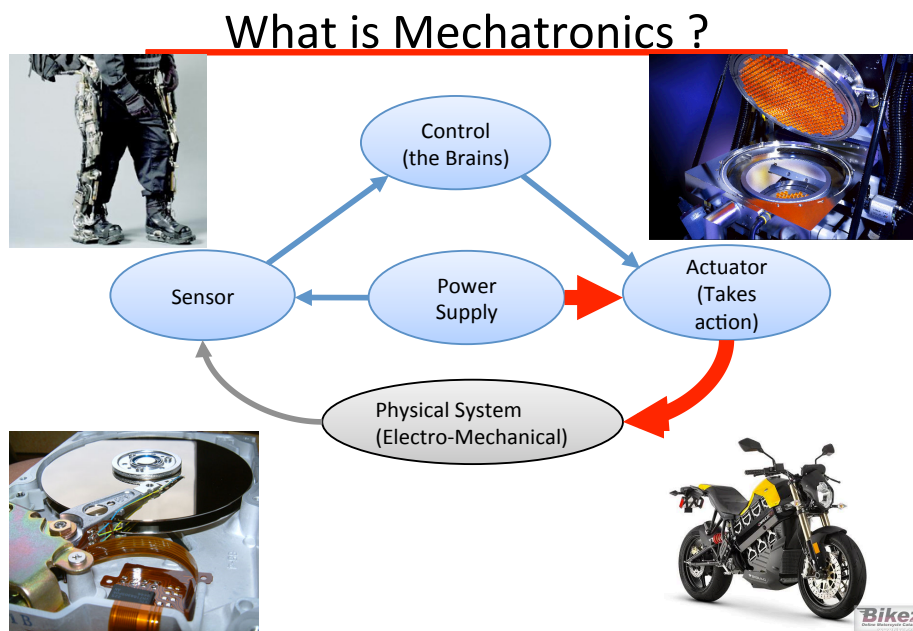


## Syllabus and schedule for:

### EK 131 M1 & M2 2020 Introduction to Mechatronic Systems and Design

**Professor Michael Gevelber (gevelber@bu.edu)**

Mechatronic systems are integrated mechanical, electrical, and computer systems, and are enabling for a number of important technologies including electric vehicles, disk drives, power and flight control systems, production machinery, and robotics. This course provides an introductory experience into the design of mechatronic systems and centers around a laboratory experience in which students design and build a succession of mechatronic subsystems, leading to an integrated system in a final project. Lectures complement the laboratory experience covering: operational principles related to programming Arduino micro-controllers, use of associated sensors and actuators, design issues associated with the spectrum of electro-mechanical components, and appreciation for how mechatronic systems can help solve society's problems.



### Course Learning Objectives:

1. Learn what mechatronic systems are and how they can solve societal problems.
2. Provide a hands-on experience where students develop and implement code, build sub-systems, work with electro-mechanical hardware, & learn how to debug their implementation. Develop intuition of how these systems function.

3. Intro to design: have exposure to determining design objectives & how to identify the nut of the problem
4. Nurture student curiosity & belief that they can “do it” through an experience where they - design it - build it - understand what they built
5. Learn how to debug: How do you figure out what’s wrong when your creation doesn’t work at all, doesn’t work as you “hoped”? **This is a critical skill you need to develop as a practicing engineer and problem solver!**  
Is the problem coming from the wire connections? The components? Your program? Multiples of the above? You need to develop the mindset of figuring out what you can & should test to figure out what’s really going on. **This can be quite frustrating**, but it will be an important capability for yourself, your company, lab etc if you can develop it.
6. Develop insight into dominant physics of engineering problems
7. Learn what mechatronics is about:
  - i. view systems from a “control” point of view: objectives, actuators, sensors, power, and computer control.
  - ii. Become familiar with core electrical and mechanical components
7. Communication: have an experience in making a technical presentation where you explain how a mechatronic system works in terms of design objectives, system components, and how it meets the needs of society.

### Course Pedagogy

- Lectures: 6 lectures. In many of the sessions, there will be a number of mechatronics examples and students will be asked questions about them. For many of these examples, students will work during class (with their lab partner) to answer them. The objective is for students to learn how to think through problems and experience the satisfaction of figuring things out. These examples will be based on high school physics.

#### Lecture topics include:

1. Mechatronic system overview: control, sensors, actuators, power consideration,
  2. Electronic & mechanical components: gears, motors, LED’s, resistor networks, MOSFETS, pumps,.
  3. Design approach: objectives and specifications.
  4. Analysis of examples: exoskeleton, electric motorbike, building vibration absorber, thermal incubator, rapid thermal processing for semiconductors, ascender, sawstop, electric grid.
- Labs: there are 5 labs:
    - 0) Intro to Electric Circuits: voltage divider, breadboarding
    - 1) Arduino programming intro: fade & blink

- 2) Actuators: small motor, gears and PWM
- 3) Large Actuators & MOSFET power control (motors and pumps)
- 4) Sensor: accelerometer

- Homework: there are three homework problems related to lecture.

- 1) Control of heating systems: bio incubator and rapid thermal processing for semiconductors. Actuator selection to meet performance spec's and sizing. Scooter robustness: how you can use basic physics and a smart phone to experimentally determine how a scooter holds up to extreme loading.
- 2) Electric rope ascender. How to select and size power pack and determine design objectives.
- 3) Saw stop: establishing design performance specifications and sensor options.

### Grading

- Labs: do each one with your lab partner and hand in a lab write up that explains, what did you do, how did it perform, answer any questions in the lab, and what problems you encountered and how did you solve them).  
5 labs. 40%
- Class participation & being there: 16%
- Homework: 3 problems, done with your lab partner. 24%
- Class presentation (with lab partner). 5 min each, on a mechatronic example or topic. 20% based on individual contribution (make sure you have the beef or tofu).

Learning strategies: This course will expose you to many different types. Some may be outside of your comfort zone, but will build your capabilities.

- Learn by example: e.g. read programming code and modify it
- Learn by instruction: how to build a gear box, but then figure out how it works and confirm theory
- Learn by reading/lecture: provides theory which you then apply. Learn to search & read tech vendor spec sheets and books.
- Learn by doing & iteration: build it, figure out why it doesn't work, and modify. Maybe even apply some theory!

Reading: will be assigned as part of lab handouts. Major documents are posted on the course blackboard website. **Critical for you to read through labs BEFORE you come in to do them.**

# EK 131 Mechatronics Outline

m1 Monday

class	date	Lab	Lecture	Hmk due
1	27-Jan		Intro and Mechatronic examples: bleex, disk drive, ascender, thermal control	
2	3-Feb		Intro arduino, digital systems, Multi-domain sytems/power	
3	10-Feb	Lab 0) arduino set up, use of multimeter, Herr Ohm & is law, POT		Hmk 1: incubator design/RTP/scooter
4	18-Feb		Power control & transistors	lab 0 due <b>Presentation proposal due</b>
5	24-Feb	Lab 1) fade & blink		Hmk 2: Ascender spec's & power
6	2-Mar		Sensors, sensor example (speed), logic control	lab1 due
		Spring Break: 3/7-3/15		
7	16-Mar	Lab 2) Acutators a): MOSFET power control, PWM, & small motor,		Hmk 3: Saw stop: sensor & design spec
8	23-Mar		Motors, gears, power control, actuator example (auto)	lab 2 due <b>Detailed presentation outline (incl ref)</b>
9	30-Mar	Lab 3) Actuators b): motors & gears		
10	6-Apr		Electrical loads, power system, [solar PV systems] how micro-controller works: sampling, I/O	lab 3 due
11	15-Apr	Lab 4) Sensor: accelerometer		
	20-Apr	no class		
12	22-Apr		Student Mechatronic Presentations	lab 4 due
13	27-Apr		Student Mechatronic Presentations	

## Notes:

Lab write & Hmks are due the day indicated

**Suggestion: read lab before previous class & come with questions.**

Lab write-ups to include brief write up of what did, what observed, present data and meaurements  
problems encountered & solved, & answers any questions raised in the lab write up.