

Project Based Engineering Instrumentation With CircuitPython

A Brief Textbook Presented to the
Student Body of the University of South Alabama

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The kit used in this textbook can be purchased here
<https://www.tangiblesthatteach.com/product-page/instrumentation-kit-for-me-316>.
A preview of the textbook has been included but only the first few chapters as an example.

Acknowledgements

The author, Dr. Carlos Montalvo would like to acknowledge a few key members who made this textbook possible. First and foremost I would like to thank Adafruit for their entire ecosystem of electronics, tutorials, blogs and forums. Much of what I have learned here to teach Instrumentation was from Adafruit and the Adafruit Learn system and specifically people like Lady Ada and John Park who have helped shape CircuitPython and the Circuit-Playground Express to what it is today. I would also like to thank Dr. Saami Yazdani for creating the blueprint for Instrumentation at my university by creating a laboratory environment for an otherwise totally theoretical course. His course was the foundation for this textbook and for that I thank him for showing the way. Id like to also thank and acknowledge Tangibles that Teach for giving me the opportunity to morph this loose set of projects into a textbook that can be used for multiple universities and classrooms and of course help students learn and acquire knowledge through creating.

About this textbook

This textbook has been designed with the student and faculty member in mind. First, this textbook goes hand in hand with Engineering Instrumentation taught at the undergraduate level at many universities. The course begins with simple plotting and moves into data analysis, calibration and more complex instrumentation techniques such as active filtering and aliasing. This course is designed to get students away from their pen and paper and build something that blinks and moves as well as learn to process real data that they themselves acquire. There is no theory in these projects. It is all applied using the project based learning method. Students will be tasked with downloading code, building circuitry, taking data all from the ground up. By the end of this course students will be well versed in the desktop version of Python while also the variant CircuitPython designed specifically for microelectronics from Adafruit. After this course students will be able to understand Instrumentation at the fundamental level as well as generate code that can be used in future projects and research to take and analyze data. Python is such a broad and useful language that it will be very beneficial for any undergraduate student to learn this language. To the professors using this textbook, 1 credit hour labs are often hard to work into a curriculum and live demonstrations in the classroom cost time and money that take away from other faculty duties. Ive created this kit and textbook to be completely stand-alone. Students simply need to purchase the required materials and follow along with the lessons. These lessons can be picked apart and taught sequentially or individually on a schedule suited to the learning speed of the course. I hope whomever reads and learns from this textbook will walk away with an excitement to tinker, code and build future projects using microelectronics and programming.

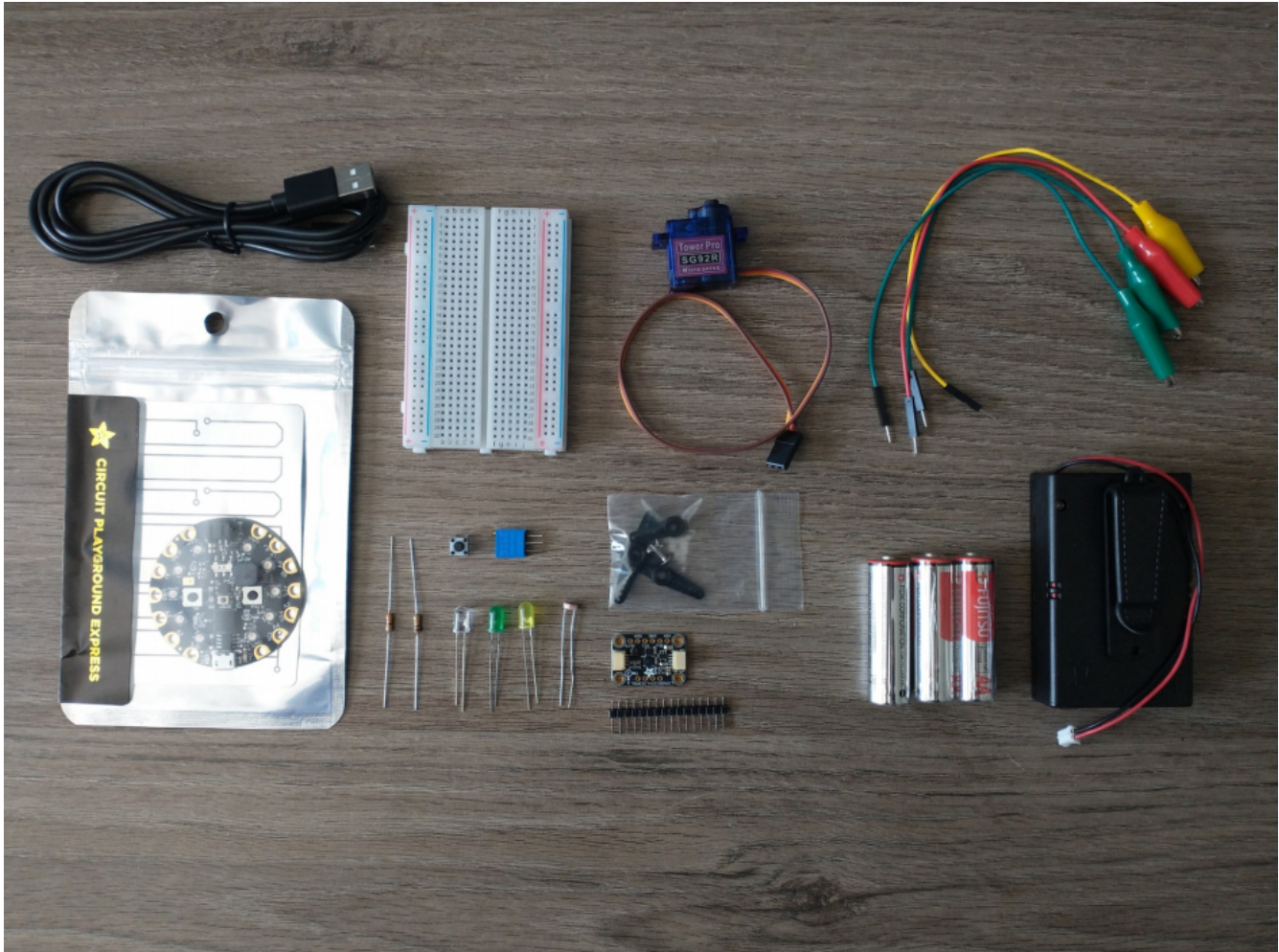
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1 Purchase Instrumentation Equipment

In this class you're going to build some circuits that will enhance your learning experience. Rather than just solving problems by hand you're going to take and analyze data. Over the summer of 2020, I wrote a textbook with Tangibles that Teach and they have graciously bundled all components together. The price is \$50 plus shipping so it's about the same price as below but you'll probably save on shipping from multiple vendors and everything is all in one place which is nice. There is an accompanying textbook that can be downloaded as well.

When you get your kit familiarize yourself with all of the components. I created an unboxing video on Youtube for you to take a look. Below is also a photo of all the components.



1.1 Quick Links

1. Kit
2. Document
3. Unboxing Video

1.2 Turning in this assignment

1. Upload a receipt of ALL of your purchases - 50%
2. Put your name and the names of your group members. If working alone, tell me you are planning on working alone in the PDF you upload. In times of COVID, everyone is working alone - 50%

ONLY READ BELOW IF YOU DONT WANT TO BUY THE KIT ABOVE

1.3 Purchase Items Yourself

The bill of materials listed below is designed for 2 or 4 students to work together and share pieces. This kit is not optimized for 3 students. If you are a remote/online student or you just prefer to work alone then you have the option of purchasing everything yourself. The cost per student in a group of 4 and 2 is listed as well as the cost if working alone. You'll find that even with the optional equipment, the cost of working alone is still less than the price of a standard college textbook. Note that if you are working alone, be sure to only purchase 1 of each item. If working in pairs you also have the option of purchasing one of each item. Finally, if you own some of these components you may wish to simply purchase each item separately. A detailed parts breakdown is shown after the rubric.

1.4 Bill of Materials (per 4 students)

Item (ONLY IF YOU DONT WANT THE KIT ABOVE)	Quantity	Total Cost
Circuit Playground Express (CPX)	2	\$50
Servo	2	\$10
USB Cable	2	\$6
Electronics Kit (Photocells, Resistors, Trimpot)	1	\$13
Alligator Clips	1	\$4
Total		\$83
Cost per student in a group of 4		\$21
Cost per student in a group of 2		\$25
Cost if working alone		\$50
Optional Equipment		
External Power Supply	2	\$6
AA Batteries	2	\$6
Analog Pitot Probe	1	\$31
Rate Gyro (LSM6D3SS)	1	\$10
Total with Optional Equipment		\$136
Cost per student in a group of 4		\$34
Cost per student in a group of 2		\$50
Cost if working alone		\$97