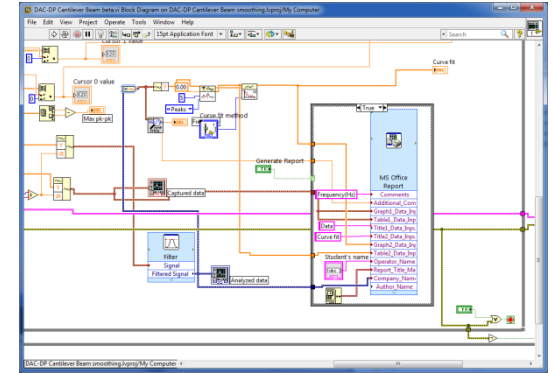


# Using Arduino Uno and LabView to Learn MEMS Concepts

**Andrew G. Bell**  
**July 22, 2019**

As the Internet of Things explodes, it is critical that technicians learn how sensors are integrated with electronics. This workshop will demonstrate the use of MEMS kits in tandem with Arduino Uno microcontrollers and LabView software. Participants will learn how pressure sensor devices and cantilever beams are built and used in educational environments. Participants will be provided mini-MEMS kits that will include pressure sensors and cantilevers with attached strain gauges. Both sensors will interface with an Arduino UNO and custom shield. The Arduino will be controlled by a PC running custom LabView data acquisition code. Participants will receive all the material and software used in the Workshop.



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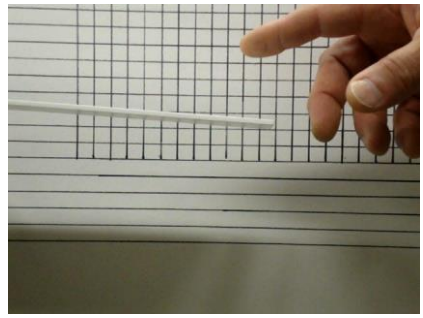
Electrical Engineering Technology  
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over 40 degree programs



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. We also have a NSF ATE small project grant for Microsystems Certification

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						



<http://scme-support.org/>

## What is an Arduino?

The Arduino is a small inexpensive microcontroller board that allows for easy and popular (electronic) project development.

A microcontroller typically includes, I/O, memory and a microprocessor. It is sort of a mini microprocessor board.

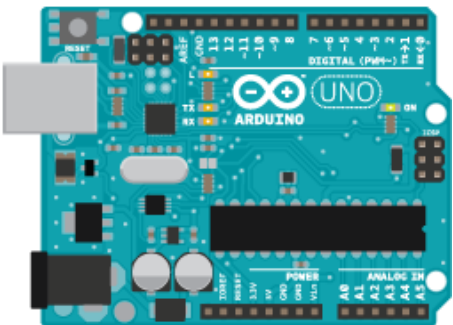
The Arduino is built to accept daughter boards called Shields and there exists many commercially available shield that you can stack onto your Arduino boards.

One of the most common shields is called a prototype shield and it allow the user to develop their own electronics.

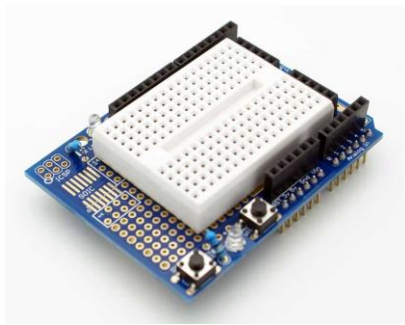
The Arduino can be programmed with simple free open source code or even high level or graphically based languages like LabView.

2 - <https://www.arduino.cc/>

# What is an Arduino?



Arduino Uno



Prototype Shield



Example Arduino Shield

```
sketch_jun27a | Arduino 1.0.6
File Edit Sketch Tools Help
sketch_jun27a Wuxi4 $
//WUXI Professional School of Science and Technology
//11/13/2014
//Code to control Single Axis Tracker Solar Panel & Limit Switches
int pbIn2 = 2;
int pbIn3 = 3;
//The two limit switches should be physically connected to pins 2
int ledOut12 = 12;
int ledOut13 = 13;
//The two limit switch LEDs are connect to pins 12 and 13 of the A
//When the state is high the limit switches is not engaged, i.e. t
int state2 = HIGH;
int state3 = HIGH;
//The states should both be high and would translate into the limi
int E1 = 4;
//This state of this pin enables or disable the motor drive.
int potPin = A0;
//The pot wiper should be connected to the A0 pin
int motorPin = 5;
//This state of this pin determines the direction of rotation of t
One file added to the sketch.
Arduino Uno on COM6
```

Open source Arduino Code

<https://www.arduino.cc/>

## What is LabView?

LabView is graphical based programming language developed by National Instruments and used extensively in industry.

LabView program are called "vi" programs and typically include a block diagram type of program that is programmed via block interconnections of various functional blocks.

LabView program also have a gui interface window that can be designed to allow users to view the data and control the programs.

LabView programs can be executed on computers with LabView installed or compiled and run as standalone programs. To create an executable program you must have a compiler.

# What is LabView?

The image displays four windows from the LabVIEW software interface:

- main.vi Front Panel:** A graphical user interface titled "Data Acquisition Control and Display Panel (DAC-DP)". It features a menu bar, a search bar, and two buttons labeled "Wheatstone Bridge" and "Cantilever Beam". Below the buttons is the logo for "IVY TECH COMMUNITY COLLEGE" and two circular icons labeled "SCME" and "NSF".
- Controls:** A palette of controls categorized into "Modern", "Silver", "System", "Classic", "Express", ".NET & ActiveX", "Robotics", "Biomedical", "DSC Module", and "Electrical Power". The "Modern" category is expanded, showing sub-categories like Numeric, Boolean, String & Path, Array, Matrix..., List, Table & ..., Graph, Ring & Enum, Containers, I/O, Variant & Cl..., Decorations, and Refnum.
- File Explorer:** A window showing the file system structure. The "main.vi" file is selected, showing its properties: "main.vi", "LabVIEW Instrument", "Date modified: 8/31/2015 12:16 PM", and "Size: 942 KB".
- main.vi Block Diagram:** A window showing the underlying logic of the front panel. It includes a "Source" table with columns for "Source", "Type", "Time", "CtrlRef", and "OldVal". A "URL" field contains "HTTPS://ivytech.edu". A "True" checkbox is checked. A "This VI" icon is connected to a "FP.Close" icon. A note says "Once a VI is selected, close this window". At the bottom, there are four buttons labeled "Cantilever Beam", "Wheatstone bridge", "SCMEWebsite", and "Ivy Tech Website", each with an "OK" button and a "FP.F" label. A note says "Buttons used to trigger events".

<https://www.ni.com/en-us/support/downloads/software-products/download.labview.html>

800-433-3488

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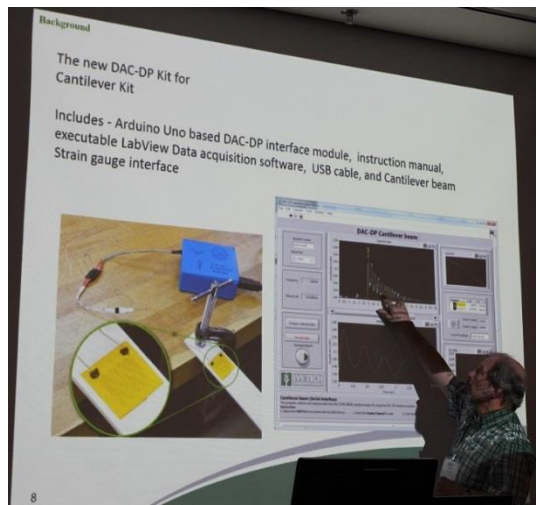
# Our Projects?

Design and build electronic kits that could be used in tandem with the SCME<sup>3</sup> kits.

These new kits should focus on cost and maximize student learning

New kits should be developed by student workers

Should be based on Arduino UNO, LabView and SCME kits



**MEMS: Data Acquisition Kit**

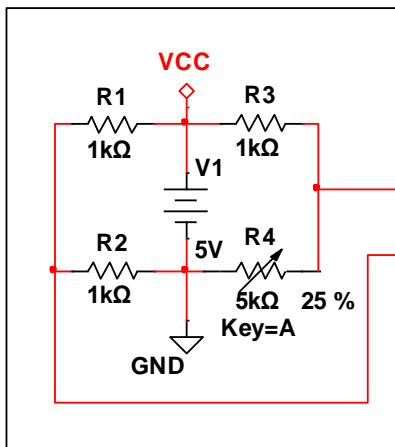
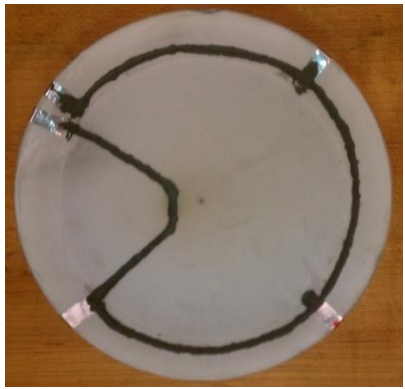
This kit is an electronic extension of the SCME pressure sensor model kit. DAC-DP interface module and LabView software allows the SCME pressure sensor model kit to interface to a computer provides a graphical display pressure sensor differential output voltage. Includes - Arduino Uno based DAC-DP interface module, instruction manual, executable LabView Data acquisition software, USB cable, and pressure sensor interface cable.



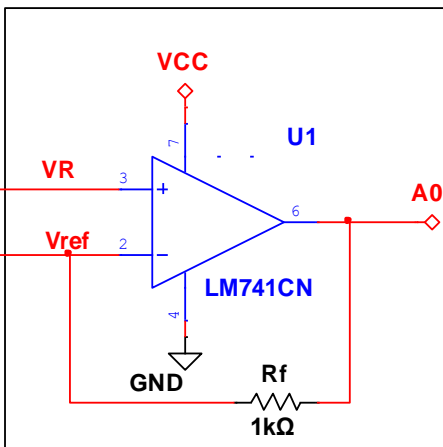
3 - <http://scme-nm.org/>



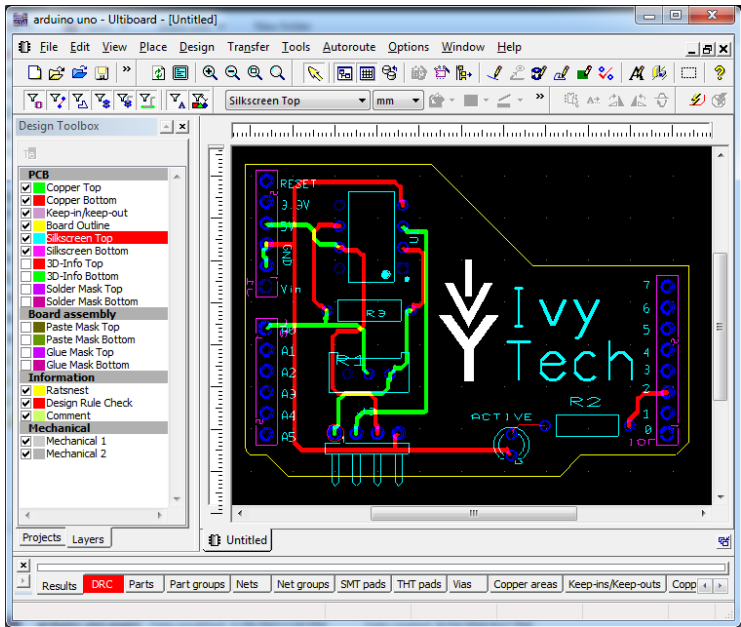
First up the Pressure Sensor kit => *Modeling a Micro Pressure Sensor Kit*



A simulated wheatstone bridge



The basic form of the DAC-DP shield








### Modeling a Micro Pressure Sensor Kit

Southwest Center for Microsystems Education

This kit contains most of the materials for the Modeling a Micro Pressure Sensor Activity in the *Micro Pressure Sensors* and the *Wheatstone Bridge Learning Module*. This activity provides participants an opportunity to study how a micro pressure sensor works and how a change in pressure affects the output of a Wheatstone bridge sensing circuit. Participants build a macro-size pressure sensor model with a Wheatstone bridge sensing circuit using pencil lead (graphene), rubber cement, a balloon (diaphragm), and a paint can (substrate). Participants test the operation of the model by creating calibration curves of the output of the sensing circuit as pressures are applied to the diaphragm.

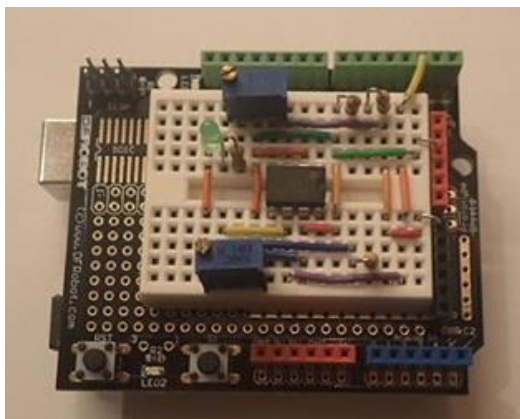
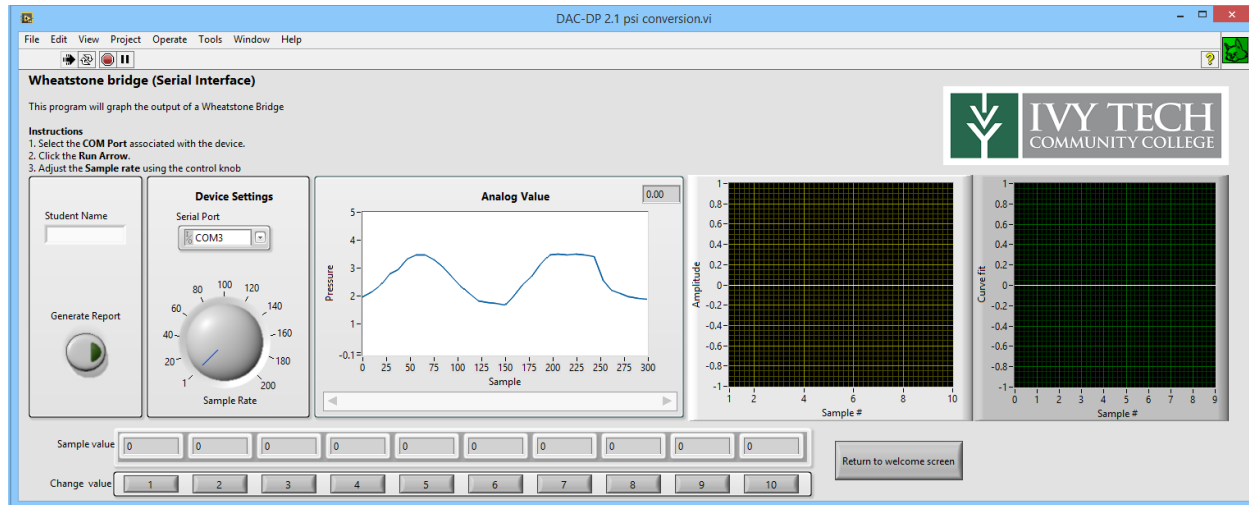
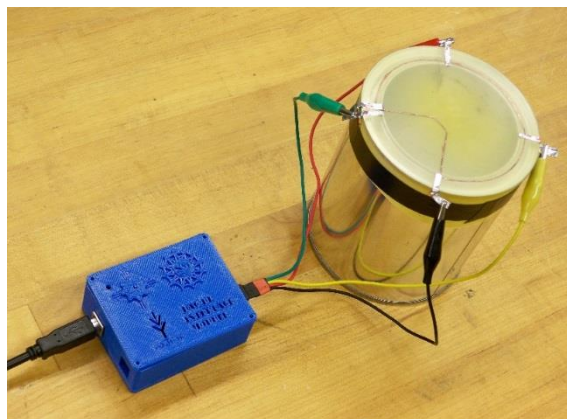
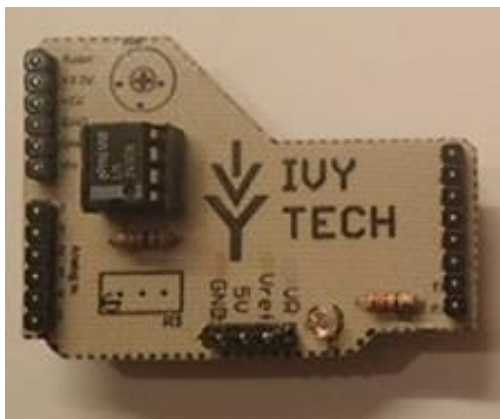





# Our Projects?

After many months ...

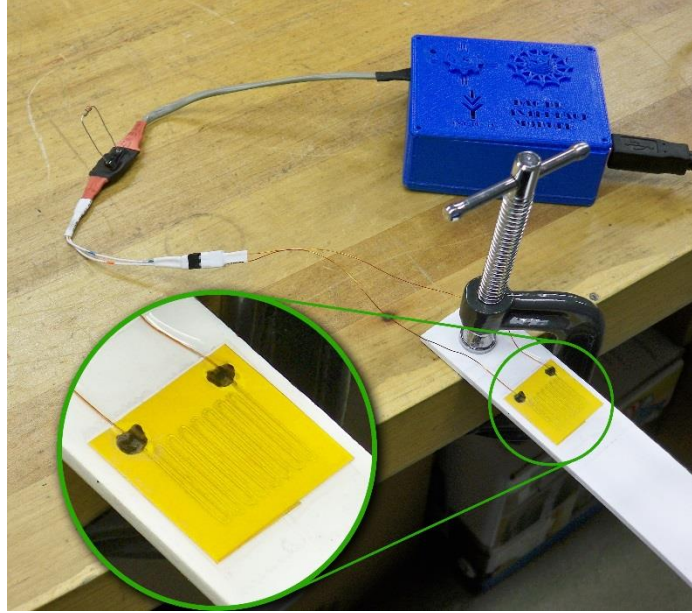
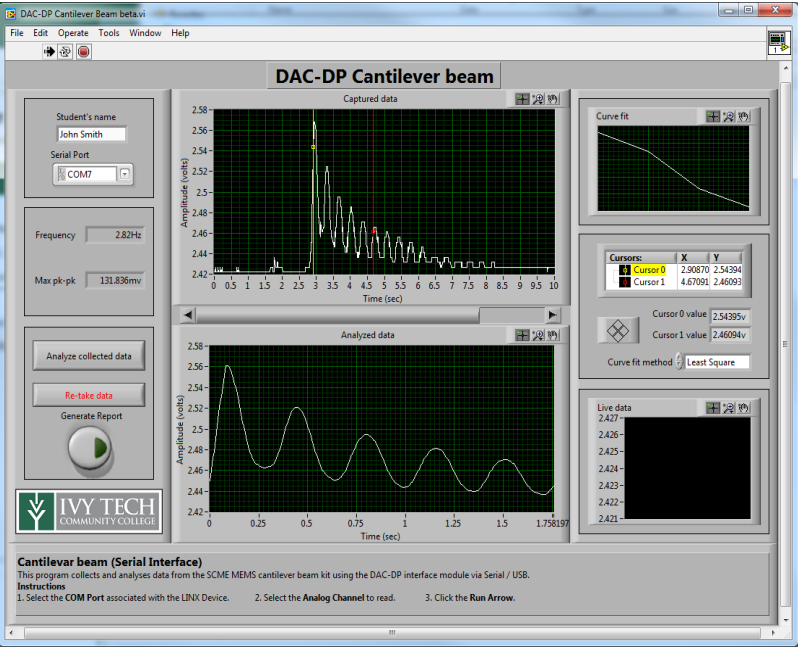
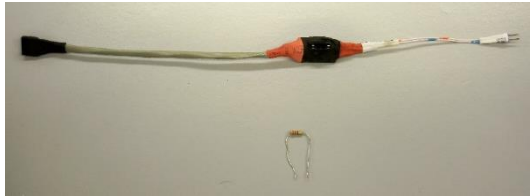


# Second up the Cantilever Beam kit => *Microcantilever Model Kit*

**Microcantilever Model Kit**

This kit contains most of the materials for the Microcantilever Model Activity in Book 2 of the Microcantilever Learning Module. This activity provides participants an opportunity to explore the motion of a cantilever under a varying mass and to determine the relationship that expresses the resonant frequency of a cantilever as a function of mass. This activity simulates the dynamic mode of operation for microcantilevers used in MEMS sensors.

Logos for SCME (Southwest Center for Microsystems Education), NSF, and THE UNIVERSITY OF NEW MEXICO are displayed. Small images show students working with the kit components.



# Questions?

<http://scme-support.org/>

<http://www.ivytech-mems.org/>

<http://faculty.ivytech.edu/~abell118/>

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