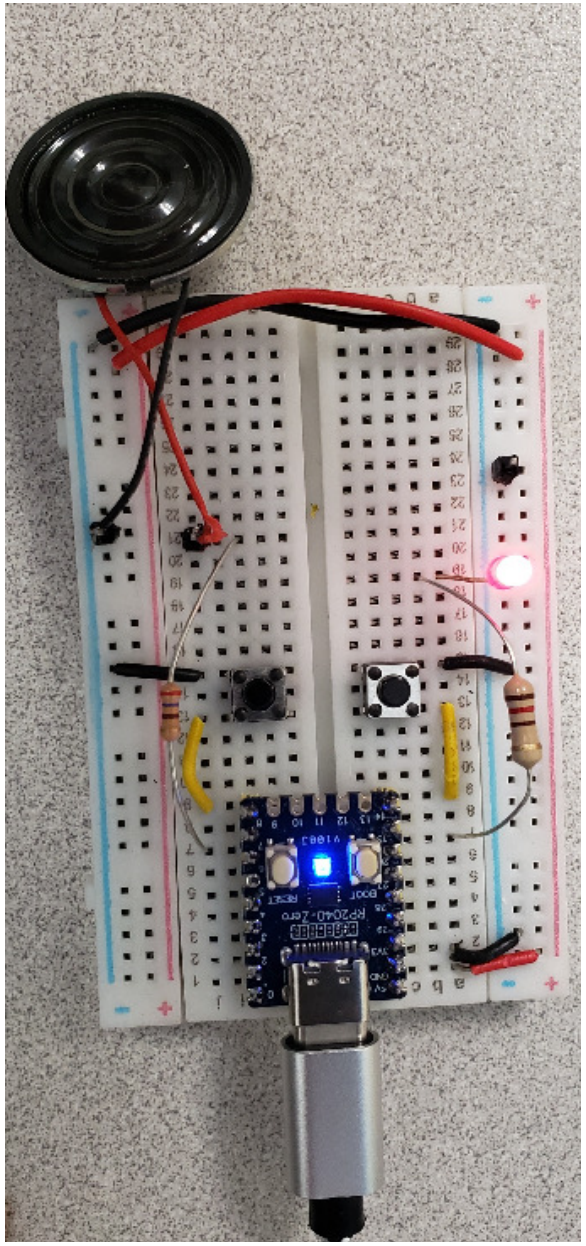
Lab Kit

ECE 211 Circuits I

Please visit Bison Academy for corresponding
lecture notes, homework sets, and solutions

Objective

- Why Circuits I has labs
- Familiarize you with the lab kit for Circuits I
- Use of breadboards
- Use of FNRSI multimeter
- https://www.bisonacademy.com/211_lab_kit.html



Why Does Circuits I Have Labs?

Several reasons

- Develop lab skills
  - Building circuits
  - Debugging circuits
  - You learn by doing
- Demonstrate that theory really works
  - We're not just pushing numbers
- Develop understanding
  - Lab is typically where a light goes off
  - "Now I get it" is a common response
- It's fun
  - You go into engineering because you want to build things
  - Only engineers get excited when a light blinks

Circuits I Lab Kit

Pick up in ECE room 201 (one per student)

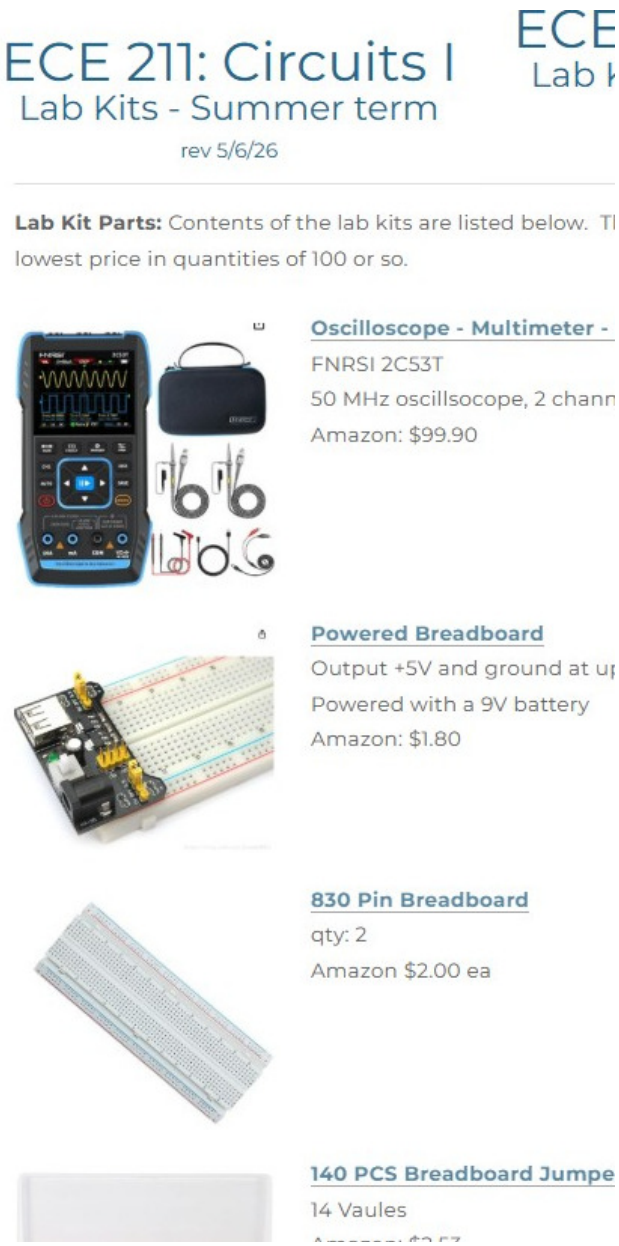
- Available May 1st
  - Can also mail to you
  - Send me your mailing address

FNRSI 2C53T

- Multimeter / Oscilloscope / Signal Generator

About $40 in parts

- Breadboards
- 9V rechargeable batteries
- 5V power supply
- Wires
- Resistors, Capacitors
- Stuff you'll use in Circuits I
  - and some stuff you'll use in other courses



FNRSI 2C53T - Volt Meter

Hold down MOVE button

- Enters multimeter mode

Arrow Right (V)

- Check the voltage of your 9V battery

AC/DC

- Click on MOVE to alternate
- AC voltage (rms)
- DC voltage (average)

FNRSI 2C53T - Ohm Meter

Hold down MOVE button

- Enter multimeter mode

Arrows left/right to Ohms

- Enters Ohm-meter mode

Measure the resistance

- Photo-resistor
  - R varies with light
- Thermistor
  - R varies with temeperature
- Cold water
  - Pure water is an insulator
- Resistors in your kit
  - Mostly fixed values
  - Vary slightly with temperature

FNRSI 2C53T - Capacitance Meter

Hold down MOVE button

- Enter multimeter mode

Arrows left/right to -| |-

- Enters Capacitance mode

Measure the capacitance

- Capacitors in your kit
- Circuit board traces
- Stuff you find around the house

FNRSI 2C53T - Ammeter

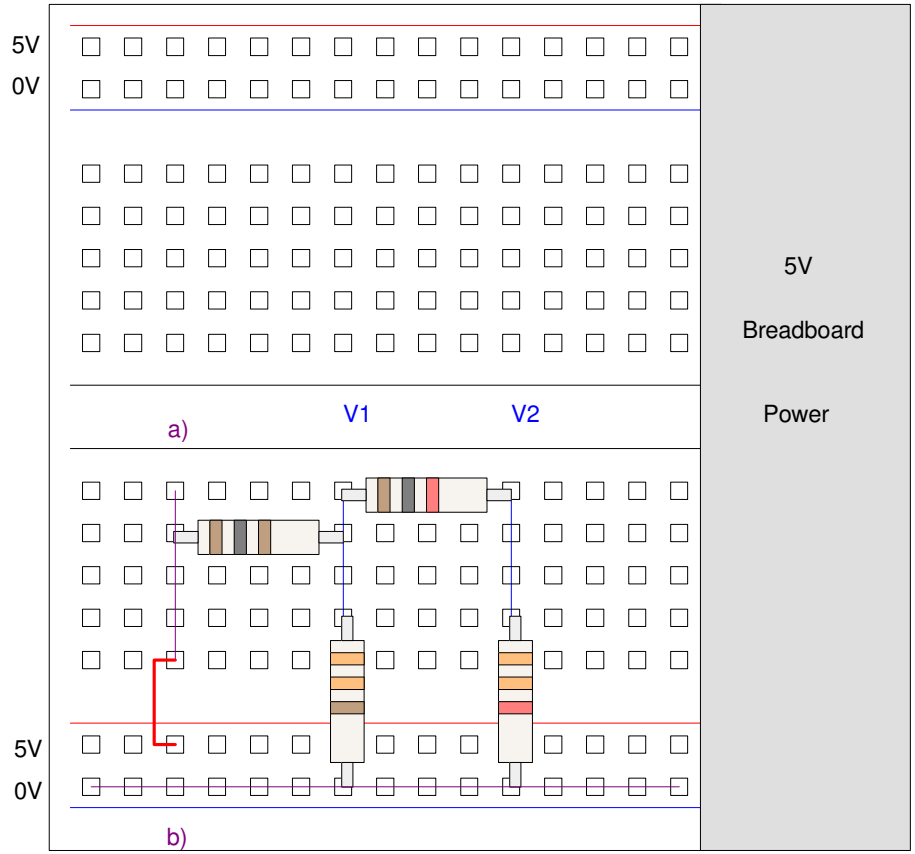
Works when meter is new

- Fuse is usually blown after first use
- Ammeters almost always have blown fuses

To measure current

- Measure the voltage a known resistor
  - Voltage across 100 Ohm resistor
  - brown - black - orange
- Compute the current

$$I = \left(\frac{V}{R}\right)$$



Breadboard

You kit also has some breadboards

- Used to build electric circuits

Groups of pins are tied together

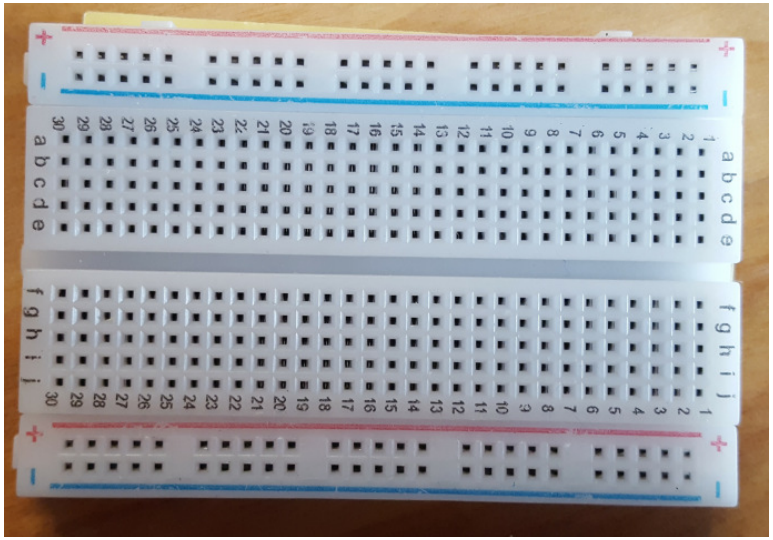
- Lets you connect several items together

Top & Bottom rows (red & blue)

- Shorted left and right
- Intended use is +5V (red) and ground (blue)

Middle pins are shorted up/down

- 5 pins connected together

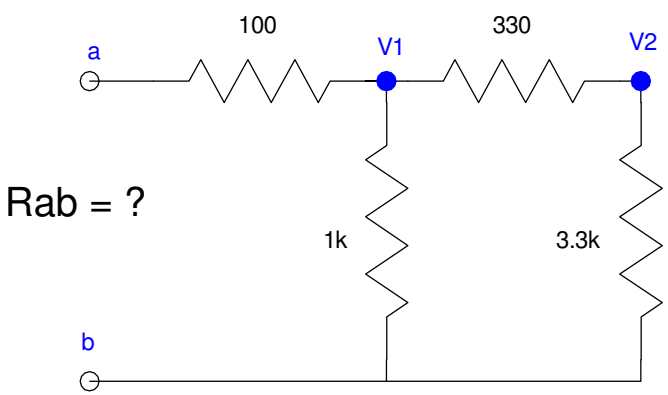


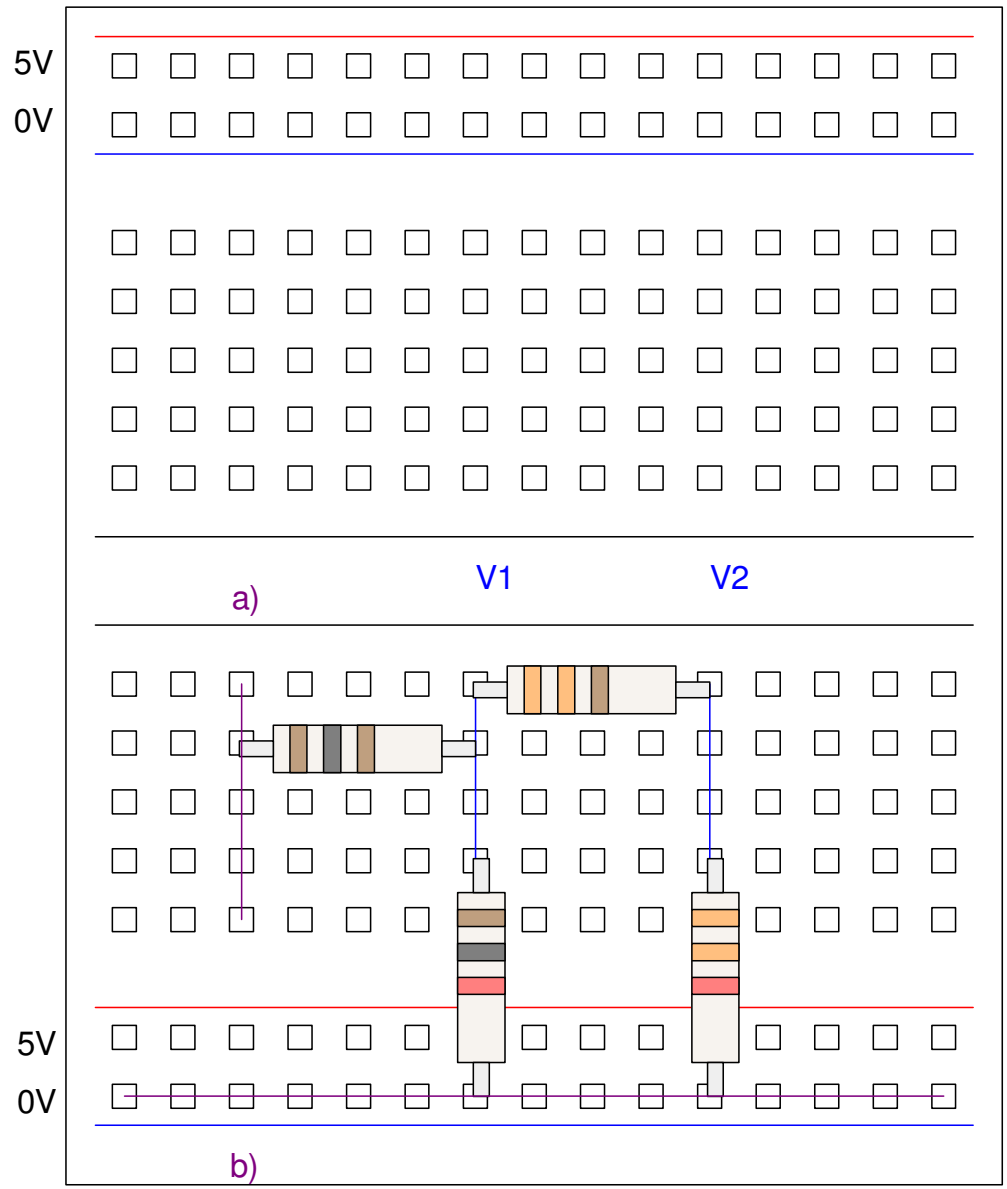
Breadboard Example

Find the resistance Rab

- 100 = brown - black - brown
- 330 = orange - orange - brown
- 1k = brown - black - red
- 3.3k = orange - orange - red

Measure the resistance from a) to b)





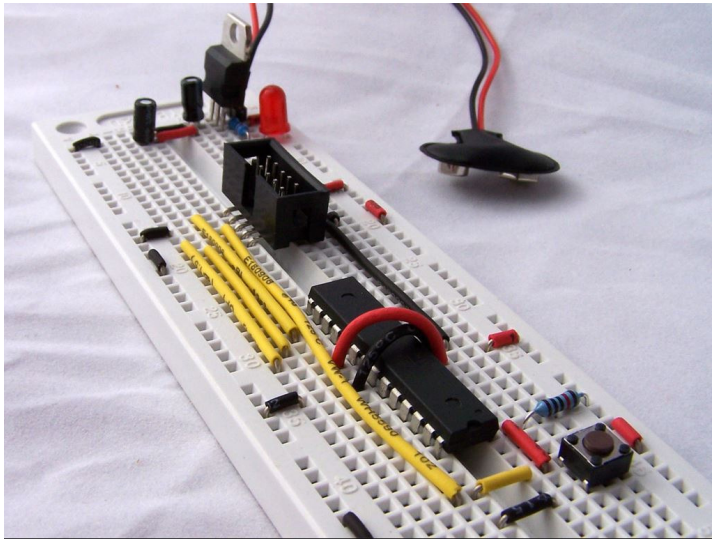
Breadboard Tricks

Keep your circuit neat

Color code your wires

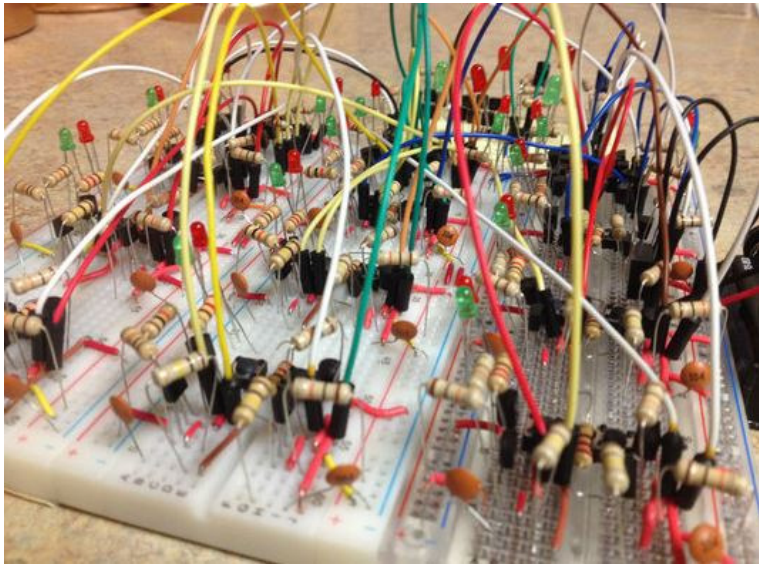
- Power = red
- Ground = black

Keep wires short



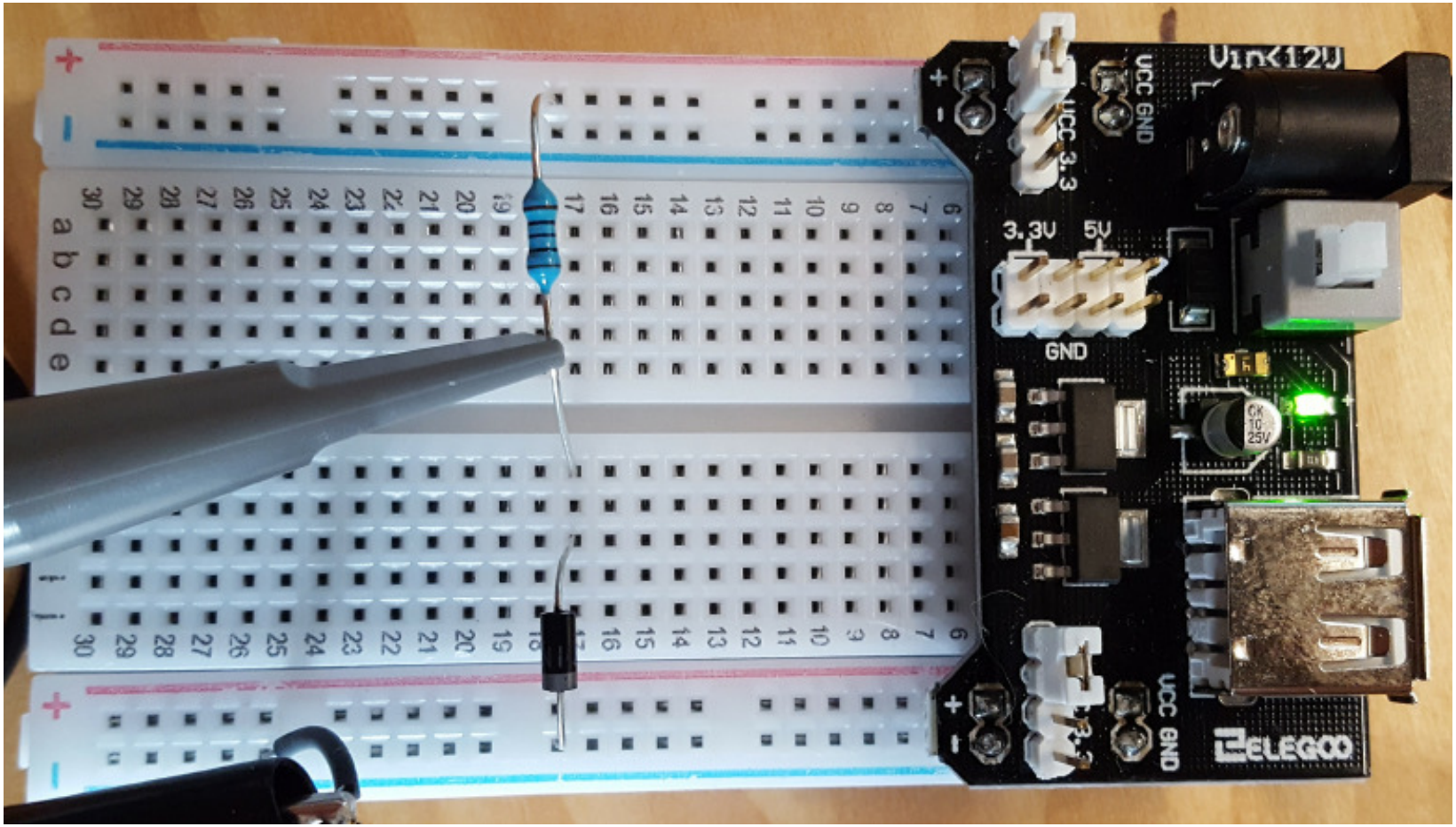
If your circuit still doesn't work

- Take apart your circuit
- Start over



Powered Breadboard

- +5V (red)
- 0V (blue)



FNRSI Signal Generator

Hold down TRIGGER

- Enters the signal generator mode

Output

- Top right BNC connector
- Use direct connection probe
- 0V to 3V, up to 10mA

Arrow up & down

- Sine - square - sawtooth...

Blue (enter)

- Change the frequency
- Change the amplitude

Example

- Sine wave - 100Hz - 1Vpp

Measuring a 100Hz Sine Wave

Multimeter converts the signal to a number

DC Voltage

- DC measures the average
- Tap MOVE to swap between AC and DC

AC Voltage

- AC measures the ripple
- Vpp: peak-to-peak (max to min)
- Vp: center to peak
- **Vrms: Equivalent DC voltage**
  - What FNRSI displays

$$V_{rms} \approx \frac{V_{pp}}{2\sqrt{2}}$$

Measuring a 100Hz Sine Wave

- take 2

Use an oscilloscope

- Displays the waveform as an image
- A *lot* more informative than a number

The waveform shows you

- It's a sine wave
- There's no clipping
- There's no distortion

Oscilloscopes are your friend

- If you can't figure out what's happening with your circuit, display the waveforms on an oscilloscope
- They *really* help you figure out what's happening in a circuit

FNRSI Oscilloscope

Hold down SELECT button

- Enter the oscilloscope mode
- Signal generator remains on

Connect oscilloscope probe to BNC

- Ch1 = top left
- Ch2 = center

Measure something

- 100Hz sine wave shown here

Oscilloscope Options

Press PRM

- Allows you to turn on & off different measurements

Oscilloscope Options

Press SELECT

- Right Arrow (yellow):
  - U/D: shift display up/down
  - L/R: shift display left/right
- Left Arrow (green)
  - U/D change the trigger level
  - L/R shift the display left/right
- V (yellow)
  - U/D: change volts/div
  - L/R: change ms/div

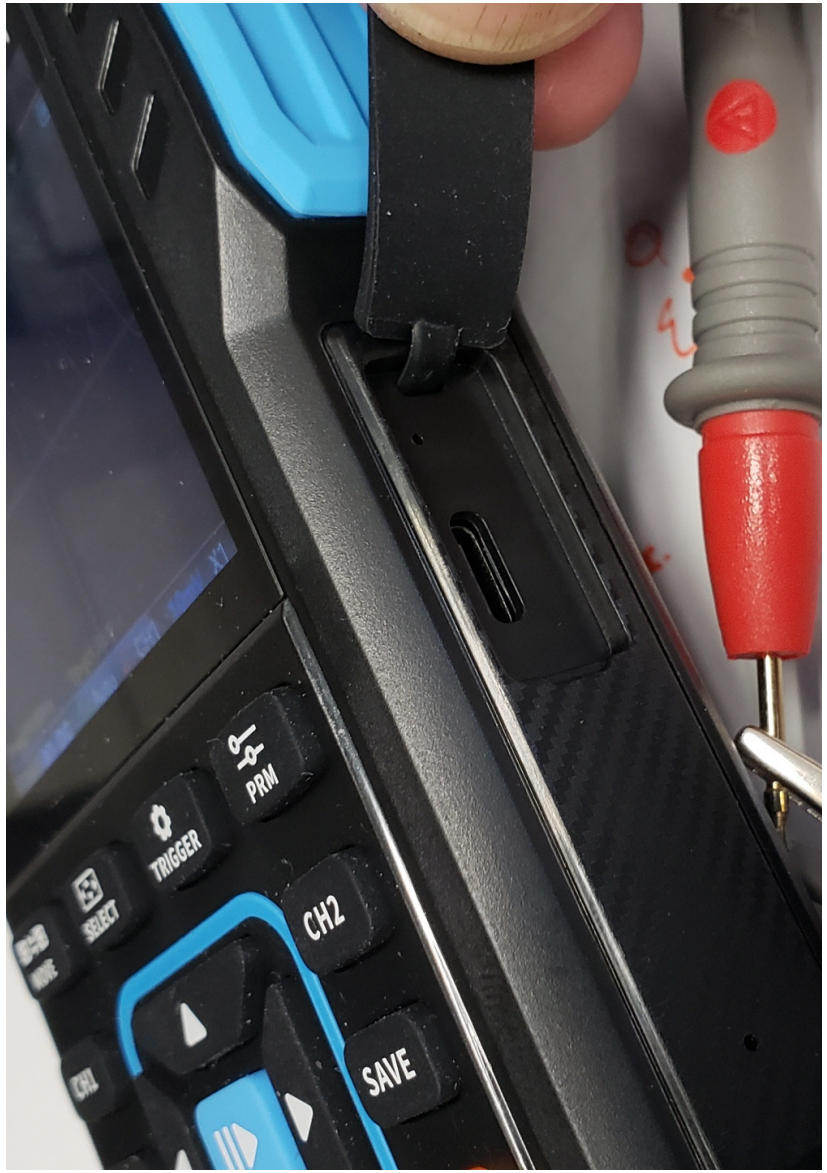
FNRSI: USB-C Rechargeable

If your battery runs low, connect to a USB-C cable

- include in your lab kit

9V batteries are also rechargeable

- USB-C cable



Labs as Part of Homework

Most homework sets will have

- Analysis
- Simulation in CircuitLab
- Lab section

Lab: build one of the circuits you analyzed

- Include a photo of your breadboard circuit

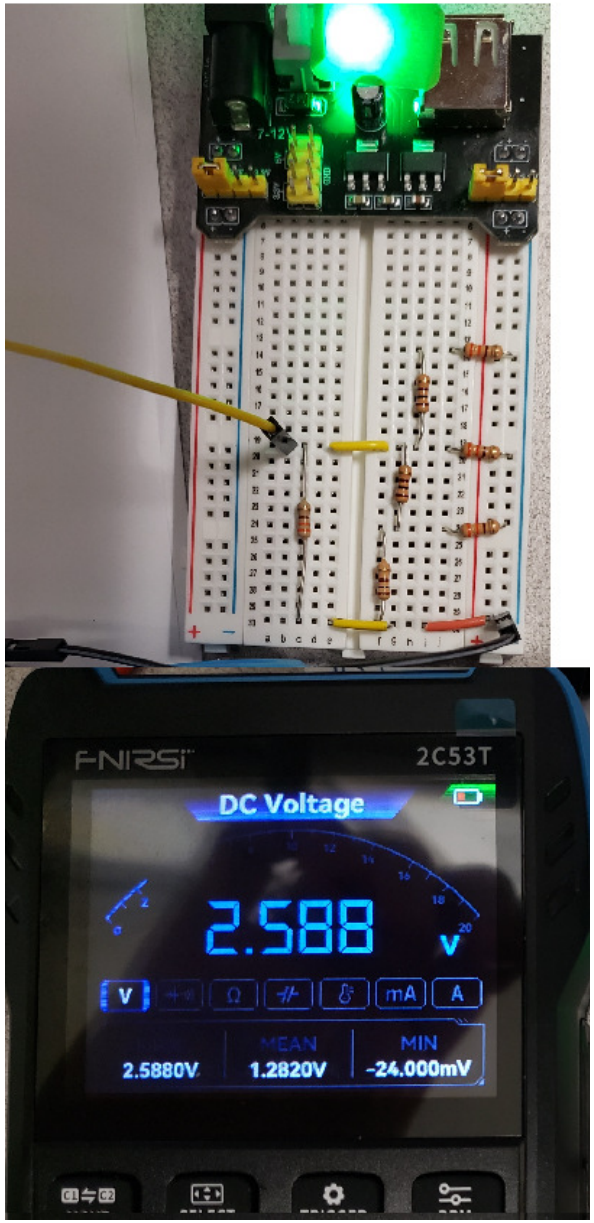
Take measurements

- FNRSI meter

Compare

- Calculations
- Simulation results
- Lab results

They should all be close



Summary

The lab kit should have most of what you'll need for Circuits I

- Also contains parts for Electronics and Senior Design I
  - A few part won't be used in Circuits I
  - Common lab kit makes inventory control easier

The FNRSI meter is a pretty nice tool

- Multimeter
- Oscilloscope
- Signal Generator

It's going to be useful in this class

- And others to follow

It has a learning curve, though

- Pretty friendly - shouldn't be too hard