

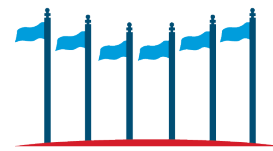
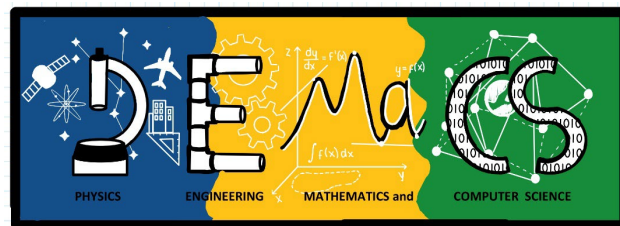


Fall 2024 Joint Semi-Virtual Meeting of the
Chesapeake & North Carolina Sections of the
American Association of Physics Teachers
October 19, 2024 @ Jefferson Lab

A Pilot Engineering Intro Course for the Early Engagement of First-Year Engineering Physics Majors

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Delaware State University*



DSU

College of Agriculture, Science
and Technology

To Bolster Undergraduate Enrollment, Some Colleges Are Emphasizing Engineering Physics Degrees

Beloit College in Wisconsin and the University of Maine model different approaches to engineering physics.



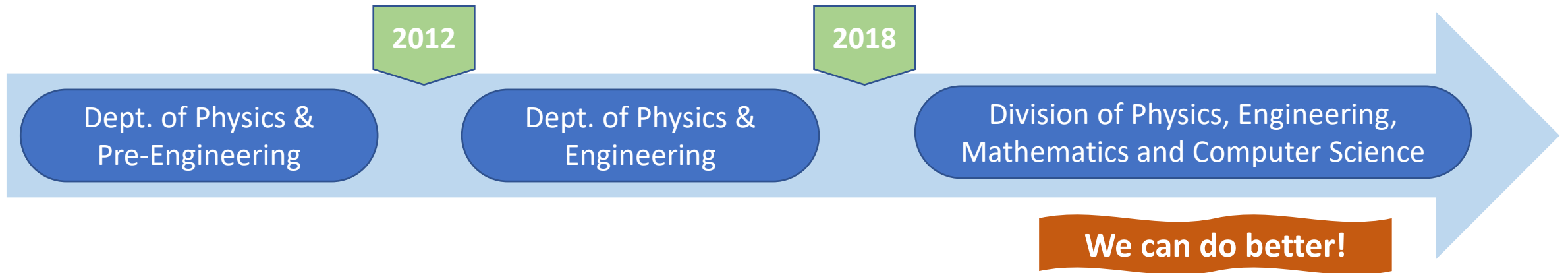
By Liz Boatman

June 15, 2023

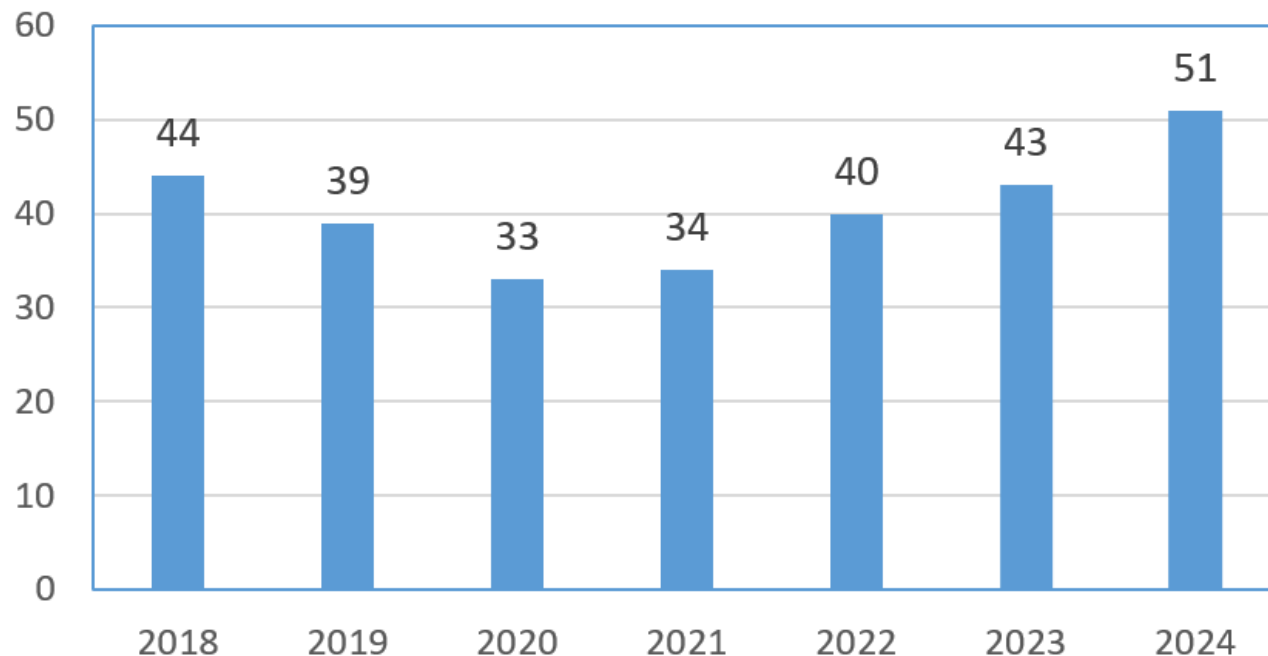
Across the United States, enrollment in undergraduate physics programs has been sliding, but engineering — which traditionally pulls from similar student demographic groups — has **fared better**. Some schools, like Beloit College in southern Wisconsin, are taking the hint.

While engineering programs are typically taught out of dedicated engineering departments and colleges, engineering physics programs are most commonly housed in physics departments. In general, they offer a similarly strong curriculum in the fundamentals, but with deeper theory content and a more scientific approach.

Physics and Engineering at DSU – Background and Numbers

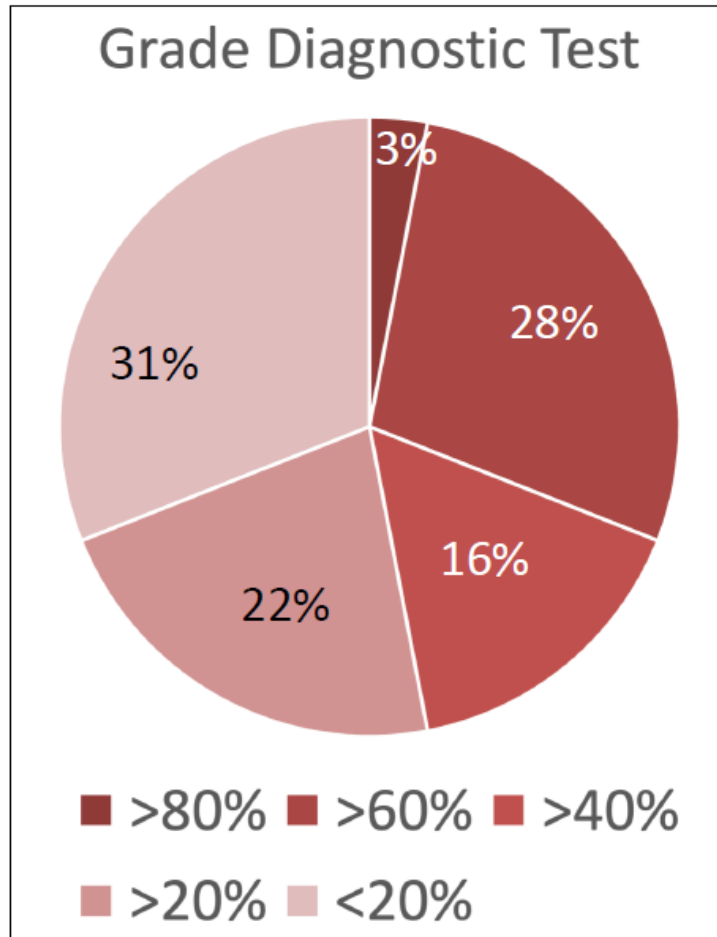


Freshman Enrollment - Phys & Engr

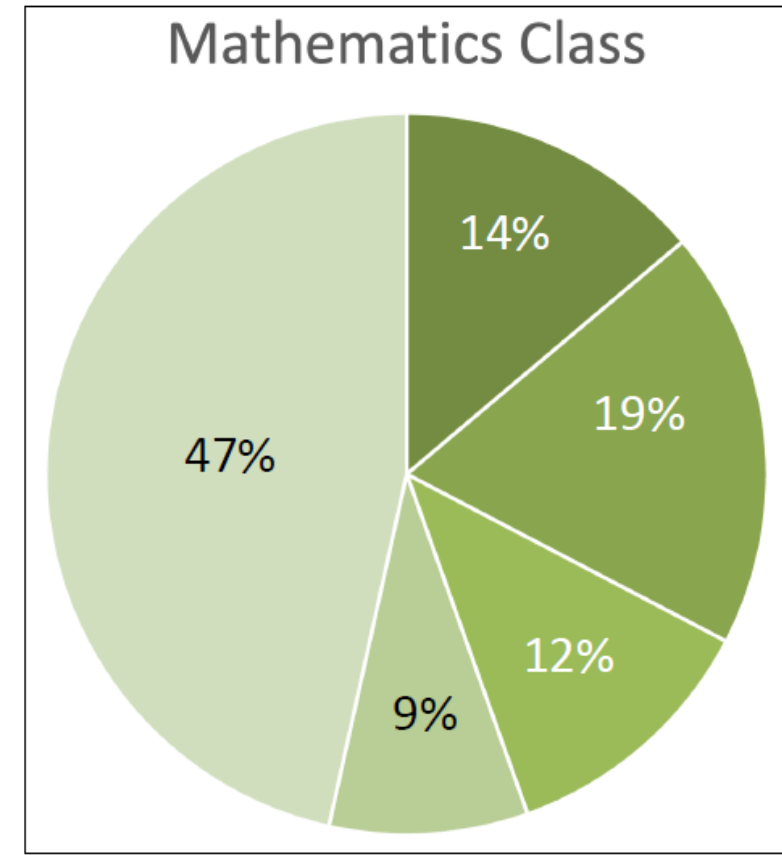


- Freshmen 4-year graduation rate **~20%**
- 90% African American students
- Two programs:
BS Engr Physics & BS Physics
- Three tracks: Electrical Engineering, Bioengineering, Optical Engineering
- Freshman physics majors < 10%
- 13 full-time faculty members (one fully administrative)
- adjuncts and teaching assistants

Freshmen Math Readiness in 2023 – Summary Report by Dr. Planchon



- Outcome of a diagnostic math test
- Only algebra and college algebra concepts
- To assess the math placement vs the math skills.



- No Math
- AlgebraAB
- College Algebra
- Trigonometry
- CalcOrAbove

Considerations...

The main goals are to **build up student skills** and have them feel belonging to the **same cohort/department**.

- **Classes in our major:** Most of our incoming students are only taking PHYS200 class in their first year. We should propose **at least 2-3 classes in our major** (not counting General Physics I) **in their first semester**.
- **Math skills:** Students should work on their **mathematics skills outside of the remedial mathematics classes** (Algebra / Coll. Algebra / Trig.). How to place our students in the same sections to enhance their sense of belonging?
- **Computer Science/Eng. Physics:** Some students will change major to computer science based on their interest. The first-year experience should have **some classes in common between ENGR/PHYS and CS** so it is easier for students to change between majors.

Redesign the First Year Experience

First Year Pilot Courses

- **Introduction to Engineering Design I & II**
- Modeling the World I & II
- Research Seminar and Professional Development I & II

Skills to know after Year 1 (Engineering/Computer Science)

- Team Building
- Critical thinking and Problem-solving
- Data analysis & basic graphs
- Basic electronics programming flow
- Basic prototyping of electronics
- Basics of optical and bioengineering
- Machine Learning/AI-based projects
- Communication skills and logical reasoning

Introduction to Engineering Design I

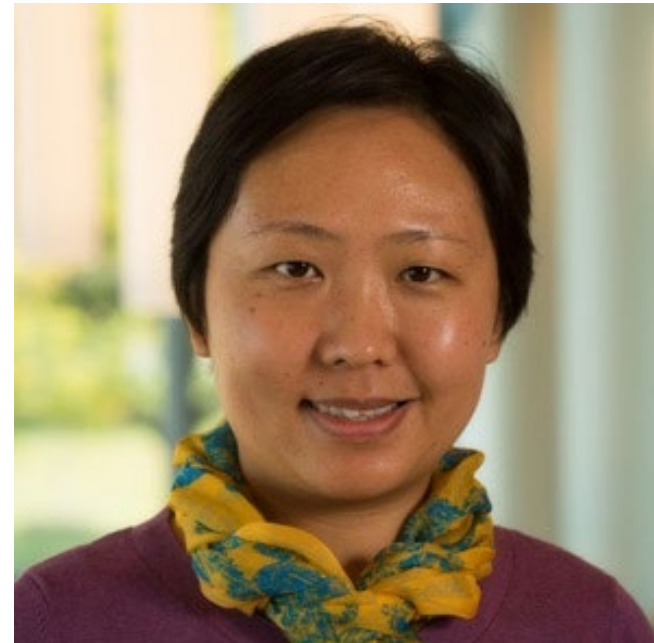
– A Pilot Course for First-Year Engineering Physics Majors



Mohammad A. Khan
Circuit Design and Prototyping
Electrical Engineering Design



Yuriy Markushin
MATLAB Onramp
System and Controls



Qi Lu
Excel Basics and Data Visualization
Bioengineering Design

Course Outline (I)

ENGR 110 Introduction to Engineering Design I

WEEK	Instructor		Deliverables
1	Khan/Lu/Markushin	Introduction to the Course	
Engineering Design Tools			
2	Khan	Circuits and Soldering (Section-1) Online Circuit Simulation (Section-2)	Lab Report (Online Circuit Simulation + In lab activity)
3	Khan	Circuits and Soldering (Section-2) Online Circuit Simulation (Section-2)	Lab Report (Online Circuit Simulation + In lab activity)
4	Markushin	Computation and Data Analysis using MATLAB	<u>MATLAB Onramp Academy Completion Certificate</u>
5	Markushin	Computation and Data Analysis using MATLAB	<u>MATLAB Onramp Academy Completion Certificate</u>
6	Lu	Introduction to Excel	Blackboard Assignment
7	Lu	Data Analysis and Visualization with Excel	Blackboard Assignment

Course Outline (II)

ENGR 110 Introduction to Engineering Design I

Design Projects				
8	Introduction to design projects and group assignments			
	Section-1	Section-2	Section-3	Deliverables
	Electrical Engineering Design- Optical Communication (Khan)	Bioengineering Design- Biosensors (Lu)	Systems and Controls- Arduino projects (Markushin)	
9	Introduction + BUILD	Introduction + BUILD	Introduction + BUILD	
10	BUILD	BUILD	BUILD	
11	Data Analysis and Document/Report	Data Analysis and Document/Report	Data Analysis and Document/Report	Prototype in a 3D printed case + Project Report
12/13/14	Switch group projects	Switch group projects	Switch group projects	Prototype in a 3D printed case + Project Report
15	Project Presentations (Each Team can present on a project of their choice)			

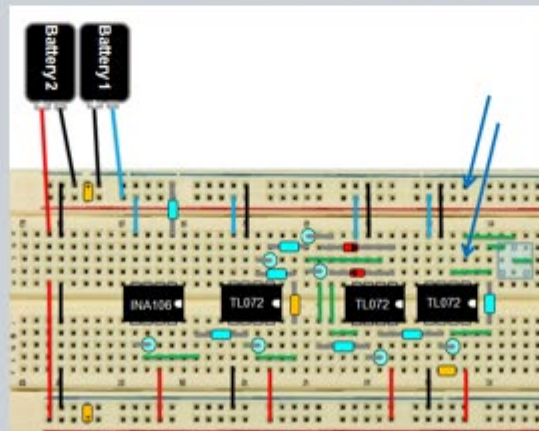
Design Projects

SECTION-1 OPTICAL COMMUNICATION

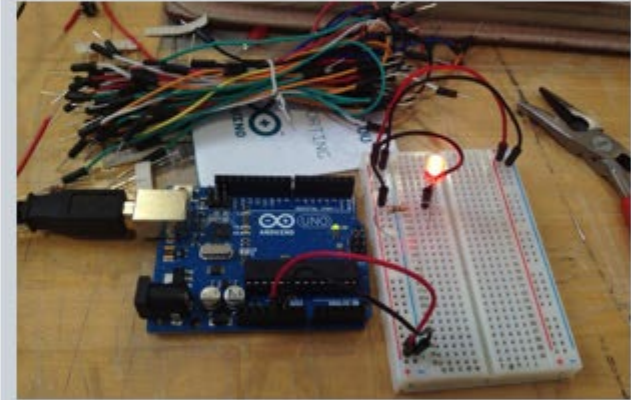


Click picture above for larger image

SECTION-2 EMG



SECTION-3 SENSORS AND CONTROLS



Section 1 - Optical Voice Link Kit



With this kit, you will assemble a fiber-optics system capable of transmitting your voice from microphone to speaker using a light beam guided by a fiber cable. No prior knowledge of fiber optics is necessary.

Transmitter Circuit Schematic

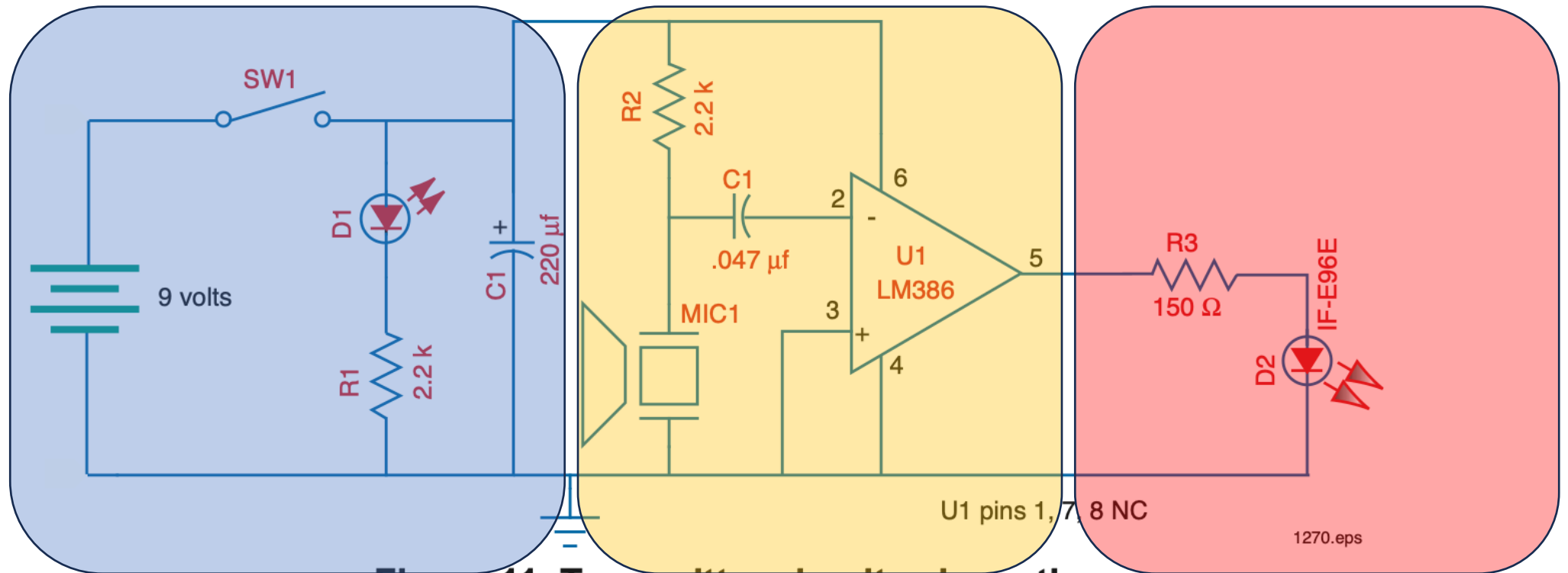
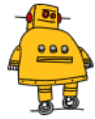


Figure 11. Transmitter circuit schematic.

Section 2 - EMG Muscle Sensor



AUTODESK
Instructables

Projects

Contests

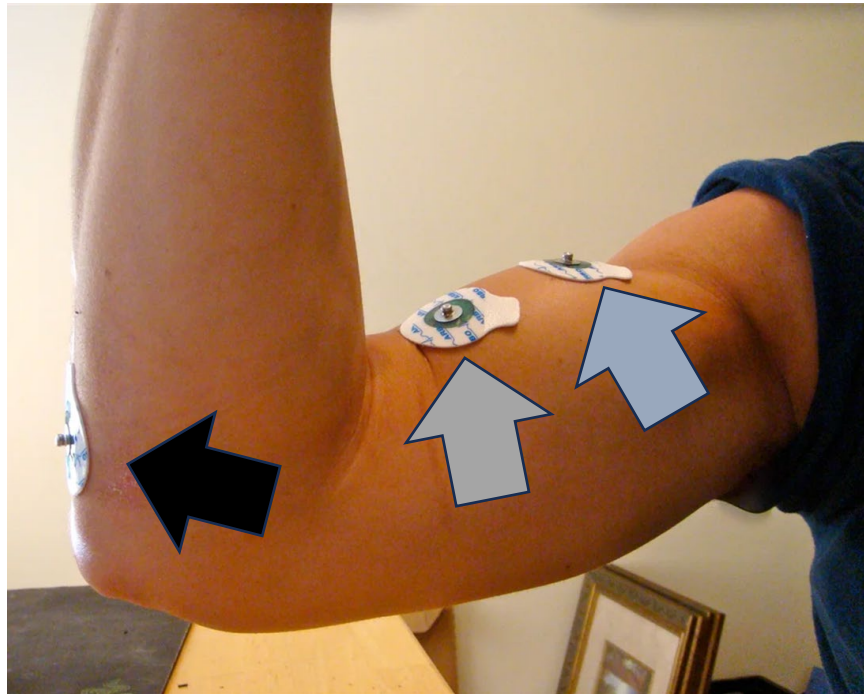
Teachers

Search



DIY Muscle Sensor / EMG Circuit for a Microcontroller

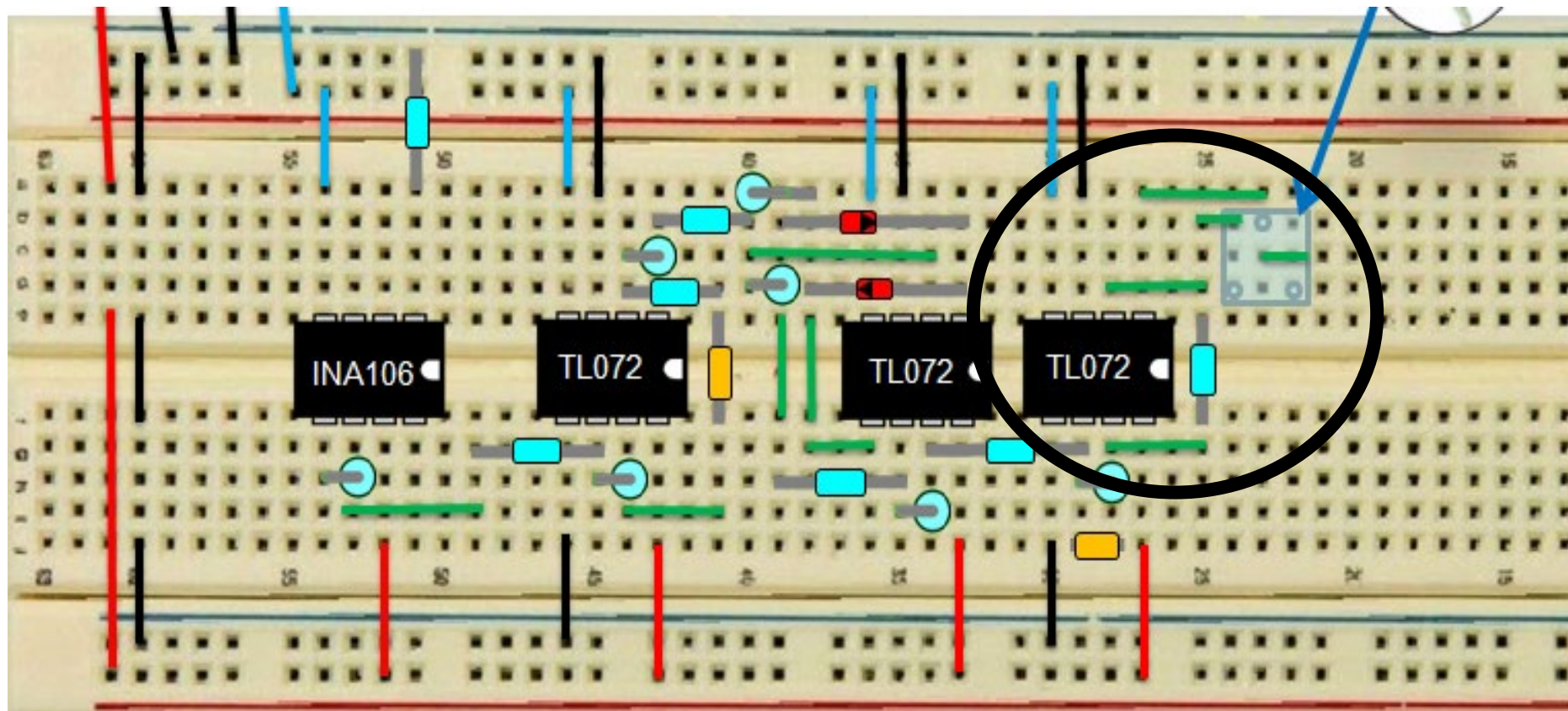
By Advancer Technologies in Workshop > Science  802,691  869  508  Featured



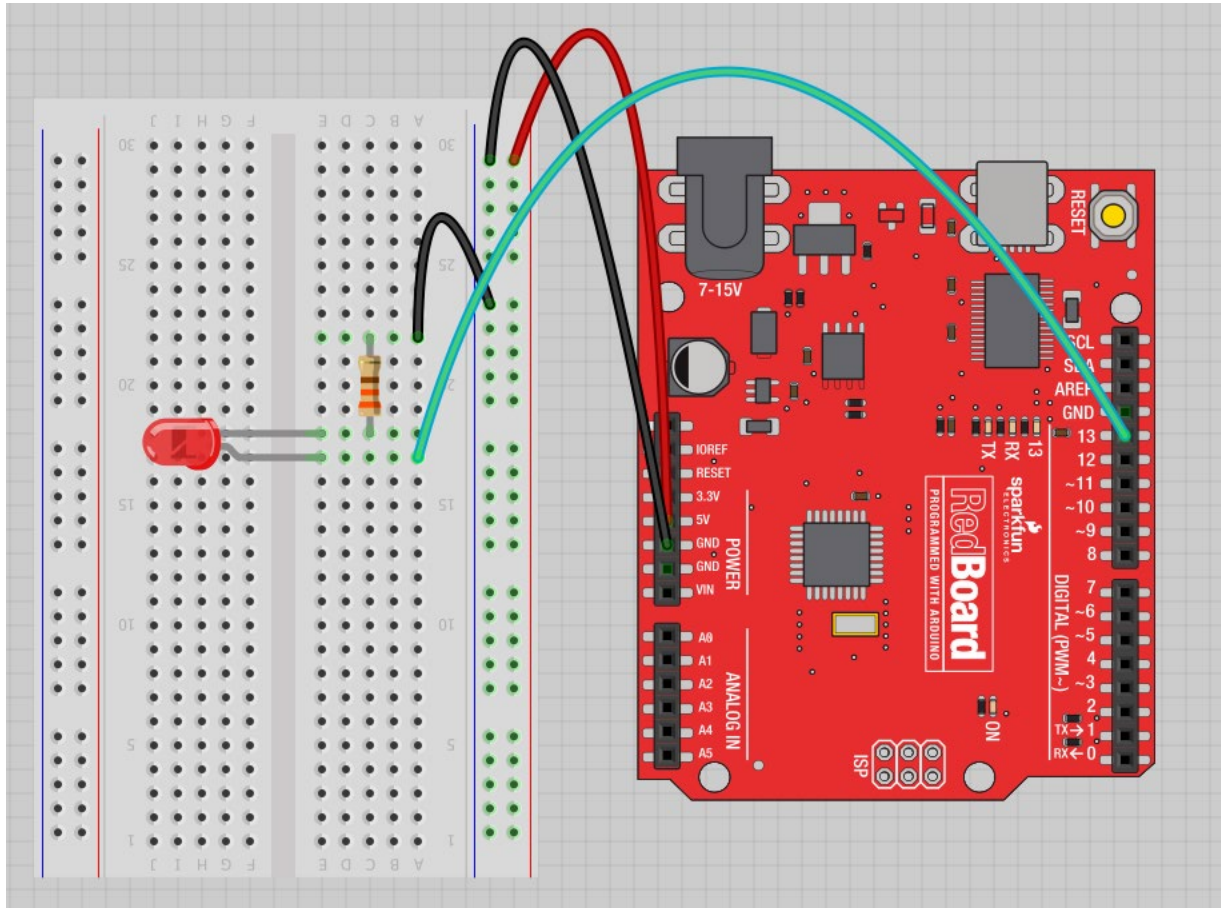
Electromyography EMG Circuit Design

Signal acquisition

Signal conditioning (amplification, rectification, smoothing + amplification)



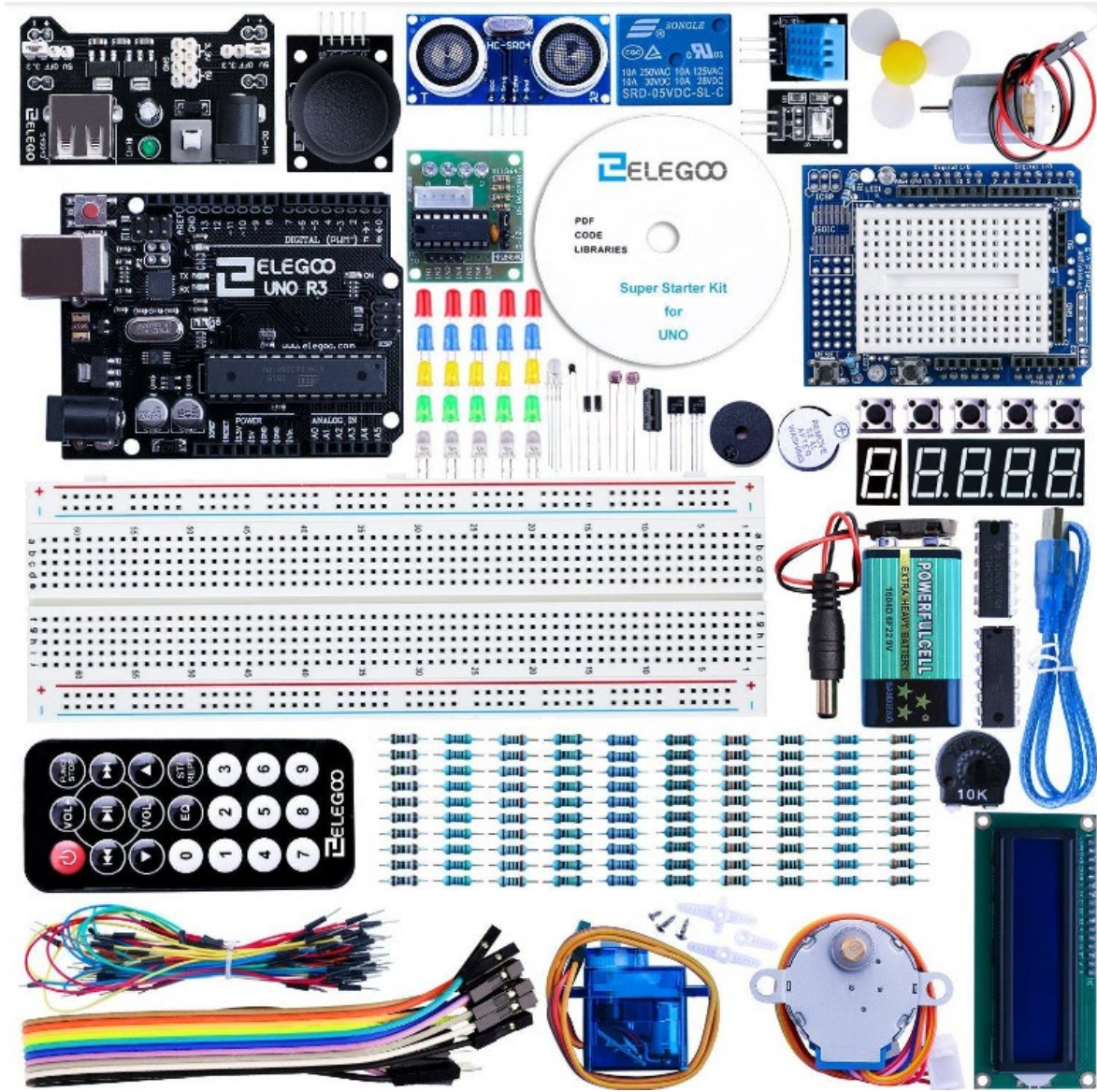
Section 3 - Sensors and Controls- Arduino Board



Move the green wire from the power bus to pin 13 (or any other Digital I/O pin on the Arduino board).

Image created in Fritzing

ELEGOO UNO Project Super Starter Kit



A few simple challenges

Let's make LED#13 blink!

- **Challenge 1a** – blink with a 200 ms second interval.
- **Challenge 1b** – blink to mimic a heartbeat
- **Challenge 1c** – find the fastest blink that the human eye can still detect...
 - 1 ms delay? 2 ms delay? 3 ms delay???

Try adding other LEDs

Can you blink two, three, or four LEDs?

(Hint: Each LED will need it's own 330Ω resistor.)

Generate your own morse code flashing

How about → Knight Rider? Disco? Police Light?

Programming Concepts: Variables

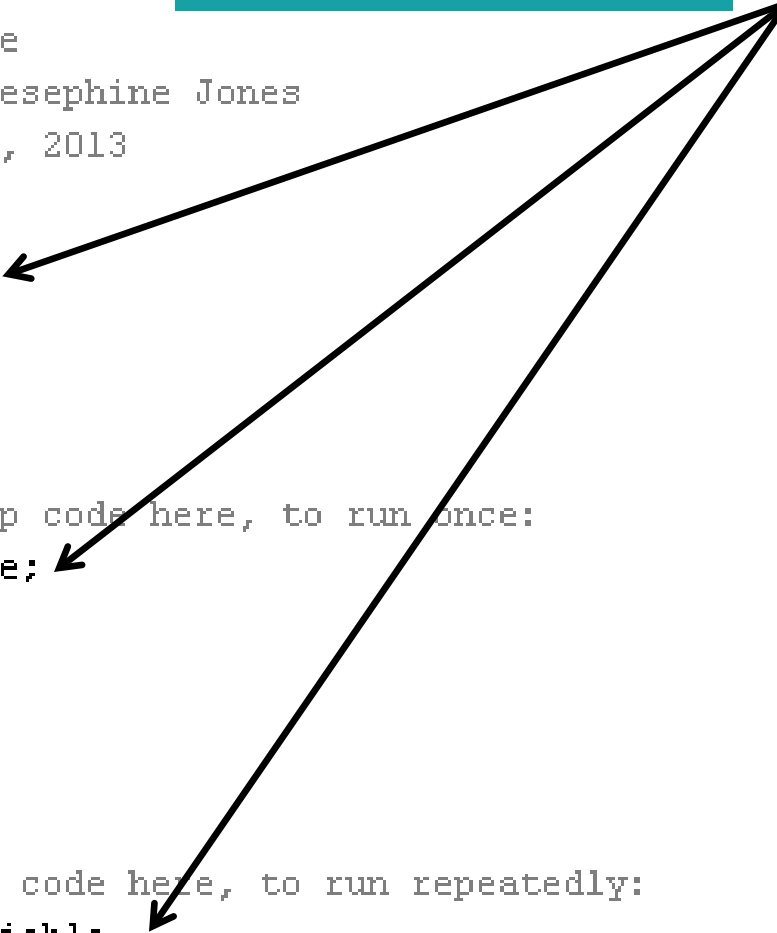
```
ProtosnapProMiniExample2$  
  
// Comments go here  
// Written by:  Joesephine Jones  
// Date:  April 12, 2013  
  
int sensorValue;  
int ledPin;  
  
void setup()  
{  
  // put your setup code here, to run once:  
  int setupVariable;  
  
}  
  
void loop()  
{  
  // put your main code here, to run repeatedly:  
  int loopScopeVariable  
}
```

Variable Scope

• *Global*

• ---

• *Function-level*





**Physics teachers,
please be prepared
to teach programing
and electronics!**