

# **Introduction to MEAM510**

# **Design of Mechatronic Systems**

## **2021C**

**Professor:** Mark Yim

**TAs:** Greg Campbell, Will Yang,  
Andreas Alexandrou, Zac Gong,  
Brian Grimaldi, Ryan Jurewicz, Sheil  
Sarda, Lilian Stoesser, Zhenyu Wang

# Topics for Today

- Class logistics
  - Teaching Staff
  - Academic Integrity
- Basic Electronics
  - Voltage and Current
  - Resistors
  - Capacitors
- First homework/lab due next Wed - on canvas.

# History of MEAM 510

## Teacher

2005-2006: Yim

2007: Yim and Fiene

2008-2015: Fiene

2016: Fiene (Stegall)

**2017: Yim and Stegall**

**2018: Yim and Stegall**

**2019: Yim**

**2021a: Yim**

**2021c: Yim**

## Microprocessor

Nanocore (9S12)

TI MSP430

MAEVARM M2 (Atmega32)

MAEVARM M2 (Atmega32)

**Teensy(Atmega32)+ESP8266**

**Teensy + NodeMCU(ESP32)**

**Teensy + NodeMCU(ESP32)**

**Teensy + PicoKit(ESP32)**

**Teensy + PicoKit(ESP32)**

# Goal for students in MEAM 510

- Introduce mechatronics design
  - Give you skills to build electro-mechanical devices.
  - Give you understanding of electromechanical elements.
  - Give you something for your resume/portfolio



Picture borrowed From Justin Chang

# What is MEAM510?

- Electro-mechanical systems
  - Sensors
  - Actuators
  - Intelligent control
- Lab-based class
  - Most learning happens in lab
  - Four labs -> build to **one final project**

# Class Logistics + Recitation

- All slides will be posted on Canvas for your reference.
- All class lectures will be recorded and available from canvas.
- Labs will be submitted to Canvas
- Lectures will be interactive (these will affect grades, if you miss class you can submit this material later).
- We will use Piazza extensively. Look for help or announcements there first.
- **Recitation Friday at 3:30PM**

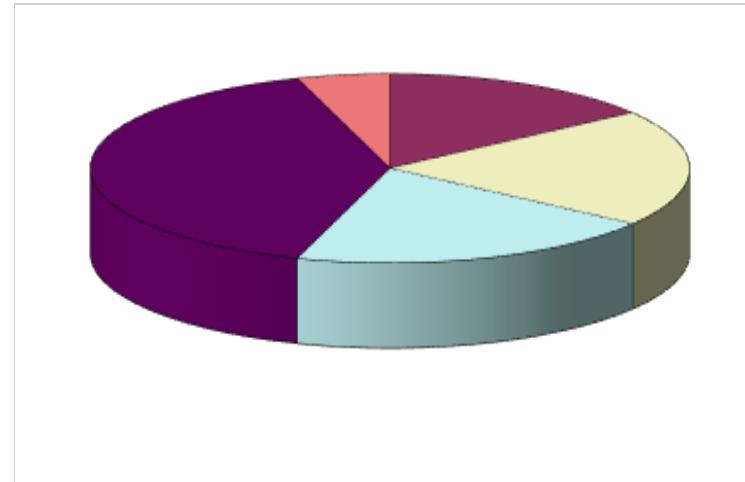
# Labs and Project

Lab 0	1 wk 5%
Lab 1	2 wk 10%
Lab 2	2 wk 10%
Lab 3	2 wk 15%
Lab 4	4 wk 20%
Final Project	5 wk 30%
Other:	10%

Quizzes/Homeworks  
Class participation  
Returning equip etc.

## Late Policy:

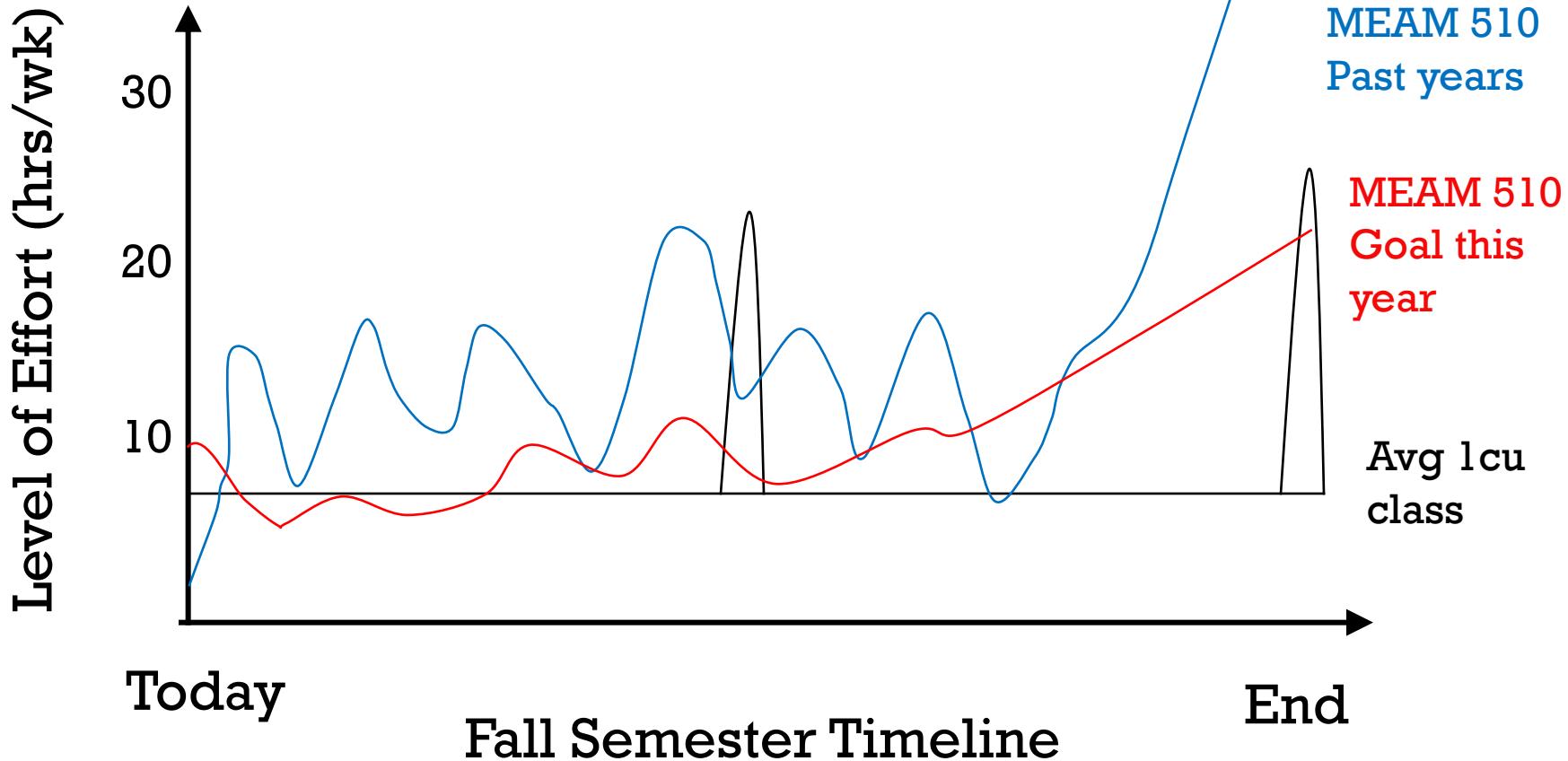
Late submissions lose 3% per day



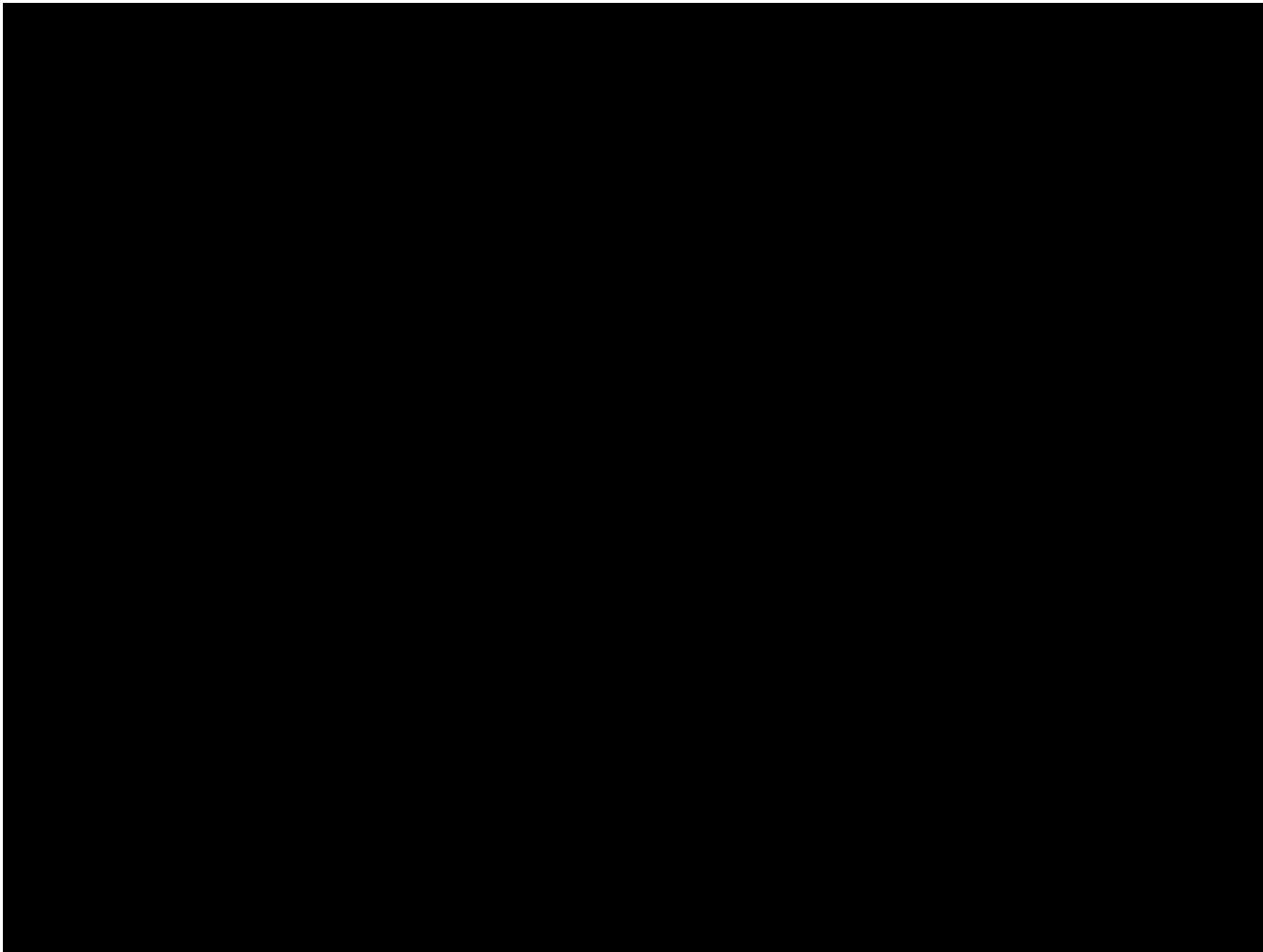
# Late Policy and COVID issues

- All students receive 5 free late days before 3% penalty accrues.
- May obtain extra late days from:
  - Valid excuses reported on CAR  
<https://www.college.upenn.edu/course-absence-report>
  - Issues out of student control arise (e.g., lab access due to COVID, slow purchasing etc.).
  - Performance on some announced activities

# Expected effort/time distribution



# Previous years': Robot MOBA project



Something like a MOBA



# This year's final project: Grand Theft Autonomous

- Build robot players
- Robots play on teams
- Some internet teleoperation/some autonomous behaviours

# MEAM510 covers

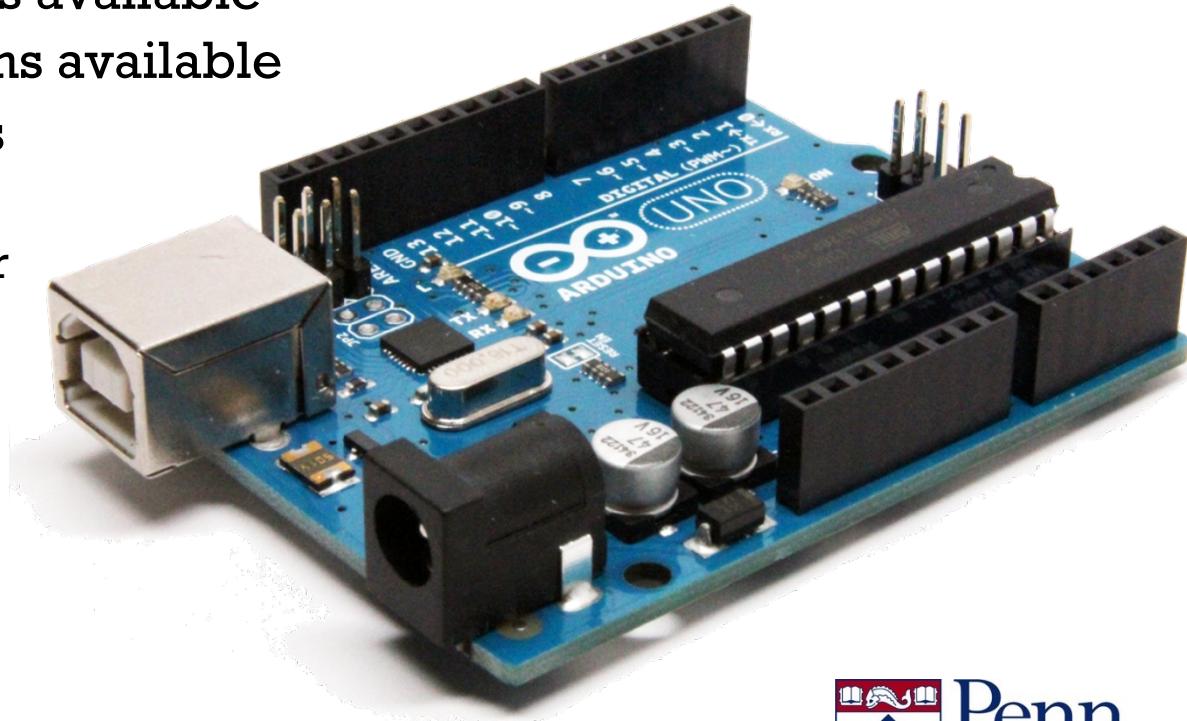
- **Electronics** – Major focus
  - Microcontrollers
  - OpAmps
  - Driving actuators
  - Communications (WiFi, Wired)
- **Software** – Major focus
  - Embedded programming techniques
  - Autonomous behavior level programming
- **Mechanical** – Minor focus
  - Use of CAD,
  - Mounting motors etc.
- **Control** – Minor focus:
  - Some on PID control

# Resources

- **Electrical Prototyping:**
  - Protoboard with solidcore wire jumpers.
  - Soldering
  - Optional Text: Horowitz and Hill (H&H) *Art of Electronics* 3<sup>rd</sup> ed.
- **Mechanical Prototyping:**
  - Laser cutting and 3D printing – you will have small allocation.
  - [meamlabs.seas.upenn.edu/](http://meamlabs.seas.upenn.edu/)
- **Software:**
  - C (we use freely available software)
  - Arduino C++
- **MicroComputer:**
  - AVR Atmega 32 U4 board (Teensy)
  - ESP32 – Arduino
- **Project Budget:**
  - \$50-80 to spend purchasing items

# MEAM510 vs Arduino projects

- Great for seeing what is possible with mechatronics
- Pros:
  - Thousands of examples online
  - Software libraries available
  - Hardware add-ons available
  - Sensor examples
    - » Touch sensor
    - » Rotation sensor
    - » Light Sensor
  - Actuators
    - » Displays
    - » Audio
    - » Motors
    - » Servos



# MEAM510 vs Arduino projects

- Great for seeing what is possible with mechatronics
- **Cons:**

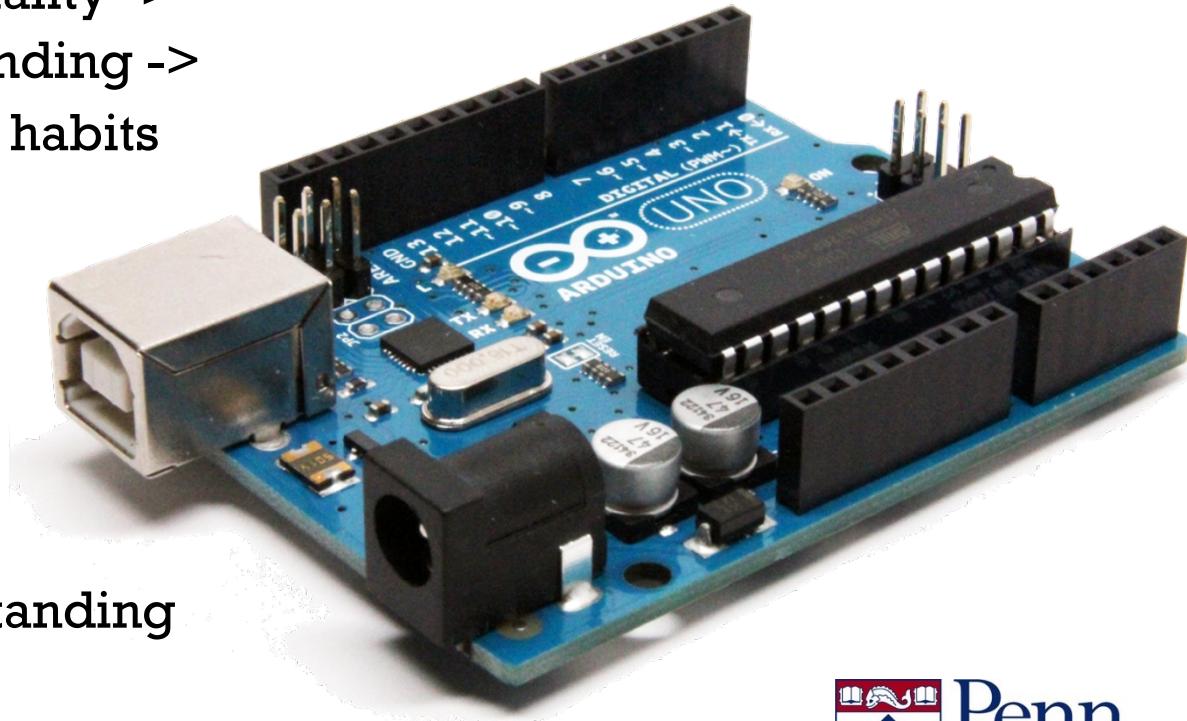
Easy to hack solutions -> (may lead to...)

- Cut & Paste mentality ->
- Lack of understanding ->
- Bad engineering habits

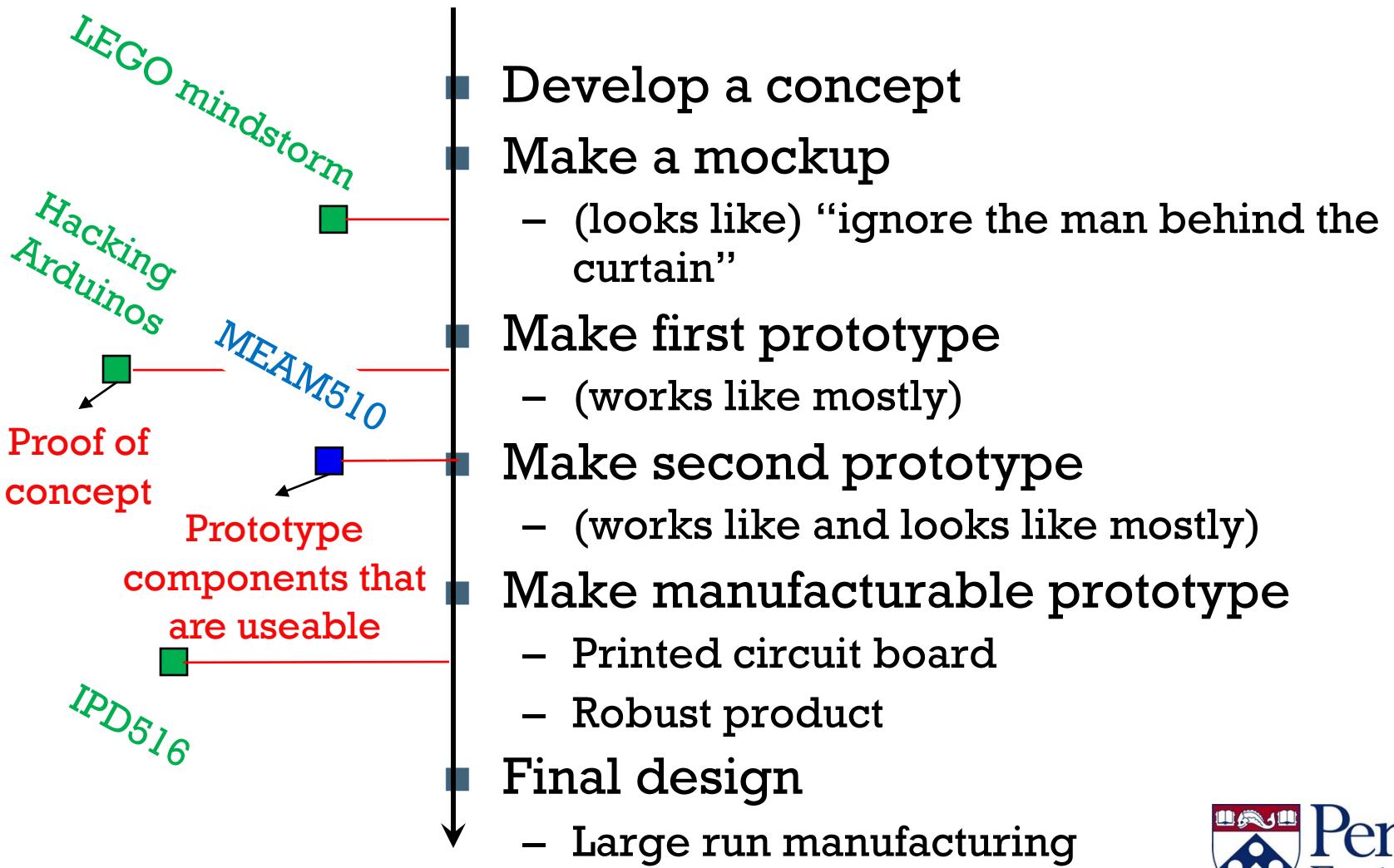
- **MEAM 510**

Teaches to:

- Create content
- Focus on understanding



# Electromechanical product design



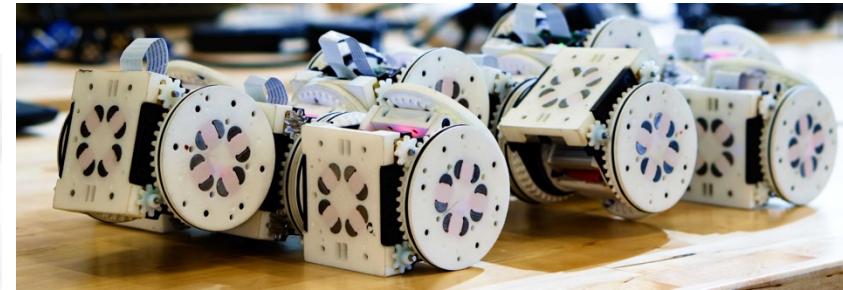
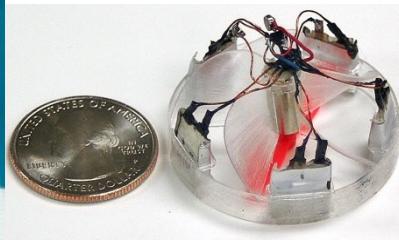
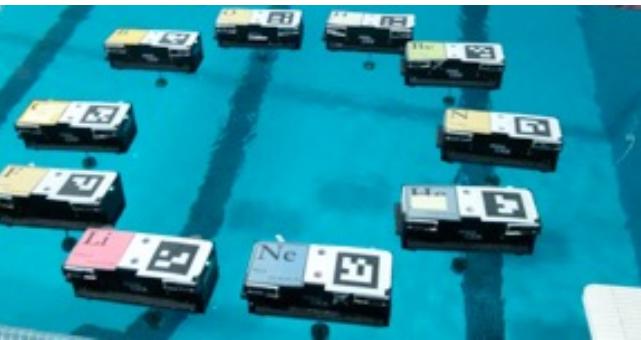
# Target Audience

- Typically, mechanical engineering.
- All should have had some structured programming (C++, Python, Java, Matlab etc.)
- Useful, but not critical:
  - CAD/prototyping (laser, 3D print, machining etc.)
  - Arduino experience
  - Control experience
- If you need 510 to satisfy curricular requirement but feel you have already had the material. Take a test to see if you can be waived out of the course – and take a replacement.

# About Mark Yim



- Professional
  - 17 years professor at Penn
  - 12 years in industrial research, (Xerox PARC)
  - Robotics research specialty
  - Faculty Director of GRASP, IPD, Design Studio @ Venture Labs
- Teaching
  - Spring: Advanced Mechatronics (IPD516)
  - MEAM Junior Lab MEAM347, MEAM348
- Personal
  - Two sons, Penn Grads, one now at startup in SF Cal. The other postdoc at CMU.



# About the TA's

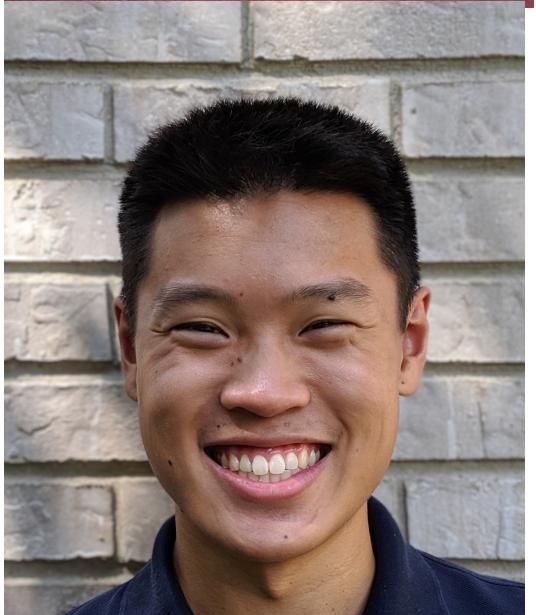
## ■ Greg Campbell (head TA)

- MEAM PhD, 3rd year, focus on soft robots
- Stanford ME218 A-C, 2014-2015
- BS ME from Villanova, MS ME from Stanford
- Worked as a Vehicle Engineer doing Accident Reconstruction for 3 years
- Interests: Board Games; Casual Team Sports; Video Games



## ■ Will Yang (2<sup>nd</sup> head TA)

- MEAM, 3rd year PhD
- Research on legged robots
- BS ME & CS from University of Michigan
- Interests: Board games and puzzles, soccer, cooking



# About the TA's



## ■ Lili Stoesser

- ROBO MSE Spring 2022
- MEAM BSE Spring 2021
- MEAM 510 Student Fall 2019
- MEAM 510 TA Spring 2021
- Interests: running, dancing, cooking, and biking



## ■ Zhenyu Wang

- MEAM 2<sup>nd</sup> year
- MEAM 510 Spring 2021
- Interests: work out, video games, movies

# About the TA's

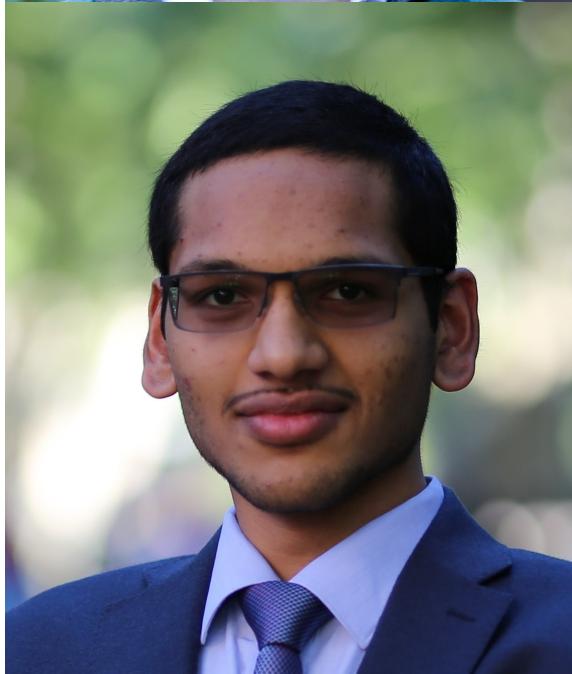
## ■ Andreas Alexandrou

- MEAM Senior, 2nd Major Philosophy
- MEAM510 Spring 2021
- Transfer from Northeastern University (2019)
- Interests: Soccer, Baking, Boxing



## ■ Sheil Sarda

- ROBO MSE Submat; UG: CS and Wharton
- From Philly suburbs (Bala Cynwyd, PA)
- MEAM510 Spring 2021 (2nd place)
- Interests: Formula 1, Surgical Robots



# About the TA's



## ■ Zac Gong

- MEAM Senior, Submat
- MEAM 510 Spring 2021
- Interests: Basketball, Volleyball, Hiking



## ■ Ryan Jurewicz

- Robotics Masters Student
- BSE in MEAM at Upenn 2021
- MEAM 510 Spring 2021
- Interests include augmented-reality games, nonograms, and the University of Pennsylvania Band

# About the TA's



## ■ Brian Grimaldi

- MEAM, 2nd year, Robotics concentration
- MEAM 510, Spring 2021
- Physics and Economics BA from Franklin & Marshall College
- Interests: Singing and musical instruments, video games, tennis, and cooking.

# GM Lab (Towne 193)

- Many hours spent in this lab.
- Most of the learning occurs here.
- NOTE: There are active cameras mounted in the room.
- It will get very crowded.



# COVID Statement

- Your actions affect others, including some that are at risk. Your awareness of, and adherence to, University COVID protocols are intended to protect everyone. Students are trusted to faithfully complete the check-in prior to any activity on campus, and follow the guidance in the app, in particular by not coming to class with a Red Pass. Masks are required for all indoor activities in this course. Again, our foremost obligation is to be thoughtful of the well-being of others.

# Canvas page

[Home](#)[Piazza](#)[Assignments](#)[Grades](#)[People](#)[Files](#)[Zoom](#)[Class Recordings](#)[Quizzes](#)[Search](#)

**MEAM-510 Class**

Today   Aug 29 – Sep 4, 2021 

[Week](#) [Month](#) [Agenda](#)

Sun 8/29	Mon 8/30	Tue 8/31	Wed 9/1	Thu 9/2	Fri 9/3	Sat 9/4
9am						
10am						
11am						
12pm				<b>12p – 1:30p Lecture</b>		
1pm					<b>1p – 3p Ryan OH</b>	<b>1p – 3p Will OH</b>
2pm						
3pm						
4pm					<b>3:30p – 4:30p Recitation</b>	
5pm						
6pm					<b>6p – 7p Will OH</b>	
7pm						
8pm						

Events shown in time zone: Eastern Time - New York [+ Google Calendar](#)

Sun 9/12

Mon 9/13

Tue 9/14

Wed 9/15

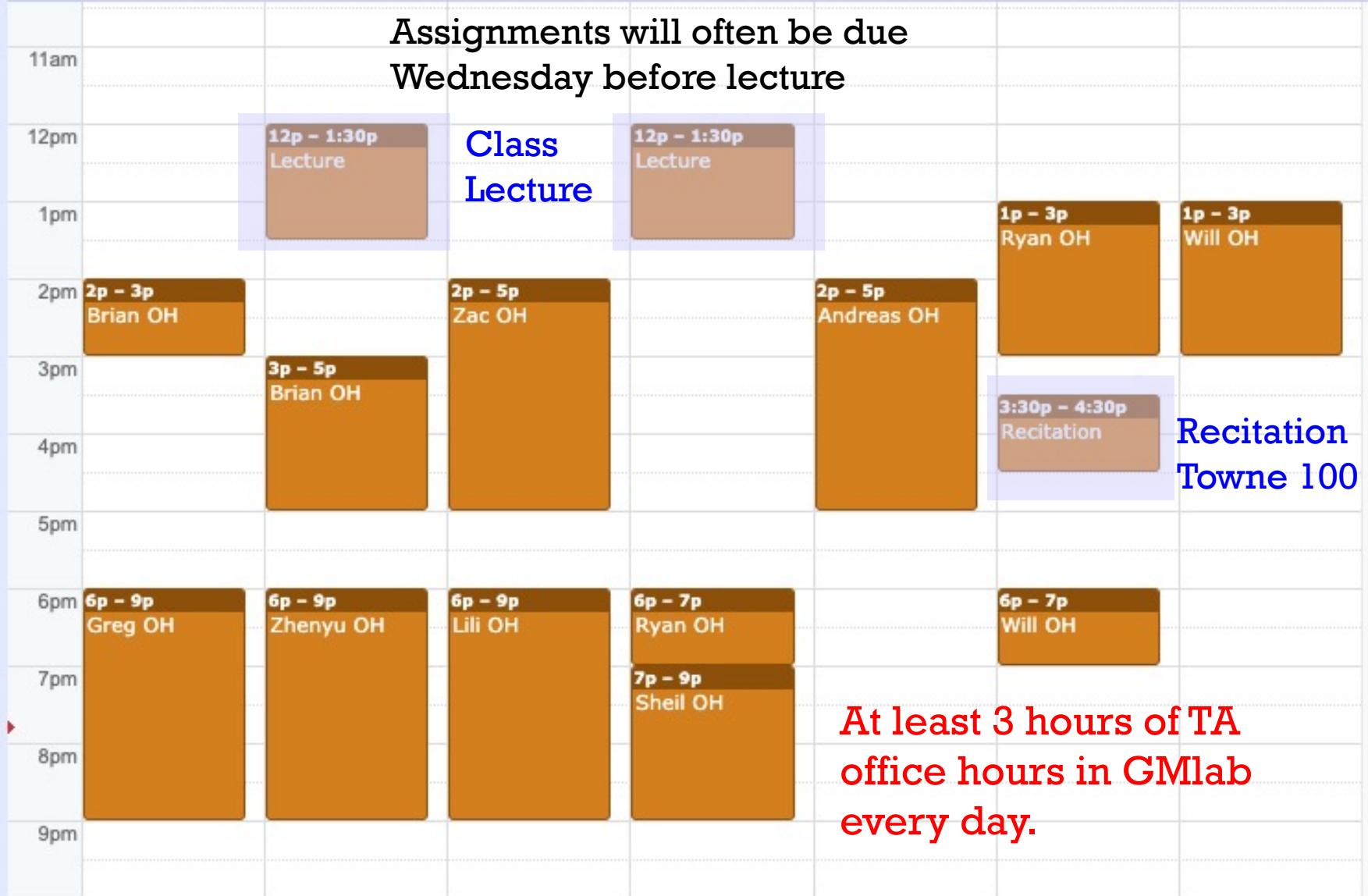
Thu 9/16

Fri 9/17

Sat 9/18

# Typical Week Google Calendar on Canvas

Assignments will often be due  
Wednesday before lecture



# Class Logistics + Recitation

- We will use Piazza extensively for announcements and questions. Look for answers there first.
- Slides are posted on Canvas (files->Lectures/)
- Some lectures will involve interactive material. Bring laptops/phone to class. Zoom chat used for grading.
- Class lectures will be recorded and available from canvas.

<https://upenn.zoom.us/j/93549031222?pwd=NGJ6ajdvWVpFNkxHZ01NWVM2QkhmUT09>

Meeting ID: 935 4903 1222

Passcode: gm1ab

- **Recitation Friday at 3:30PM in Towne 100.**

(This Friday will introduce equipment in the GM Lab)

# Course Philosophy

- Learn more by doing
- If you get stuck on something ask others in online forum. Ask TA's. Post to Piazza
- Helping others best way to make sure you know the material
- Every lab will include extra credit for those who help others the most!

# Code of Academic Integrity

1. **Collaborative work:** Please do!
  - a) Don't copy, but feel free to ask for and give help.
2. **Sources that can be consulted:**
  - a) Labs: internet, texts, etc. (don't copy work from previous years. **Chegg** and **Course Hero** should NOT be used).
  - b) Final Project work: Use anything and everything.
  - c) Quizzes: Nothing but your brain.
3. **Re-using work:** Explicit reference must be stated – consult prof if it is okay (e.g. using previous students code, using code found on the web).
4. **Penalties for Violations:**

Students who do not follow these guidelines will receive a lower grade or an incomplete.

Egregious violations will be reported to OSC.