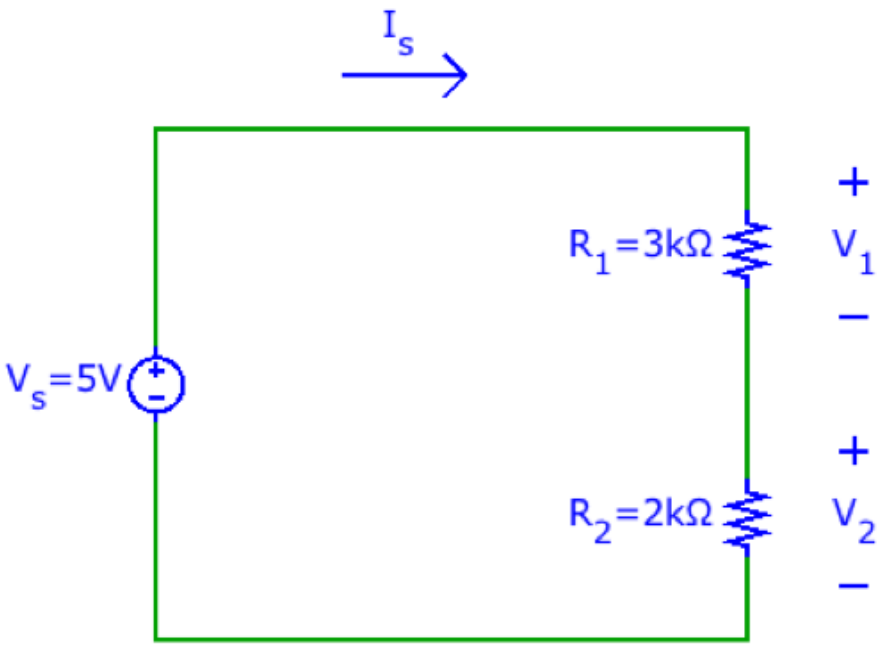
Kirchhoff's Voltage Law (KVL)



KVL Example



Circuit Example



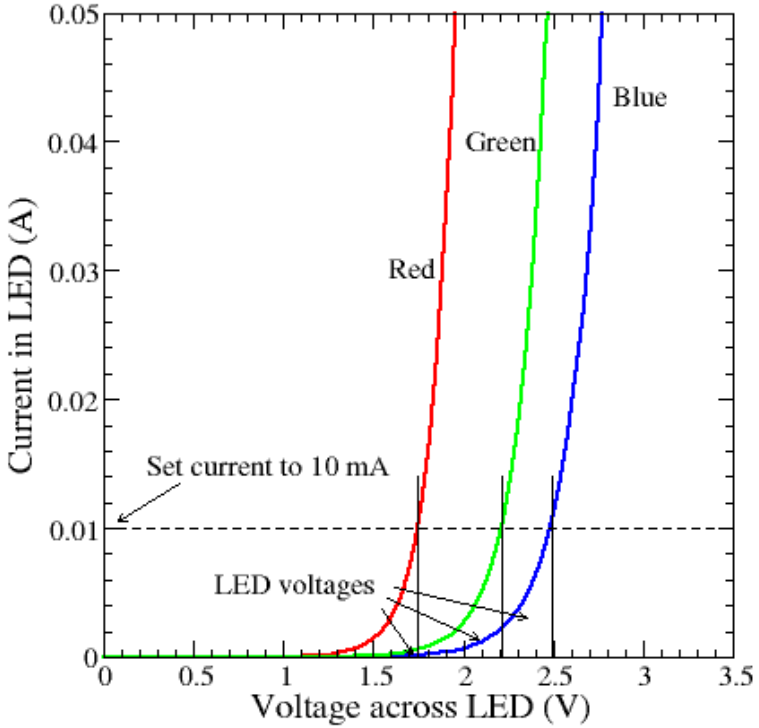
Resistors in Series

Resistors in Parallel

Design Problem

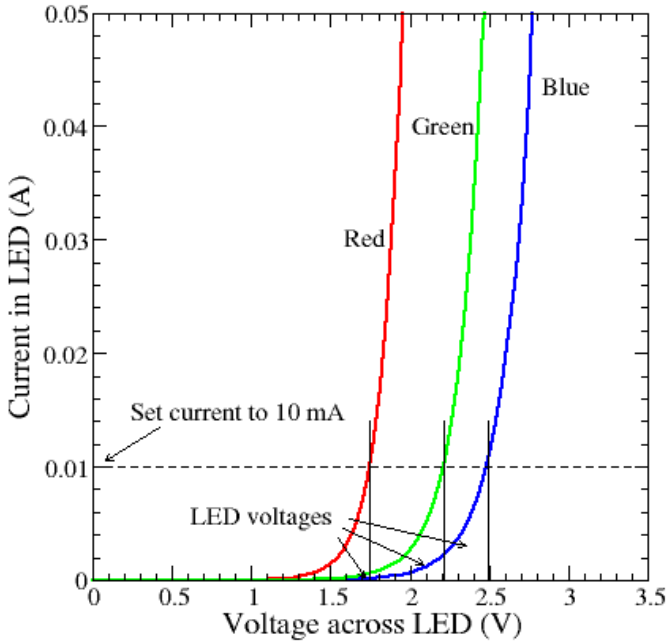
- Given:
  - 12 V battery
  - Box full of resistors
- Design circuit for
  - 5 V

LED Example



- How can we power a Red LED from a 5V supply?
- Direct connection …
  - I = ?

10mA LED Circuit

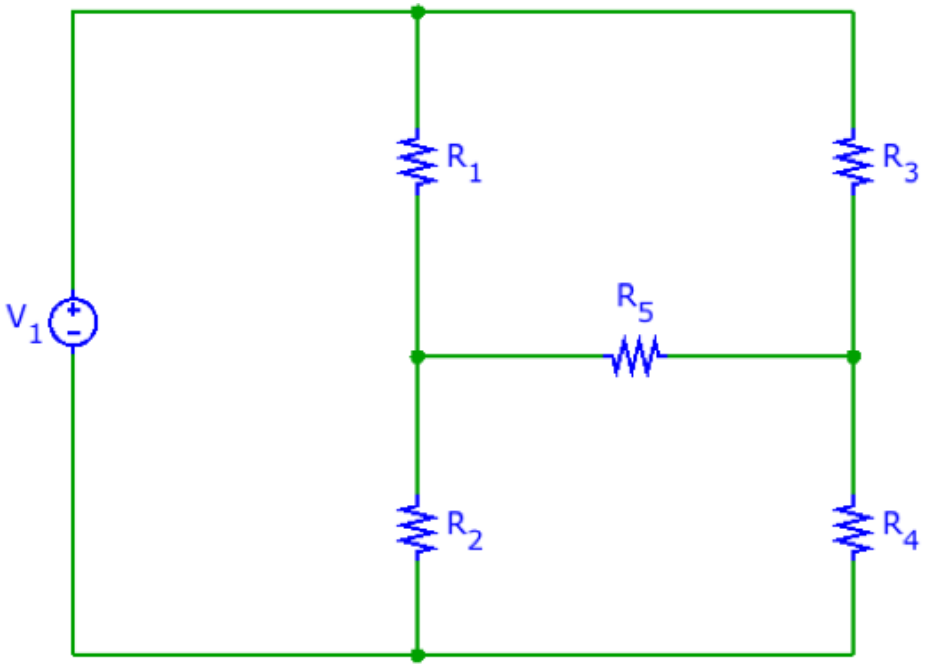


Equations, equations, …

- KVL & KCL
  - Many more equations than we need
  - Linear dependent
- Systematic way to write just the equations needed?

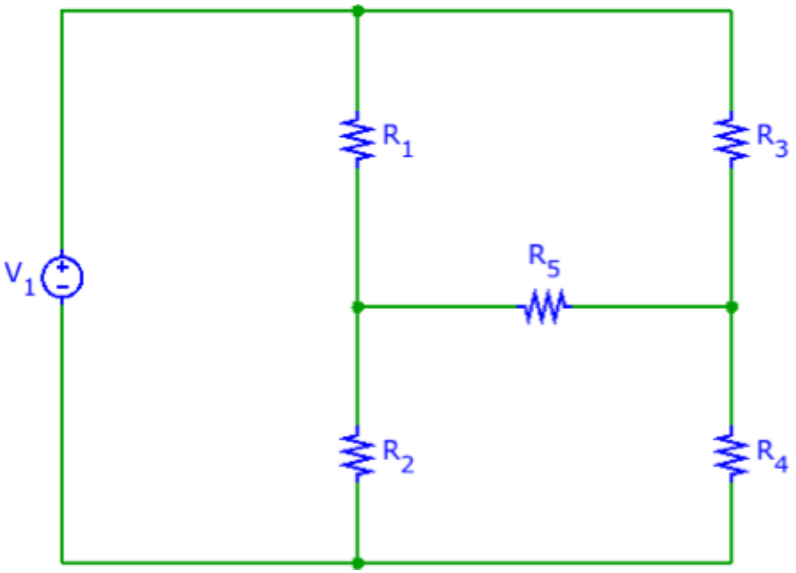
Nodal Analysis

- Objective
  - Find all unknown voltages in circuit

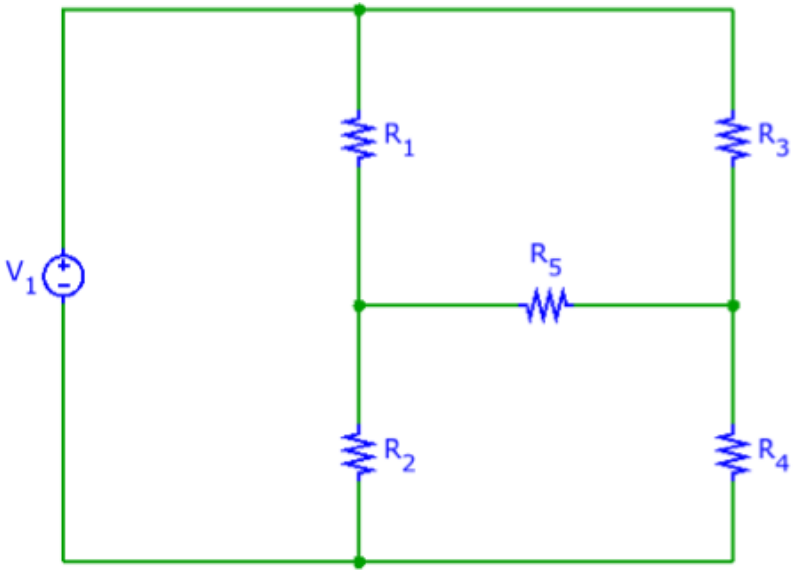


Nodal Analysis

1. Choose ground (GND)
2. Mark unknown node voltages
3. Write KCL equation for each unknown node
4. Solve set of equations



Nodal Analysis Example



Summary

- Voltage, Current, Power
- Electrical components
  - Resistors, potentiometer
  - Solar cells, batteries, …
- Ohm's law
- Kirchhoff's laws
  - KVL
  - KCL
- Circuit analysis: determine I, V, P, … using
  - KVL, KCL, (nodal analysis)
  - Component characteristics

Next Time

MicroPython & Circuits

= IoT Device!