**Insert your names here**
IMPORTANT: LAB CAPACITY

- Only students enrolled in this lab section should be present here.

- If you lie about being enrolled in this section, you will be REMOVED from the course.
  - Please be ready to show either CalCentral enrollment or an email confirming a switch.
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 should have received lab materials (TI MSP430F5529 + lab kit)
- Circuits + Breadboarding 101
- Build circuit that reacts to light intensity
  - Use Launchpad/TinkerCAD to see how the circuit behaves
- Graded checkoff starts today!
- If you haven’t received your lab kit yet, you can still do today’s lab and get checked off
Today’s Lab: Imaging Part 1

- Hardware lab
  - Uses physical Launchpad and breadboard
  - All students with kits should do this option

- Software lab
  - Uses online circuit simulations in TinkerCad
  - Look at other group members’ physical setups and lab videos to get an idea of the hardware
  - All students without kits should do this option
Do not worry if you don’t get the Launchpad/Energia setup working today
  ○ Attend buffer section to get help with Energia issues
  ○ Can still get checked off for Imaging 1 today

Imaging 2 and 3 are software labs
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 [male-to-male vs male-to-female]
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>±0.25</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>±0.5%</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>±0.10</td>
</tr>
<tr>
<td>GOLD</td>
<td>0</td>
<td>0</td>
<td>0.1</td>
<td>±5%</td>
</tr>
<tr>
<td>SILVER</td>
<td>0.01</td>
<td>0.01</td>
<td></td>
<td>±10%</td>
</tr>
</tbody>
</table>
Poll Time! What color is a 100 ohm resistor?

<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>±2%</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>±1%</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>±5%</td>
</tr>
<tr>
<td>WHITE</td>
<td>9</td>
<td>9</td>
<td></td>
<td>±10%</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>

1. black-brown-red
2. brown-black-black-brown
3. brown-black-red
4. brown-black-black
Poll Time! What color is a 100 ohm resistor?

1. black-brown-red
2. brown-black-black
3. brown-black-red
4. brown-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>±0.5%</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></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 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
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
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!
Equipment for Today: Capacitors

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

Male End

Female End
Equipment for Today: Voltage Source

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? →

5V PWR
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?

5V PWR
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

3.3V

Ambient Light Sensor

100 kΩ

1 μF
How to get your lab kit (1 per student)

● After finishing ~20% of the lab you will reach the end of the “Obtaining a Lab Kit” section
● Call over a lab staff member and: (also described in lab notebook)
  ○ Show answers to PSU, Oscilloscope, and lab kit questions
  ○ Demonstrate how to use the equipment
  ○ Be able to name components in the lab kit
● Everything in kit (bag+Launchpad) is yours to keep but EACH STUDENT HAS TO BRING THEM BACK TO EVERY LAB
How to start

- Please use the station desktops for this lab
- If you need an instructional account, let us know
- Work in pairs
- This week’s lab is listed as “Imaging Lab 1”
- Make sure website says Spring 2020
FAQ

- Lab notebook link is on course website
- Check following slide for common Energia Install errors and possible fixes
- Keep voltage source leads from LaunchPad to breadboard disconnected whilst building your circuit
  - Female ends can stay connected to the LaunchPad
- **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**
- Complete the lab in **GROUPS OF 4** in your assigned breakout room
  - You must each build your own setup and answer all questions in your own notebook
- **DON’T LEAVE/PACK UP YOUR CIRCUIT WITHOUT BEING CHECKED OFF FIRST**
- Use the help queue and google checkoff form (linked in the lab)
  - lab.eecs16a.org
Common Energia Install Errors

- **Error:** The system cannot find the file specified
  - Fix: Manually update your board from version 1.0.6 to 1.0.7 (Tools --> Board --> Boards Manager --> Energia MSP430 Boards --> Update)

- **Error:** Serial monitor not displaying anything
  - Fix: select correct Baud rate in the serial monitor window (refer to lab notebook); press RST (reset) button on LaunchPad

- **Error:** Serial monitor displaying strange symbols
  - Fix: close serial monitor; reupload the code to the other COM port and open serial monitor again.

- **Error:** not detecting the launchpad as a launchpad (something like COM3 and COM4 show up)
  - Fix: if on Windows, make sure to install drivers [https://energia.nu/guide/install/windows/](https://energia.nu/guide/install/windows/)

- **Error:** If you have a space in your Windows username and you encounter an error when running the program, follow these instructions (courtesy of a 16B student’s Piazza post)
  - Energia stores some important stuff in this directory `C:\Users\First Last\AppData\Local\Energia15` - note: username has a space
  - Create the following directory structure: `C:\Users\First\AppData\Local`
  - Now copy the Energia15 folder from your actual home directory into the local folder in your firstname only user home directory.