Using Arduino & LabView for Teaching MEMS Devices

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IVY TECH COMMUNITY COLLEGE

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Background

Ivy Tech Community College is Indiana’s largest public postsecondary institution and the nation’s largest singly accredited statewide community college system. Ivy Tech serves nearly 200,000 students annually and has campuses throughout Indiana.

We offer Associates of Science degrees in:

Electrical Engineering Technology
Mechanical Engineering Technology
Engineering Technology
Pre- Engineering
Nanotechnology
Design Technology

over 40 degree programs

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So what is an Arduino?

Arduino is a inexpensive Microcontroller CCA that interface to your PC via USB

They typically cost ~ 20 to 25 and are available many places online

Software to program them is free, open source. https://www.arduino.cc/

Arduino Uno (and other models) have daughter boards call “shields” that you can stack

Shield include Motor Drives, Prototype boards, Displays, etc.

Arduino microcontrollers have become very popular with hobbyist, students and colleges.

http://www.jameco.com/
https://www.adafruit.com/
http://www.elexp.com

ARDUINO

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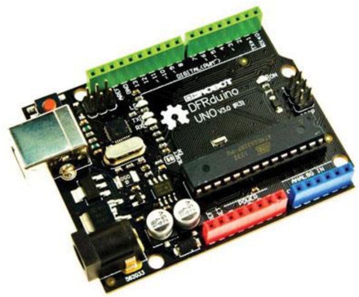
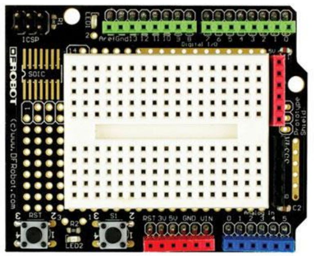
What is an Arduino?

Arduino Uno Rev3 is a 8-bit microcontroller board based on the ATmega328P,

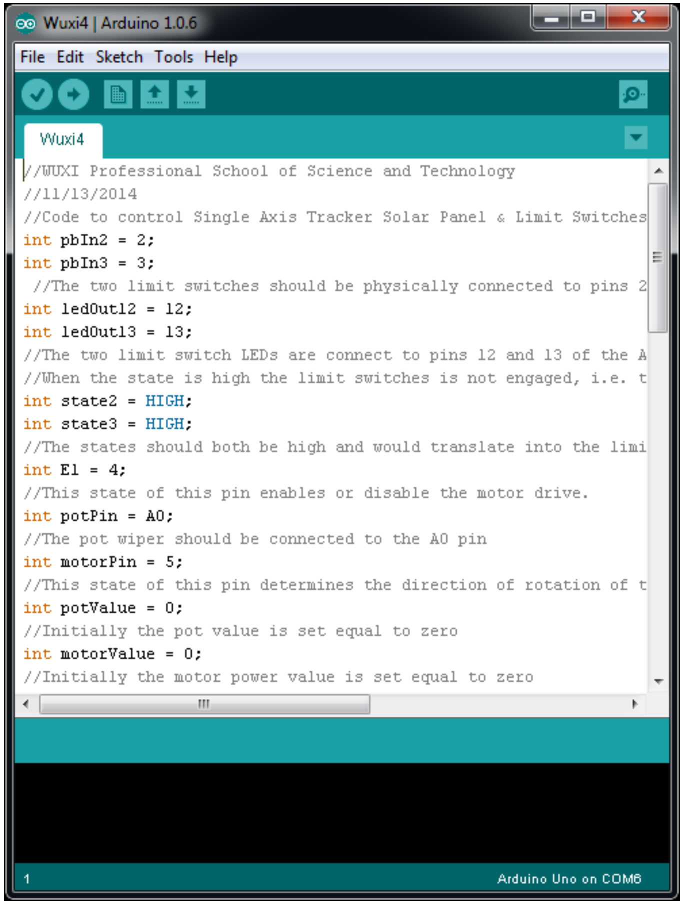
Specification	
Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage	7-12V
Digital I/O Pins	14
Analog Input Pins	6
Flash Memory	32 KB
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz
PC Interface	USB



Arduino Uno



Prototype Shield



https://www.arduino.cc/en/Main/ArduinoBoardUno

LabView is a graphical programing language made by National Instruments (NI) http://www.ni.com/labview/

Designers can use LabView to build custom compiled software.

LabView training has three basic level: LabView Core 1, 2 and 3

LabView can be used for control, data acquisition and displaying results using custom

LabView can interface with other NI software and hardware products use in both educational and industry

LabView can also be used with microcontrollers like the Arduino Uno

Support for this is now provided by MakerHub @ https://www.labviewmakerhub.com/

NATIONAL INSTRUMENTS LabVIEW

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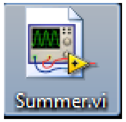
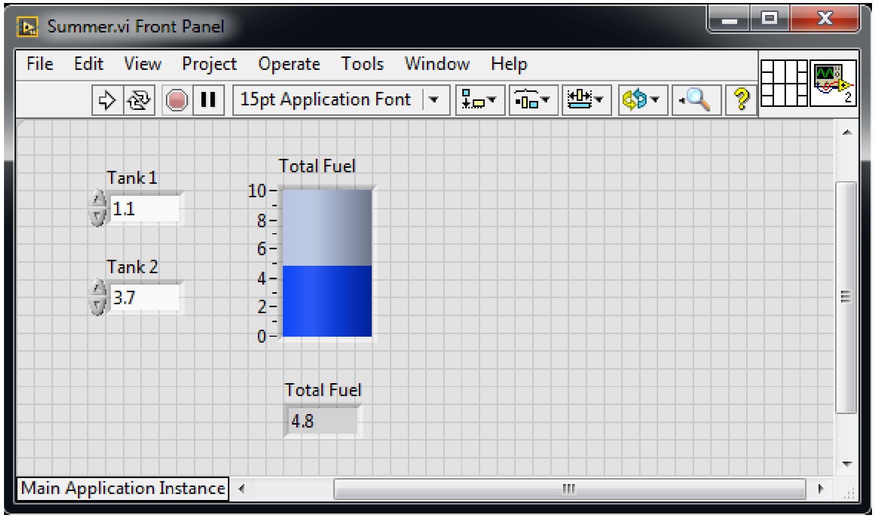
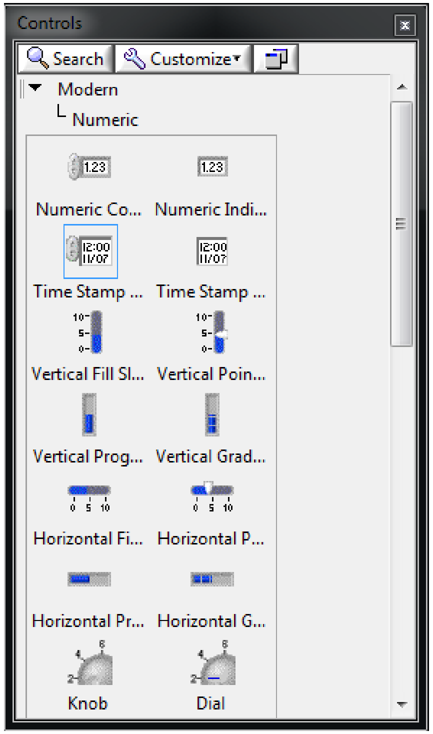
What is LabView?



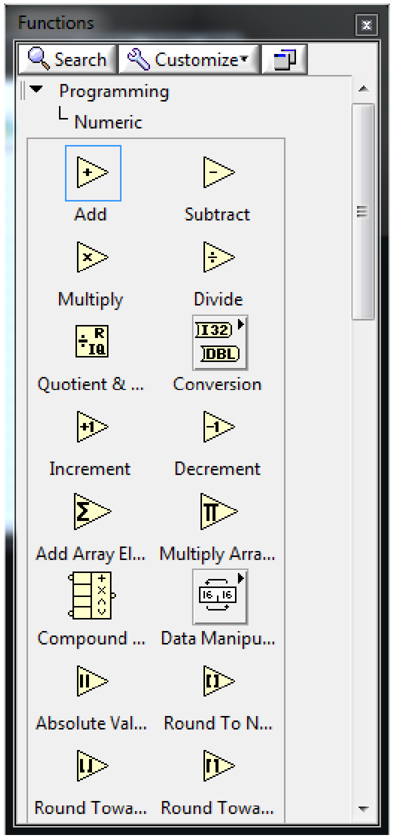
GUI Interface



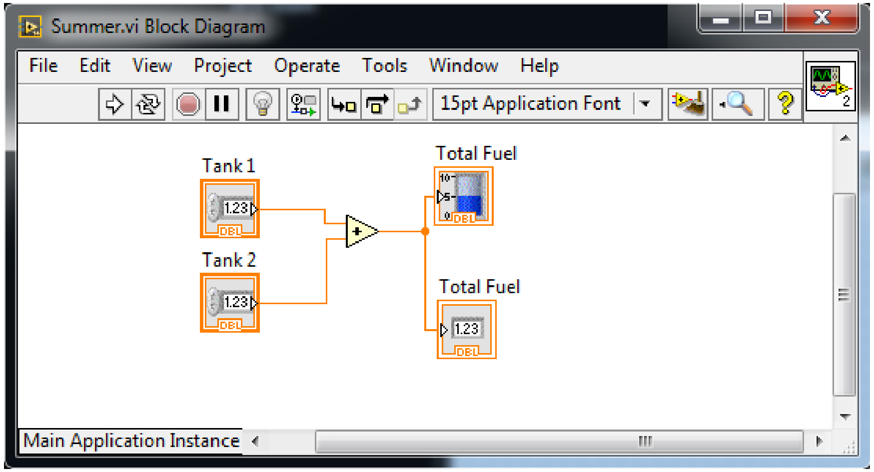
GUI Controls



Numeric Functions



Graphical Program



MEMS stands for MicroElectroMechanicalSystems

MEMS from my perspective are sensors: pressure, accelerometer, gyroscope, etc.

They also include actuators and transducers

MEMS are microscopic devices that contain both electronics and mechanical parts

They translate physical, environmental phenomena into electrical signals

They are manufactures using the same types of ways that semiconductor devices are made: photolithography, etching, deposition, lift-off

MEMS are used in automotive, defense, biomedical, etc.

MEMS devices are based on the same type of electrical and mechanical principles as can be found in the macro world.

http://www.scme-nm.org

Ivy Tech started its associating with SCME in the Fall of 2012 and has been a Co-PI on Southwest Center for Microsystem Education (SCME) NSF ATE Grant.

MEMS Kits Implementation Plan IVY TECH (Fort Wayne & Valparaiso)								
	MEMS Kit	**ENGT 120**	**METC 111**	**METC 143**	**EECT 111**	**EECT 112**	**ENGR 251**	**ENGT 279**
1	MEMS: Making Micro Machines Kit	X						
2	Dynamic Cantilever Kit		X	X			X	
3	Crystallography Kit			X				
4	Pressure Sensor Model Kit	X			X	X	X	
5	GeneChip Model Kit	X						
6	MEMS Innovators Kit							X
7	Lift-off Kit			X	X			
8	Pressure Sensor Process Kit				X			
9	LIGA Micromachining Simulation Kit			X				
10	Anisotropic Etch Kit			X	X			
11	Rainbow Wafer Kit	X						

The scope of our effort was to integrate the SCME material into some of our engineering programs courses

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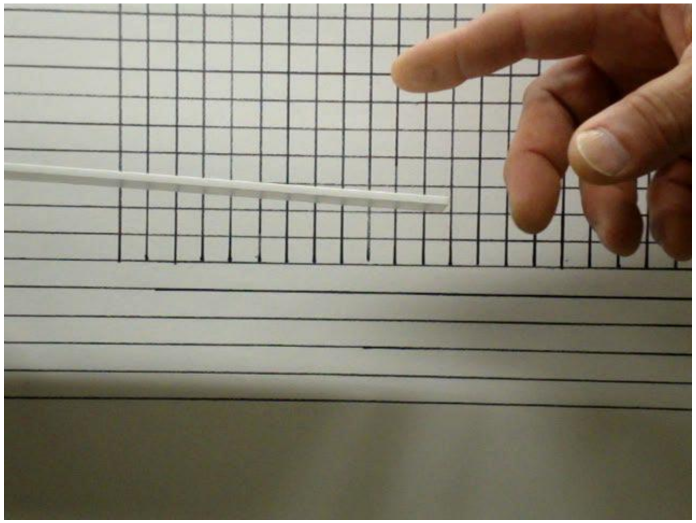

In Fort Wayne we have used three basic kits:

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In 2014 we decided to develop supplemental data acquisition electronics for two of the kits.

Reasons

- To improve on data collection of the experiments
- Add more "electronics" to the kit material

Approach

Use LabView and Arduino micro-controllers

Reasons

- Knowledge of LabView can help students get a job
- Arduinos are cheap, popular and very flexible

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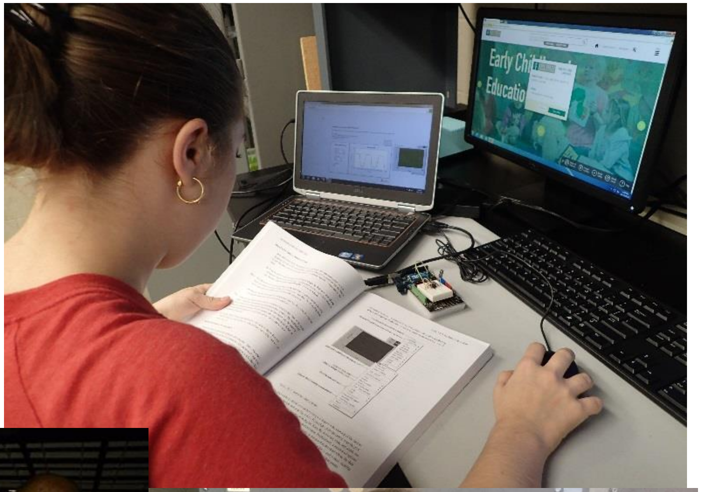
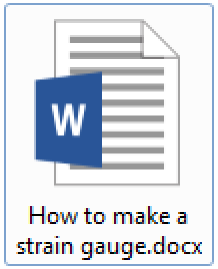
Use Discovery Based Learning Approach

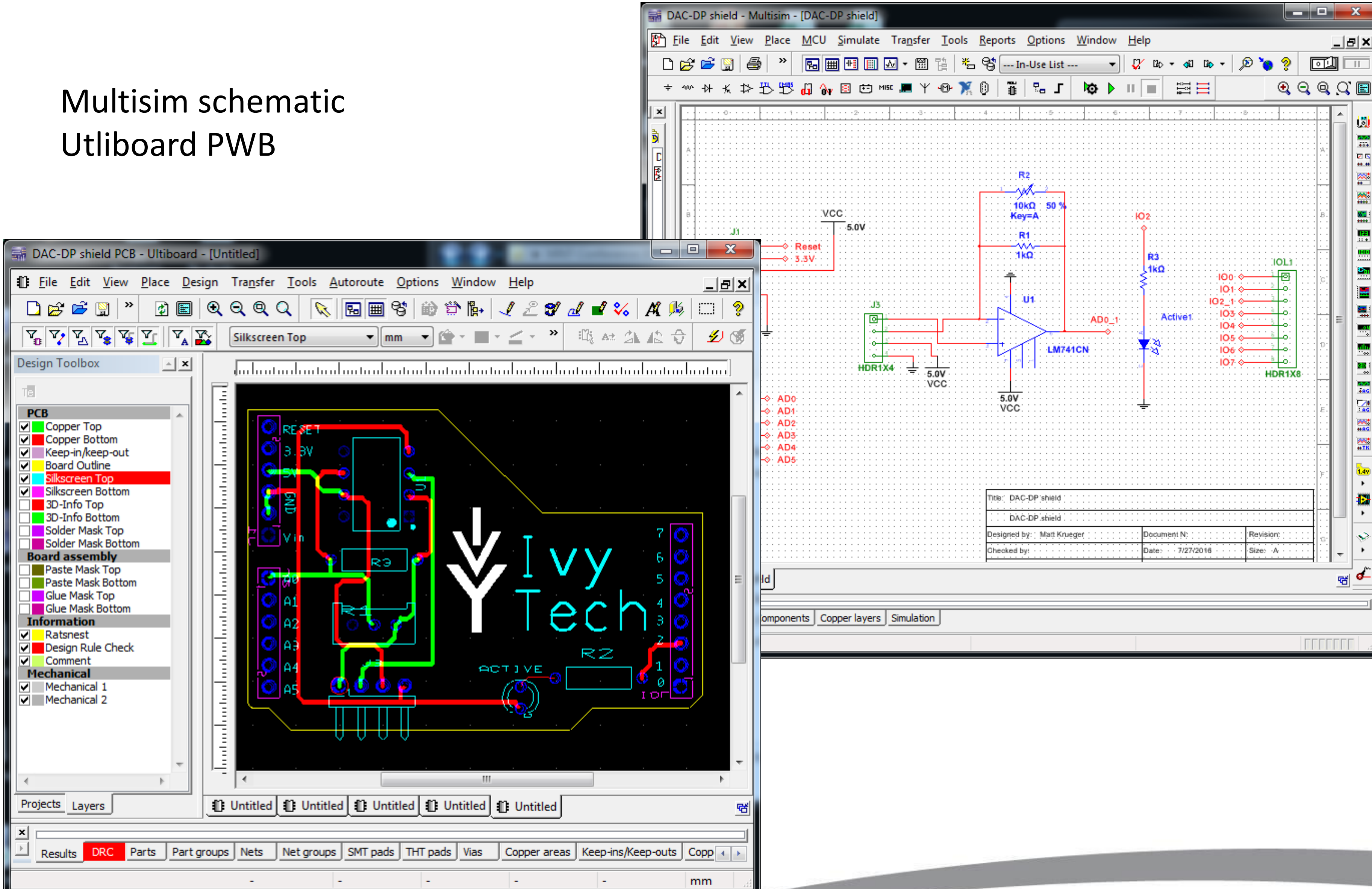
1.) Give students general idea and requirements for design
2.) Provide students with resources to design, build and test
3.) Provide feedback as needed but don't micromanage
4.) Allow students time to learn, fail and succeed
5.) Provide positive feedback and recognition
6.) Step back and let them learn …





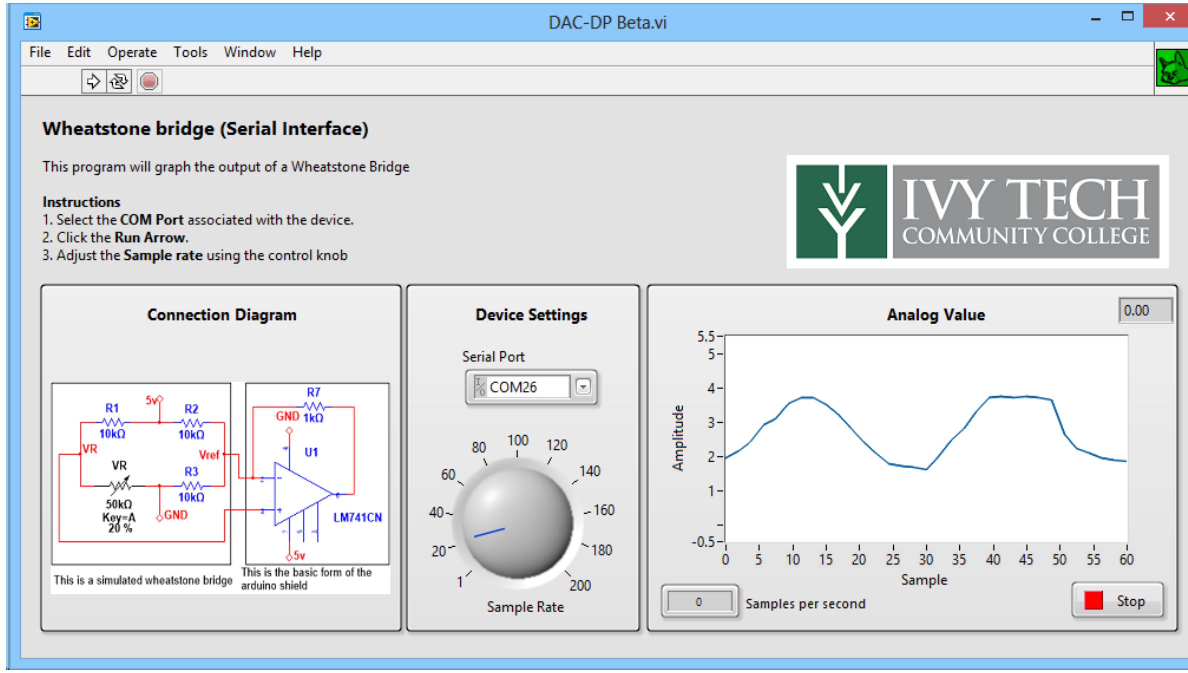
Our Results - Using Arduino & LabView for Teaching MEMS Devices

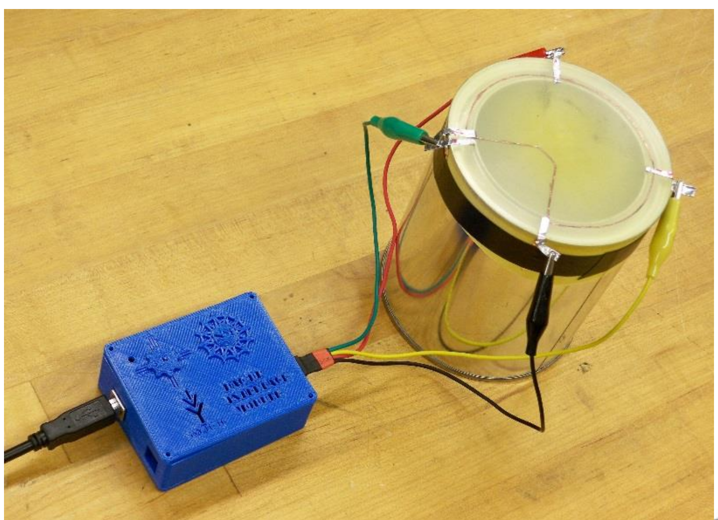
Multisim schematic
Utliboard PWB

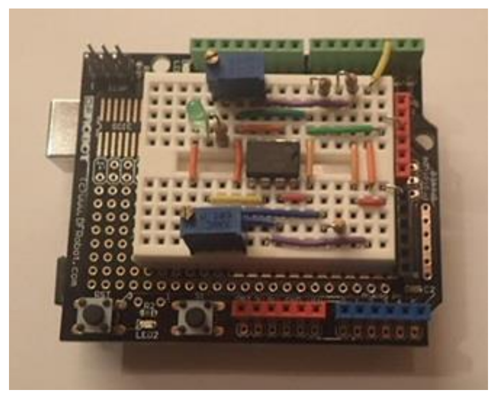


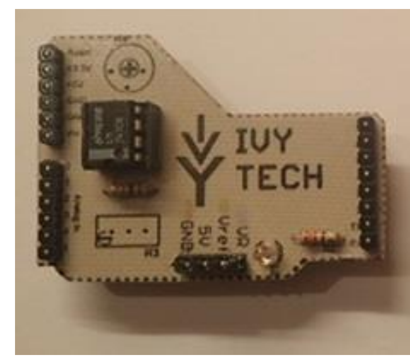
The new DAC-DP Kit for Pressure Sensor Kit

Includes - Arduino Uno based DAC-DP interface module, instruction manual, Executable LabView Data acquisition software, USB cable, and pressure sensor interface cable.



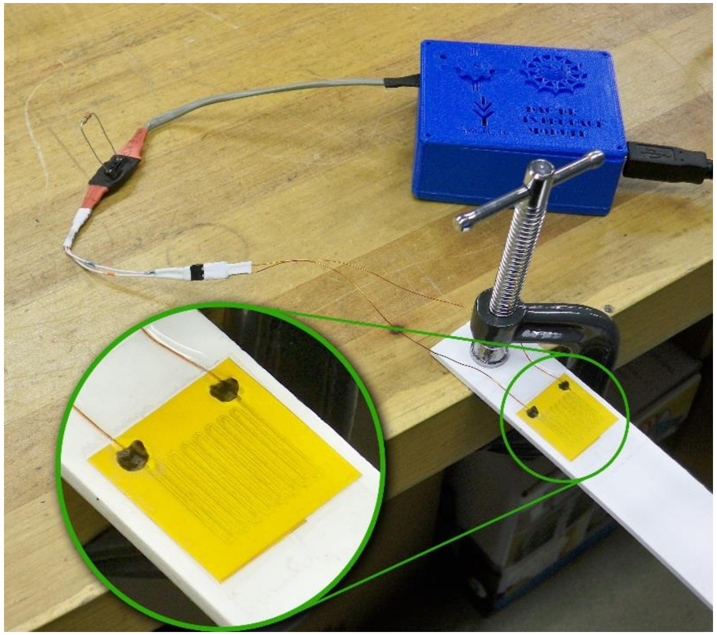


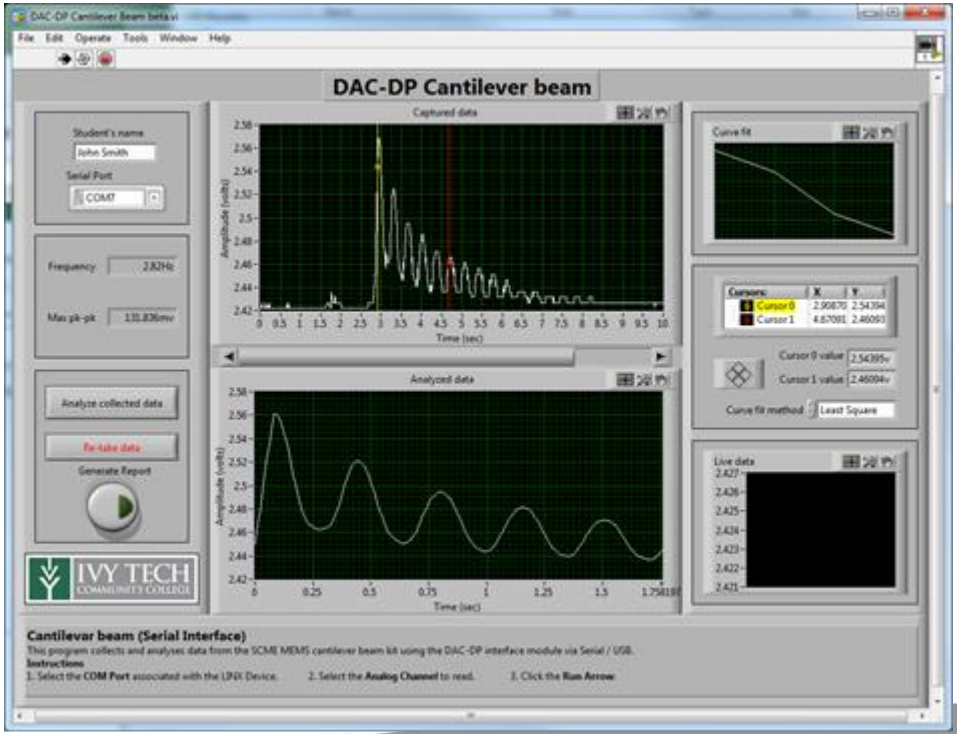




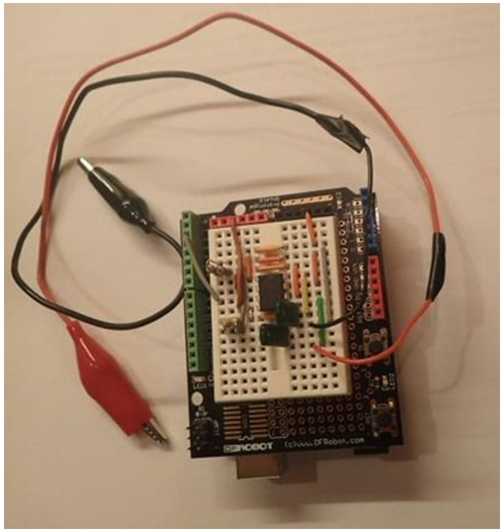
The new DAC-DP Kit for
Cantilever Kit

Includes - Arduino Uno based DAC-DP interface module, instruction manual, executable LabView Data acquisition software, USB cable, and Cantilever beam Strain gauge interface – Discovered “How to make a Strain Gauge”





New Variable Capacitor design
Can use same code as Cantilever LabView code
Based on common 555 Timer design



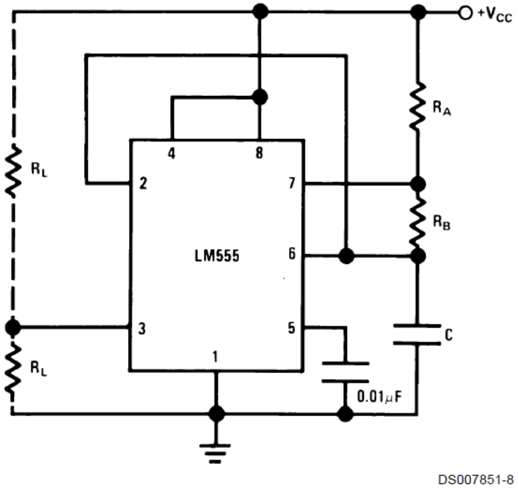
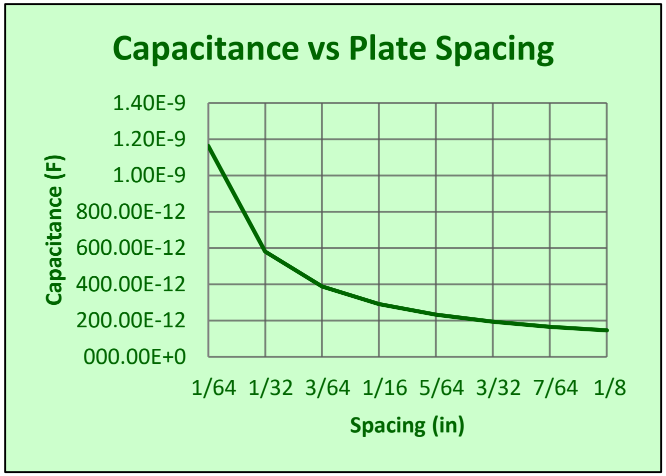


FIGURE 4. Astable



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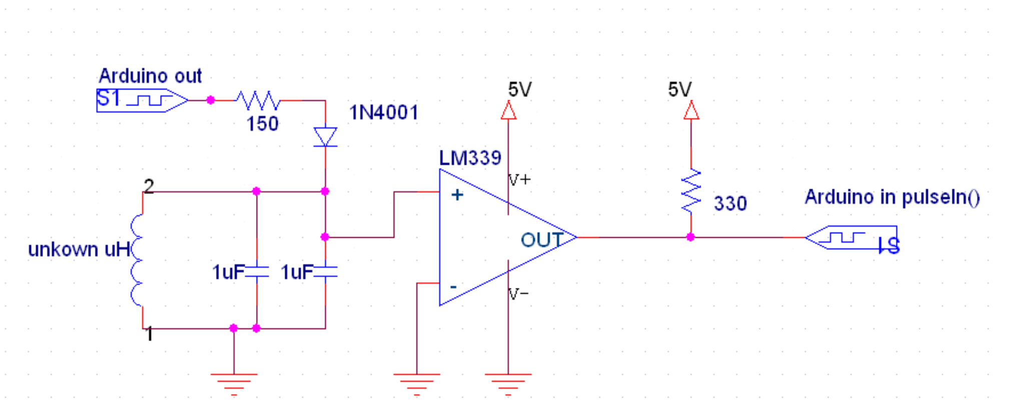
New Variable Inductor design
Want to use same code as Cantilever LabView code
Could be based on oscillator design
Could be based on LCR design
Could be based on DC-DC converter design

http://langster1980.blogspot.com/2013/07/arduino-lc-meter-shield.html
https://forum.arduino.cc/index.php?topic=80357.0
http://mchp.blogspot.com/2014/11/arduino-rclf-meter.html
http://hackaday.com/2011/07/24/using-an-arduino-to-measure-inductance/
https://reibot.org/2011/07/19/measuring-inductance/



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Building more electronic kits based on Arduino and LabView

Developing three new MEMS course to focus on "how to use MEMS devices" with electronics

Continue to use discovery based learning

http://www.scme-nm.org/
http://www.ivytech-mems.org/

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