

# **Introduction to MEAM510**

# **Design of Mechatronic Systems**

## **2021a**

**Professor:** Mark Yim

**TAs:** Walker Gosrich, Greg Campbell, Shaylin Marn, Shivam Dehinwal, Jorge Echeverria ,  
Geli Yang, Chenxi Ji, Kevin Chazotte, Kelly Babitz, Lilian Stoesser, Martin Yang, Malavika Manoj, Tony Qiu

# Topics for Today

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

# History of MEAM 510

Teacher	Microprocessor
2005-2006: Yim	Nanocore (9S12)
2007: Yim and Fiene	TI MSP430
2008-2015: Fiene	MAEVARM M2 (Atmega32)
2016: Fiene (Stegall)	MAEVARM M2 (Atmega32)
<b>2017: Yim and Stegall</b>	<b>Teensy(Atmega32)+ESP8266</b>
<b>2018: Yim and Stegall</b>	<b>Teensy(Atmega32)+ ESP32</b>
<b>2019: Yim</b>	<b>Teensy(Atmega32)+ ESP32</b>
<b>2021: Yim</b>	<b>Teensy(Atmega32)+ ESP32</b>

# 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, typically due on Wednesdays.
- Some lectures will involve interactive material (these will affect grades, if you miss class you can submit this material later).
- We will use Piazza extensively. Look for answers there first.
- **Recitation Friday at 3:00PM**

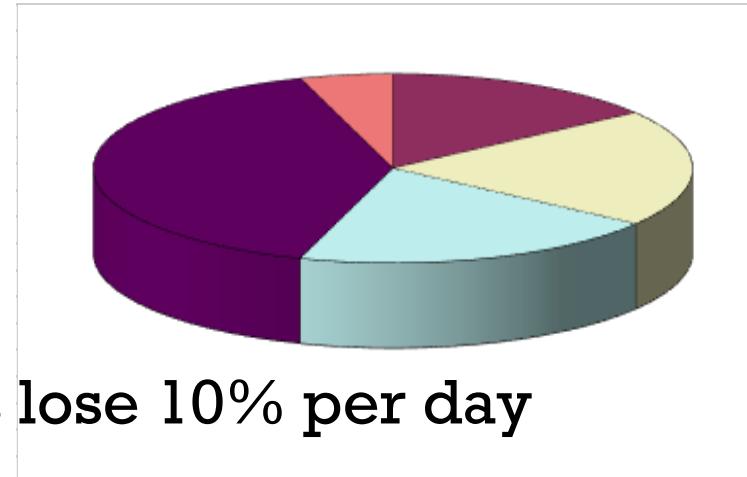
# Labs and Project

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%

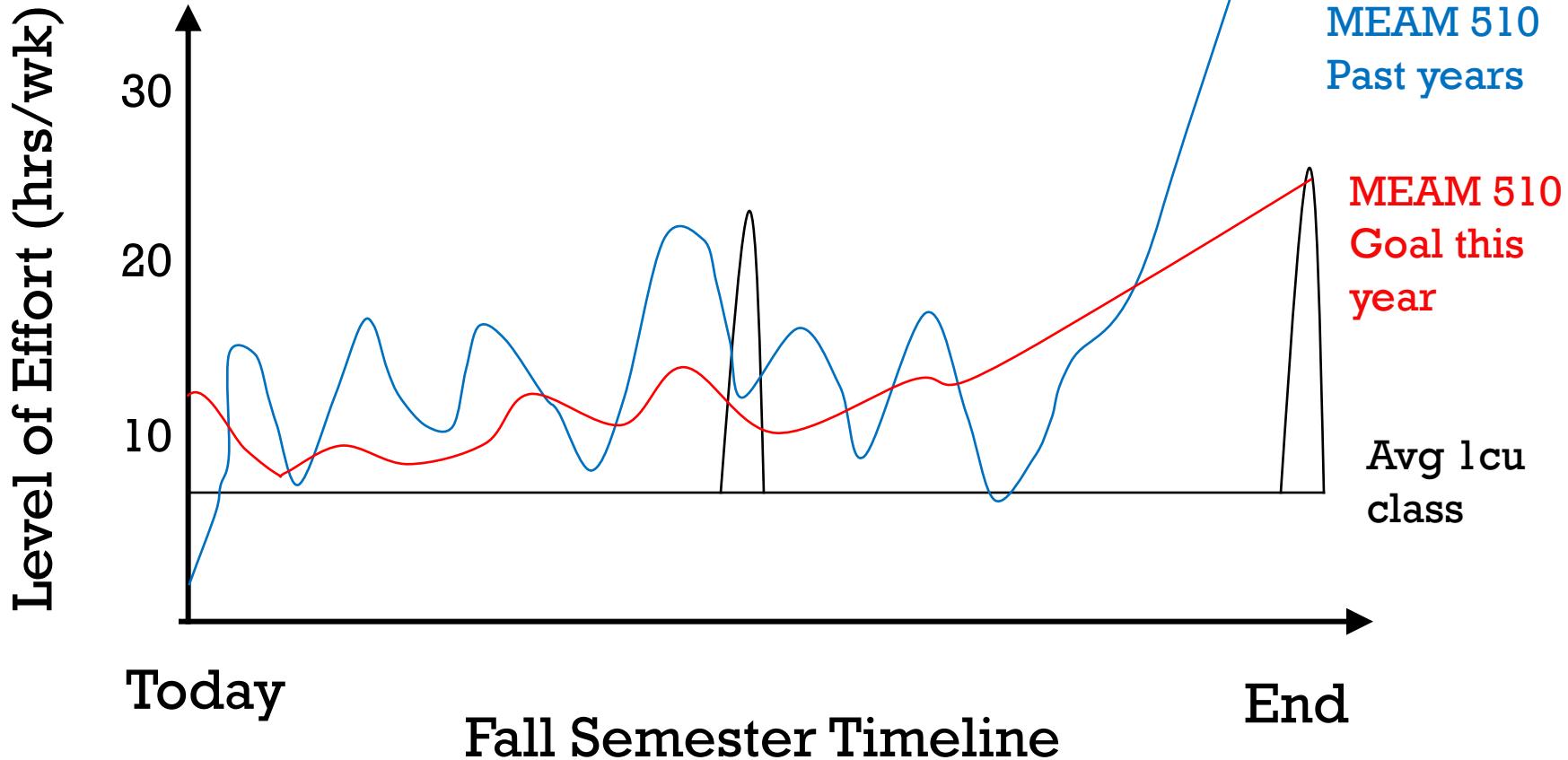
Quizzes/Homeworks  
Class participation  
Returning equip etc.

## Late Policy:

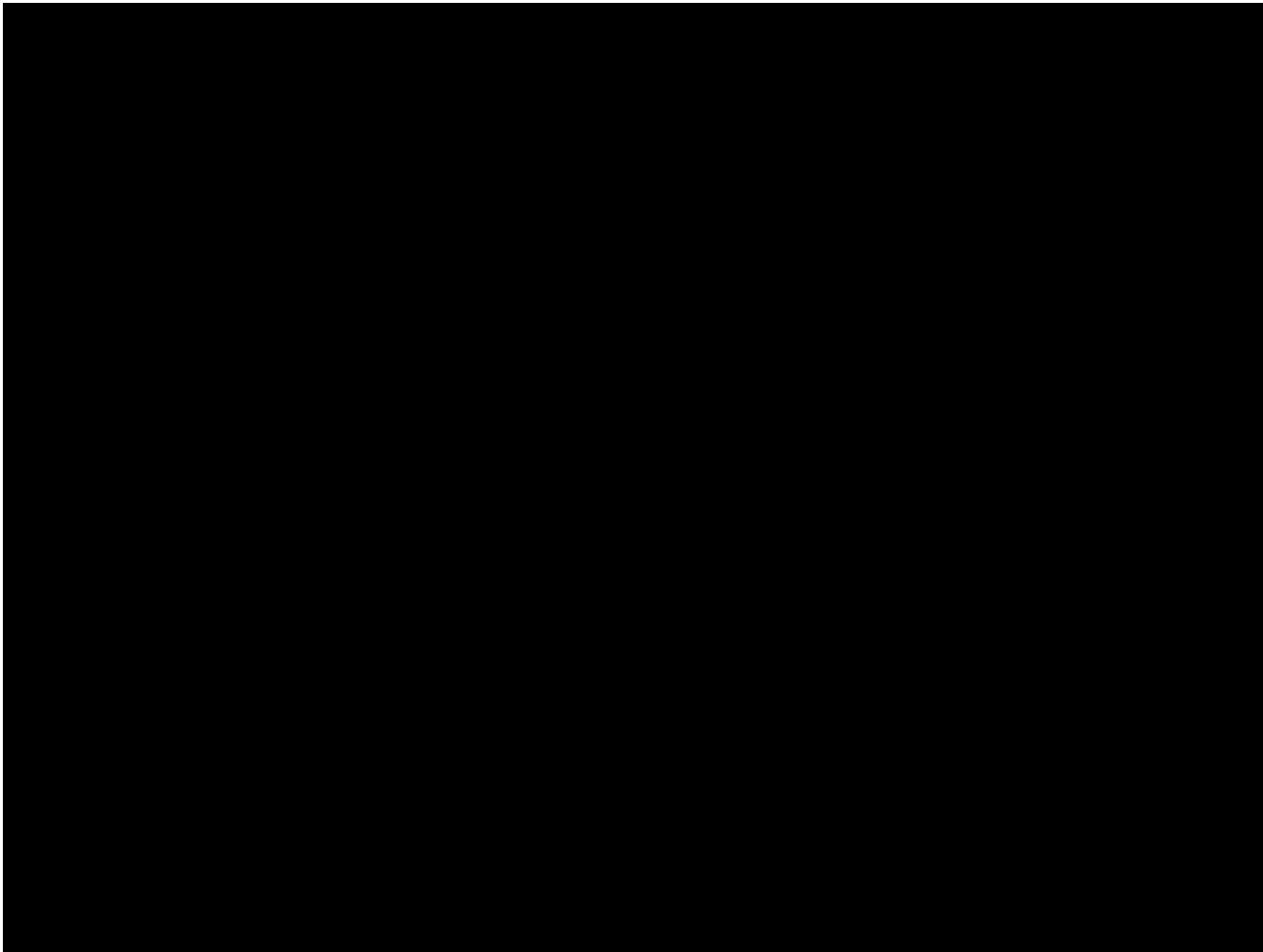
4 free late days – afterwards lose 10% per day



# Expected effort/time distribution



# Previous years': Robot MOBA project



Something like a MOBA



# This year's final project: Semi-Autonomous Capture the Flag

- Build Robot players
- WiFi control from home – teleoperation
  - Remote video transmission (zoom)
  - "autonomous zones"
- May have one or two players on a team
- Winning the game requires some autonomy

# 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:

- You design – TA's fabricate
- Laser cutting and 3D printing – you will have small allocation.
- [meamlabs.seas.upenn.edu/](http://meamlabs.seas.upenn.edu/)

## ■ Software:

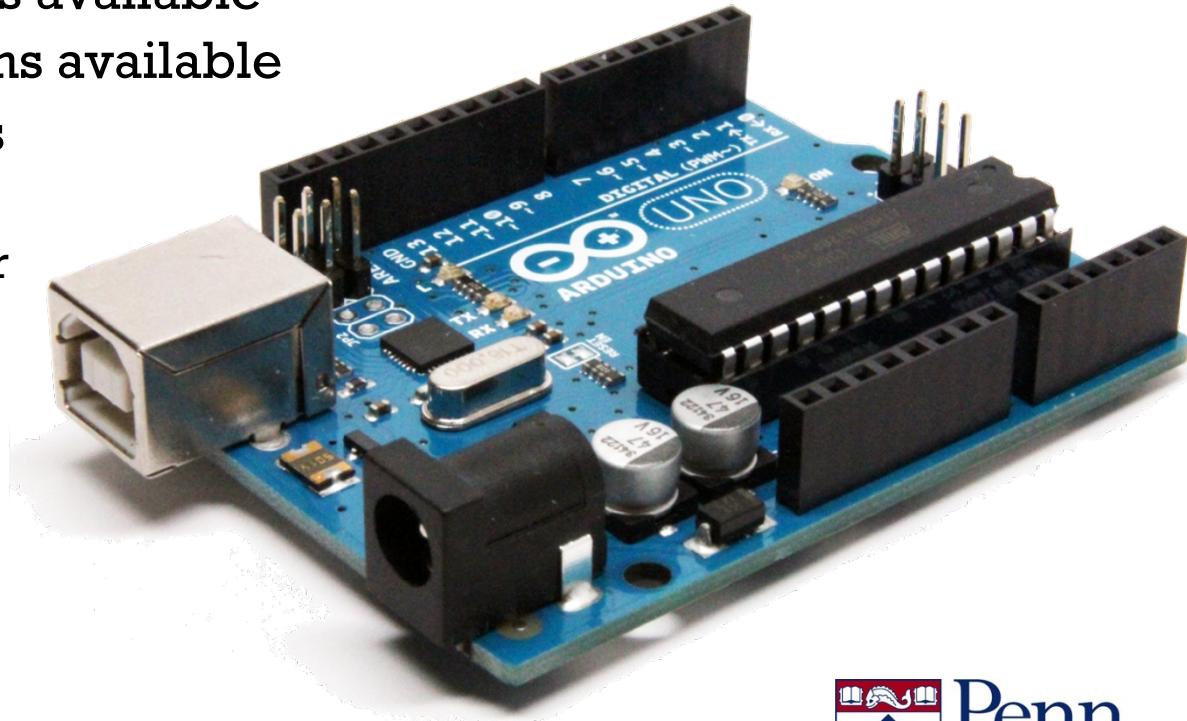
- C (we use freely available software)
- Some Arduino C++

## ■ MicroComputer:

- AVR Atmega 32 U4 board (Teensy)
- ESP32 - Arduino

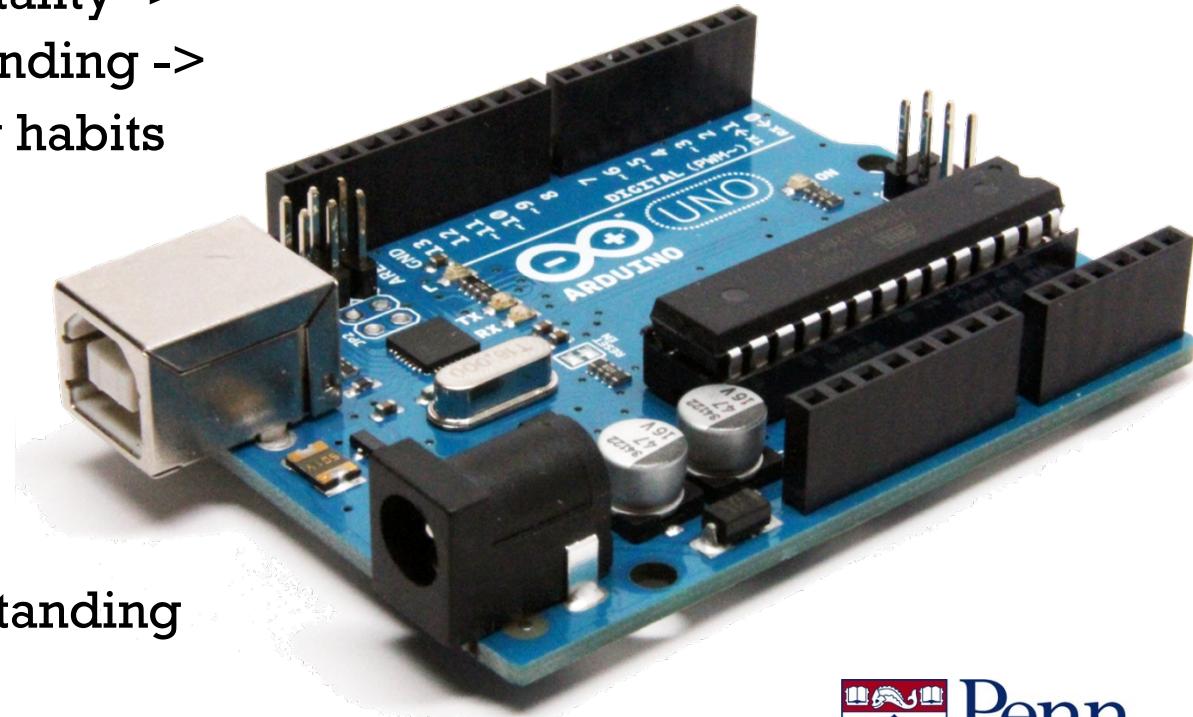
# MEAM510 vs Arduino projects

- 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

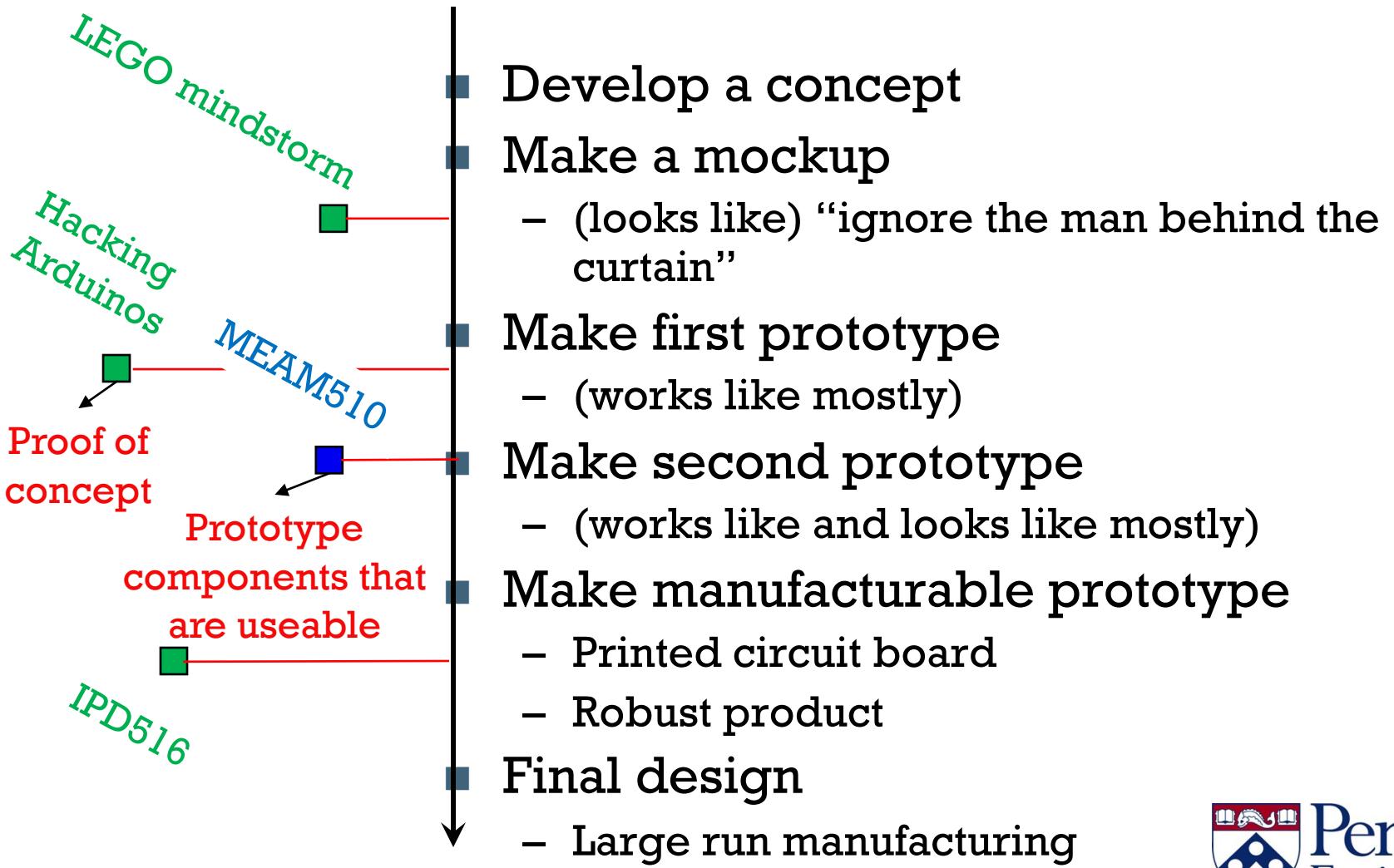


- **MEAM 510**

Teaches to:

- Create content
- Focus on understanding

# Electromechanical product design



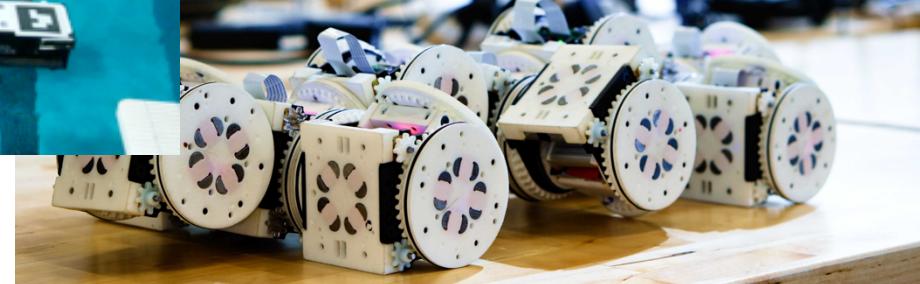
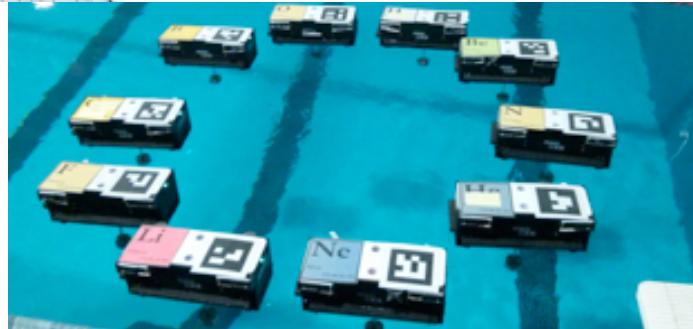
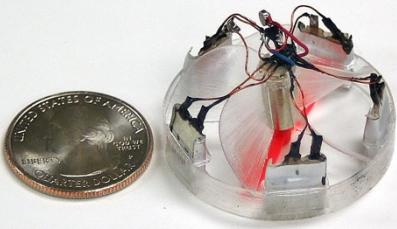
# Target Audience

- 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
  - 16 years professor at Penn
  - 12 years in industrial research, (Xerox PARC)
  - Robotics research specialty
  - Faculty Director of GRASP and IPD
- Teaching
  - Spring: Advanced Mechatronics (IPD516)
  - MEAM Junior Lab MEAM347, MEAM348
- Personal
  - Two sons, Penn Grads, now in SF California.



# About the TA's



## ■ Walker Gosrich

- MEAM PhD, 2nd year, focus on Robotics
- BS ME from University at Buffalo
- from upstate NY (almost Canada)
- Interests: Rock climbing, music making, all things outdoors

## ■ Greg Campbell

- MEAM, PhD Student, 2nd year
- Researching soft robotics
- 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 (pre-covid); Video Games





# About the TA's

## ■ Tony Qiu

- MEAM Senior, submat
- MEAM510 Fall 2018, was carried to 1st place
- MEAM510 TA Fall 2019
- Interests: Board Games, Ultimate Frisbee, Competitive Eating



## ■ Shaylin Marn

- Energy Data Analyst at Power & Systems Inspection Group Hawai‘i
- BSE in MEAM, Penn c/o 2020
- MEAM 510, Fall 2019
- Interests: gardening, hiking, sustainability

# About the TA's



## ■ Lili Stoesser

- MEAM Senior, ROBO submat
- MEAM 510 Fall 2019
- Interests: Dancing, running, sewing, and cooking!



## ■ Malavika Manoj

- MSE Robotics, 2nd year
- MEAM510, Fall 2019
- BE Instrumentation
- Interests: Cooking, dancing

# About the TA's



## ■ Martin (Woohyeok) Yang

- MEAM 2<sup>nd</sup> year, Robotics Concentration
- MEAM510, Fall 2019
- Physics BS from Kookmin University
- Interests: Swimming, Badminton, Wool felting



## ■ Kelly Babitz

- MEAM Senior, Submat in Design and Manufacturing
- MEAM 510 Fall 2019
- Interests: Volleyball, coaching, board games

# About the TA's



## ■ Kevin Chazotte

- MEAM BSE 4th year, ROBO MSE Submat
- MEAM 510 Fall 2019
- Academic Interests: deep learning, robotics, electronics
- Personal Interests: building racecars, ultimate frisbee, colorful socks



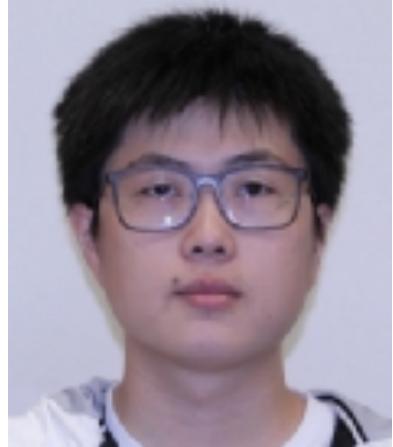
## ■ Geli Yang

- MEAM, MSE, 2nd year, Robotics Concentration
- MEAM510 in Fall 2019
- Interests: Video Games, Movies

# About the TA's



- **Shivam Dehinwal**
  - IPD 2nd year,
  - MEAM 510 Fall 2019



- **Chenxi Ji**
  - MEAM MSE 2<sup>nd</sup> year
  - MEAM 510 Fall 2019 – Won competition
  - Undergrad at UC Irvine



- **Jorge Echeverria**
  - IPD 2<sup>nd</sup> year,
  - MEAM 510 Fall 2019

# GM Lab (Towne 193) of the past

- Many hours spent in this lab.
- Most of the learning occurred here.
- We want to simulate this somehow



# Zoom and Toucan for Virtual GM



<https://www.toucan.events/>

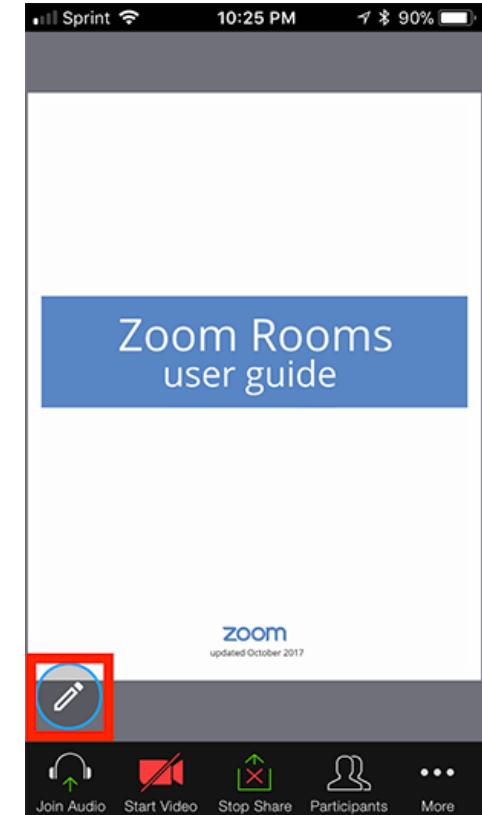
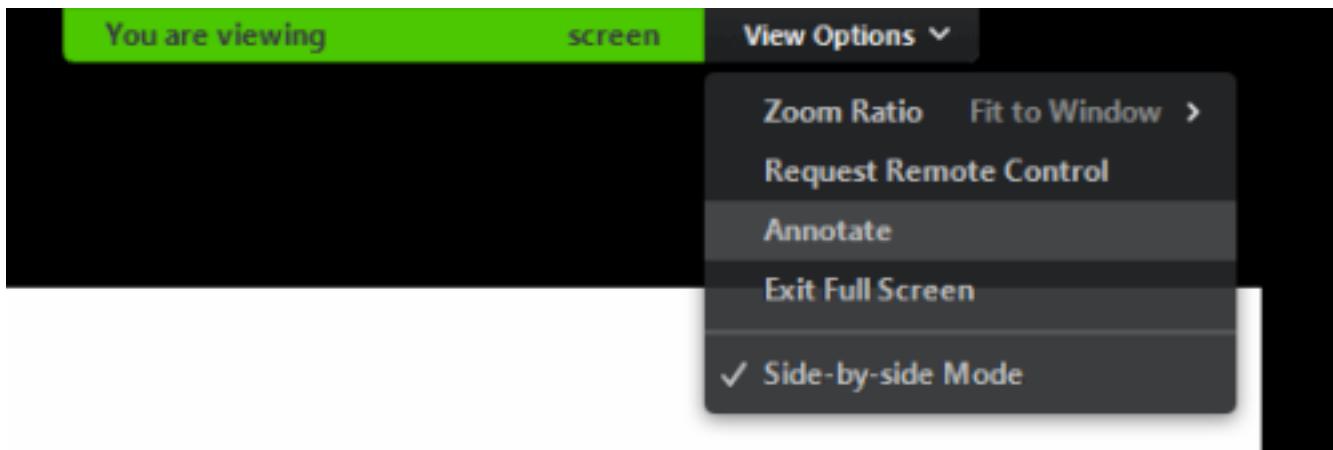
# Toucan Social Introduction



Meet a few people.  
Ask TA questions.  
End of class.



# Zoom Annotate Practice



Draw circle here.  
The circle will  
appear to others  
when you release.

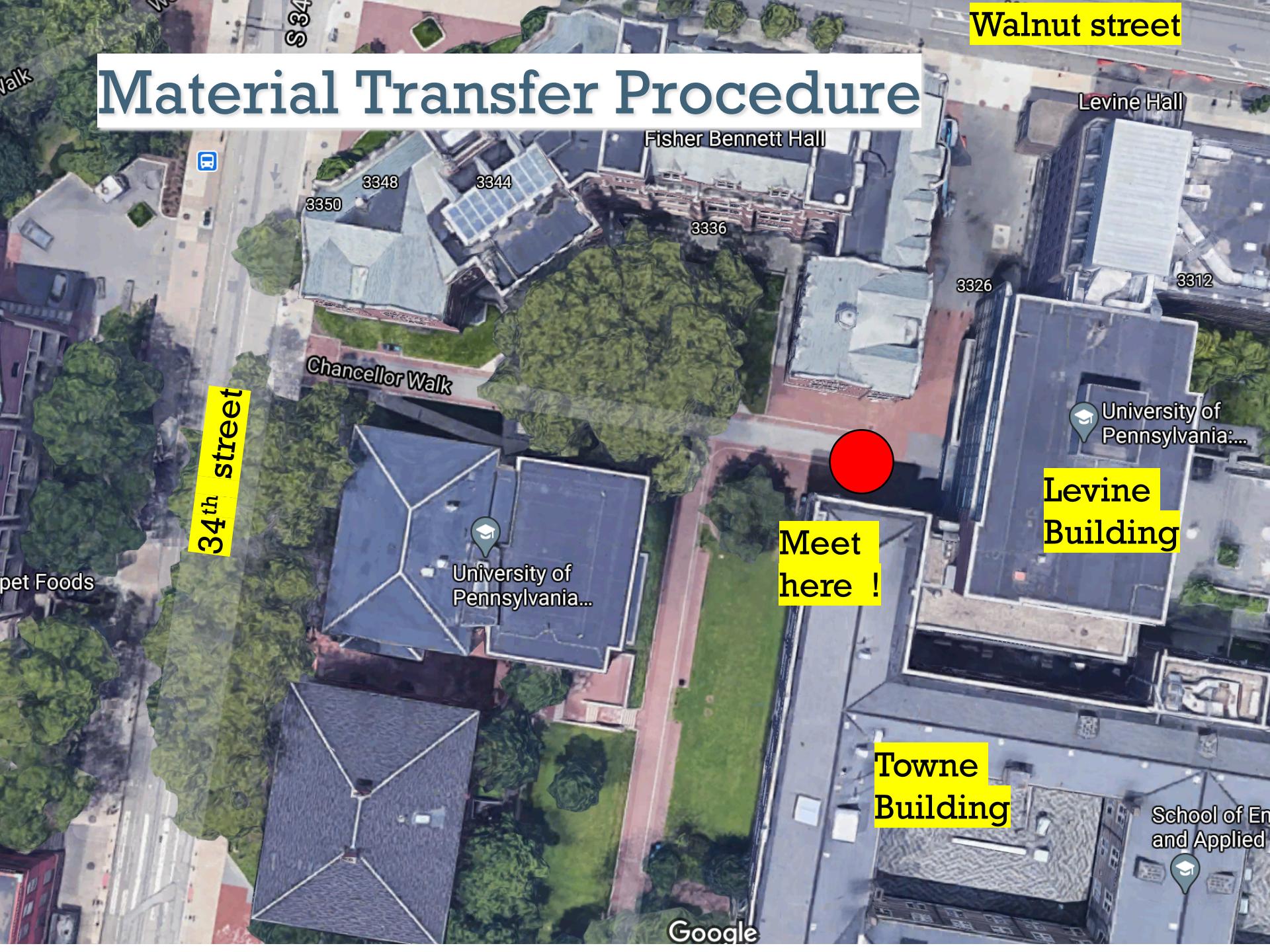
Draw circle here, but hold  
down the button. Don't  
release until I say so

# Material Transfer Protocol

1. Sign up on google doc for 5 min appt.
  1. You must use your SEAS account to get access.
  2. <https://docs.google.com/spreadsheets/d/1LY161gre9hpWRGrWspwu4KDOvvMtjbHdACgzssAxrQc/edit?usp=sharing>
  3. Link will also be on Canvas home page
2. Find phone# for TA on duty on sign up doc.
3. Call TA when you arrive.
4. Wave hello to each other from far away.
5. Item should be dropped on ground.
6. Deliverer walks away.
7. Deliveree picks up item.
8. Yell thank you from far away - through your mask.
9. No-one gets close to the other.

Walnut street

# Material Transfer Procedure

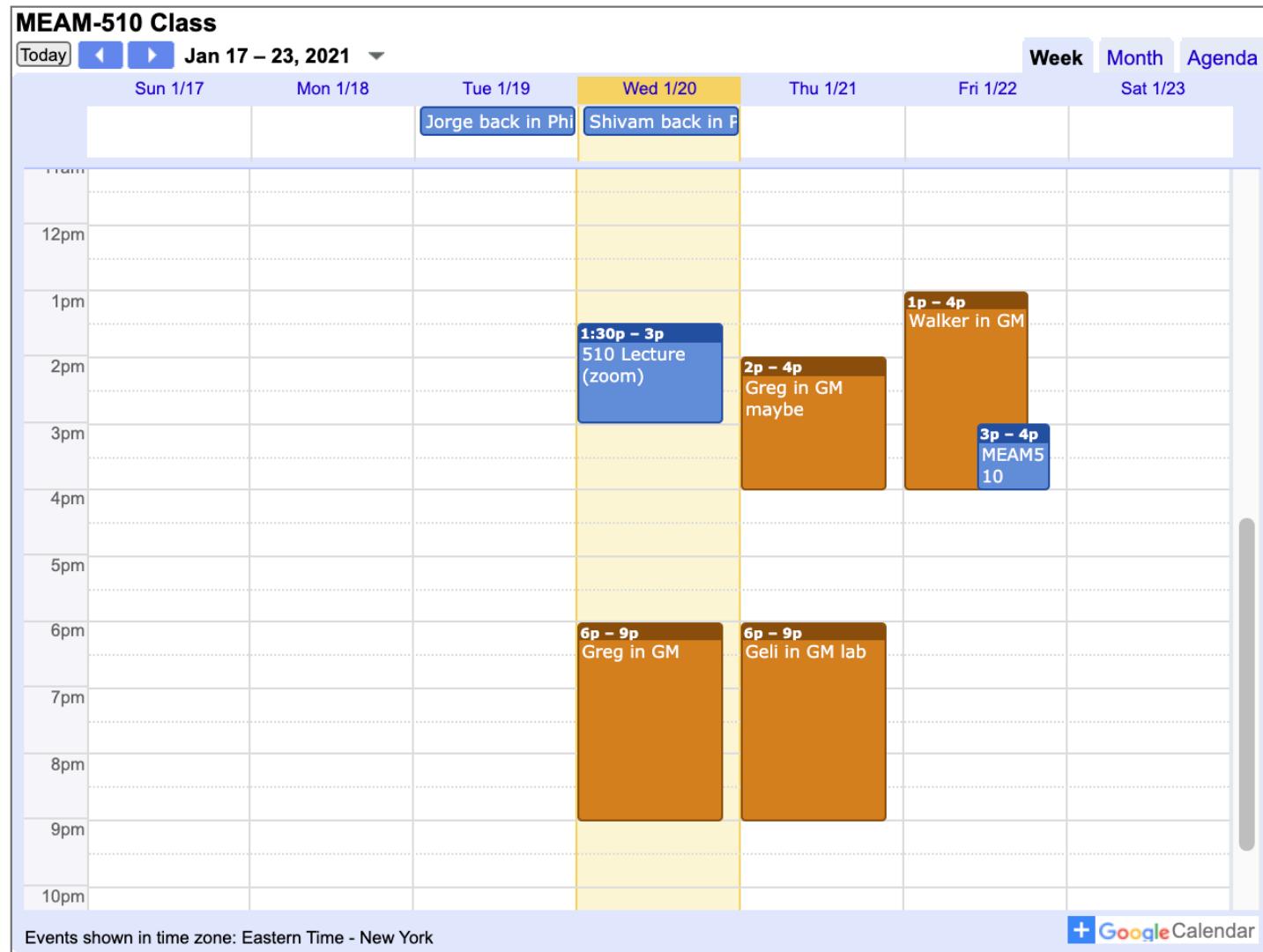


[Home](#)[Piazza](#)[Assignments](#)[Grades](#)[People](#)[Files](#)[Zoom](#)[Class Recordings](#)[Quizzes](#)[Search](#)

## MEAM 510-001 2021A Dsgn OfMechatronic Sys

## Canvas page

Lectures are recorded Monday and Wednesday 1:30 to 3:00PM.



# Calendar (google on Canvas)

Jorge back in Phil Shivam back in P

1<sup>st</sup> class

1:30p – 3p  
510 Lecture  
(zoom)

2p – 4p  
Greg in GM  
maybe

1p – 4p  
Walker in GM

3p – 4p  
MEAM5  
10

Assignments will  
often be due  
Wednesday

Recitation

6p – 9p  
Greg in GM

6p – 9p  
Geli in GM lab

GMLab  
Office Hours-  
Pick up Kits

# Calendar (google on Canvas)

10am

Typical TA office hours:

- Most afternoons 2 hours
- Every night 6PM to 9PM sun-fri

1pm

1:30p – 3p

510 Lecture  
(zoom)

1:30p – 3p

510 Lecture  
(zoom)

1p – 3p

TA in GMLab

2pm

2p – 5p

TA in GMlab

2p – 4p

TA in GM Lab

2p – 4p

Online TA

3pm

3p – 5p

Online TA

3p – 5p

TA in GMLab

3p – 4p

MEAM510  
Recitation

4pm

5pm

GMLab

Office Hours :

Pickup and Dropoff

6pm

6p – 9p

Online TA

6p – 9p

TA in GMLab

6p – 9p

TA in GMLab

6p – 9p

TA in GMLab

7pm

8pm

9pm

# 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).
  - 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.