Semester Outline

- Imaging Module
- Touchscreen Module
- Acoustic Positioning Module
Why Imaging?

- Use linear algebra techniques to capture real world images with limited sensors
- Today:
  - Finding a link between physical quantities and voltage
  - If you can digitize it, you can do anything (IOT devices, internet, code, processing)
Today’s Lab: Imaging Part 1

● You’ll receive lab kit materials after completing part 1 of today’s lab (TI MSP430F5529 + lab kit)
  ○ You must bring your kit to each subsequent lab

● Circuits + Breadboarding 101

● Build circuit that reacts to light intensity
  ○ Use Launchpad (+ Oscilloscope) to see how the circuit behaves

● Graded checkoff starts today!
Our circuit
A Little Physics: Voltage, Current, and Resistors

- **Voltage [Volts]** - pushes charge through circuit
- **Current [Amps]** - flow of charge through circuit
  - 1 Amp = 1 charge per second
- **Resistor [Ohms]** - circuit component that resists the flow of charge through circuit
Simple Circuit: The Tools™

- Components
  - Resistors
  - Capacitors
  - Voltage Source
- Wires / Jumpers [pin-to-pin vs pin-to-socket]
What’s in your circuit? : Resistors
What’s on your circuit? : Resistors

<table>
<thead>
<tr>
<th>COLOR</th>
<th>1ST BAND</th>
<th>2ND BAND</th>
<th>MULTIPLIER</th>
<th>TOLERANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLACK</td>
<td>0</td>
<td>0</td>
<td>x1Ω</td>
<td>±1%</td>
</tr>
<tr>
<td>BROWN</td>
<td>1</td>
<td>1</td>
<td>x10Ω</td>
<td>±1%</td>
</tr>
<tr>
<td>RED</td>
<td>2</td>
<td>2</td>
<td>x100Ω</td>
<td>±2%</td>
</tr>
<tr>
<td>ORANGE</td>
<td>3</td>
<td>3</td>
<td>x1000Ω</td>
<td>±2%</td>
</tr>
<tr>
<td>YELLOW</td>
<td>4</td>
<td>4</td>
<td>x10000Ω</td>
<td>±0.5%</td>
</tr>
<tr>
<td>GREEN</td>
<td>5</td>
<td>5</td>
<td>x100000Ω</td>
<td>±0.5%</td>
</tr>
<tr>
<td>BLUE</td>
<td>6</td>
<td>6</td>
<td>x1000000Ω</td>
<td>±0.25</td>
</tr>
<tr>
<td>VIOLET</td>
<td>7</td>
<td>7</td>
<td>x10000000Ω</td>
<td>±0.10</td>
</tr>
<tr>
<td>GREY</td>
<td>8</td>
<td>8</td>
<td></td>
<td>±0.05</td>
</tr>
<tr>
<td>WHITE</td>
<td>9</td>
<td>9</td>
<td></td>
<td>±5%</td>
</tr>
<tr>
<td>GOLD</td>
<td>9</td>
<td>9</td>
<td>0.1</td>
<td>±5%</td>
</tr>
<tr>
<td>SILVER</td>
<td>9</td>
<td>9</td>
<td>0.01</td>
<td>±10%</td>
</tr>
</tbody>
</table>
Poll Time! What color is a 100 ohm resistor?

1. black-brown-red
2. brown-black-black-brown
3. brown-black-red
4. brown-black-black-black

<table>
<thead>
<tr>
<th>COLOR</th>
<th>1ST BAND</th>
<th>2ND BAND</th>
<th>MULTIPLIER</th>
<th>TOLERANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLACK</td>
<td>0</td>
<td>0</td>
<td>x1Ω</td>
<td>±1%</td>
</tr>
<tr>
<td>BROWN</td>
<td>1</td>
<td>1</td>
<td>x10Ω</td>
<td>±1%</td>
</tr>
<tr>
<td>RED</td>
<td>2</td>
<td>2</td>
<td>x100Ω</td>
<td>±2%</td>
</tr>
<tr>
<td>ORANGE</td>
<td>3</td>
<td>3</td>
<td>x1000Ω</td>
<td>±2%</td>
</tr>
<tr>
<td>YELLOW</td>
<td>4</td>
<td>4</td>
<td>x10000Ω</td>
<td>±0.5%</td>
</tr>
<tr>
<td>GREEN</td>
<td>5</td>
<td>5</td>
<td>x100000Ω</td>
<td>±0.25%</td>
</tr>
<tr>
<td>BLUE</td>
<td>6</td>
<td>6</td>
<td>x1000000Ω</td>
<td>±0.10%</td>
</tr>
<tr>
<td>VIOLET</td>
<td>7</td>
<td>7</td>
<td>x10000000Ω</td>
<td>±0.05%</td>
</tr>
<tr>
<td>GREY</td>
<td>8</td>
<td>8</td>
<td></td>
<td>±0.05%</td>
</tr>
<tr>
<td>WHITE</td>
<td>9</td>
<td>9</td>
<td></td>
<td>±0.05%</td>
</tr>
<tr>
<td>GOLD</td>
<td></td>
<td></td>
<td>0.1</td>
<td>±5%</td>
</tr>
<tr>
<td>SILVER</td>
<td></td>
<td></td>
<td>0.01</td>
<td>±10%</td>
</tr>
</tbody>
</table>
Poll Time! What color is a 100 ohm resistor?

1. black-brown-red
2. brown-black-black-brown
3. brown-black-red
4. brown-black-black-black
Poll Time! What color is a 100K resistor? (100 kilo-ohms, so 100,000 ohms)

1. brown-black-red
2. brown-black-black-brown
3. brown-black-yellow
4. brown-black-white
Poll Time! What color is a 100K resistor? (100 kilo-ohms, so 100,000 ohms)

1. brown-black-red
2. brown-black-brown
3. brown-black-yellow
4. brown-black-white
Light Emitting Diode (LED)

When a sufficient potential difference is placed across its terminals, the LED emits light!

Direction matters!
Ambient Light Sensor

It behaves like a resistor and the current passing through it depends on how much light there is around it!

Direction matters! **Note: Polarity is opposite LED’s**
Capacitors

They store your charge! Called capacitors because they have a set capacity (in Farads)
Wires/Jumpers

Pin End

Socket End

IMPORTANT: we use pin/socket terminology for wiring. You may encounter male/female in documentation or in industry.
IMPORTANT: Always keep current limited @ 0.1 A limit

PSU cables are hanging on back wall
We will be using the LaunchPad instead of the PSU as our voltage source. The 3V3 and GND pins on the LaunchPad are the + and - terminals of the voltage source respectively.
Simple Circuit: The Theory

- Components
- Nodes
  - Point in circuit where circuit elements meet
  - Wire between components are considered part of one node
- We know you don’t know much about circuits yet; we’ve given you very detailed instructions on how to build the circuit in the lab
Simple Circuit: The Theory™

- Components (Resistors, LEDs, Capacitors)
- Nodes
  - Point in circuit where circuit elements meet
  - Wire between components are considered part of one node

What components?  
How many nodes?  
Where are these nodes?
Simple Circuit: The Theory™

- Components (Resistors, LEDs, Capacitors)
- Nodes
  - Point in circuit where circuit elements meet
  - Wire between components are considered part of one node

What components?
**Voltage source, resistor**

How many nodes? **2**

Where are these nodes?
Simple Circuit: The Theory™

- Components (Resistors, LEDs, Capacitors)
- Nodes
  - Point in circuit where circuit elements meet
  - Wire between components are considered part of one node

What components?  
How many nodes?  
Where are these nodes?
Simple Circuit: The Theory™

- Components (Resistors, LEDs, Capacitors)
- Nodes
  - Point in circuit where circuit elements meet
  - Wire between components are considered part of one node

What components? **Same**

How many nodes? **3**

Where are these nodes?
Breadboard

Horizontal holes are linked together.

But not across the middle divider.
Breadboard
Breadboard Do’s and Don’t’s

How do we make this circuit?
Breadboard Do’s and Don’t’s

✓ Do plug component’s ends into two different rows - separate nodes
Breadboard Do’s and Don’t’s

✗ Do plug components across the gap in your breadboard - A-E and F-J are separate
Breadboard Do’s and Don’t’s

Is this okay? If there is an error, where?
Breadboard Do's and Don’t’s

✘ Do not plug both ends of component into the same row! This creates a short
Breadboarding Color Convention
Light-detecting Circuit
Why the Capacitor?

- The capacitor acts like a bucket of charge – if the input instantaneously increases or decreases, it’ll adjust the output flow to compensate.
- This results in reducing noise and curve smoothing!
FAQ

● Complete the lab in **PAIRS**, do ONE setup and notebook per group
● Speak to the staff if you do not have a partner and would like one
● **DON’T LEAVE/PACK UP YOUR CIRCUIT WITHOUT BEING CHECKED OFF FIRST**
FAQ

- Make sure current limit of power supply is set to 0.1A
- Turn PSU output off while building your circuit
- Keep voltage source leads from LaunchPad to breadboard disconnected while building your circuit
  - Socket ends can stay connected to the LaunchPad
- Probes are on the back wall
- Make sure you are using the correct resistors (Brown Black Yellow Gold for light sensor)
- Make sure your ambient light sensor is in the right direction
- Before leaving, please return the wires, power off your machines, and sign out of the computers
- If images in the notebook don’t show up, save your work and reopen the notebook
30 minutes left

- BOTH partners need to fill out the checkoff form for credit!