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## Course Rational - Introduction to Solar Energy, Arduino Electronic Circuits and mBot Robots

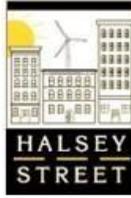
How can educators prepare students for jobs that haven't been created yet? In October of 2020, General Motors and Ford gave us the answer by announcing that they will eliminate all gas and diesel light-duty vehicles by 2035. GM said it plans to invest \$27 billion in electric and autonomous vehicles by 2025, while Ford announced that it will invest \$22 billion in electric vehicles and \$7 billion in autonomous vehicles through 2025. In addition, the [Internet of Things Revolution](#), which uses Arduino electronic circuits and the cloud to connect our devices (e.g., the smartphone to a refrigerator, or a stove, or a car, etc.) is in full bloom.

Out of this revelation, we developed an electronic circuits and robotics course to introduce participants to electronic circuits, robotics and C++ coding. Our Train-the-Trainer capacity building program offers schools and youth organizations an inexpensive way to add this program to your course activities catalog. This course is designed as a turn-key system which includes all the course training material, 10 mBot Robots, 10 Arduino Circuits Kits and 10 Zoom lectures which will enable your organization to teach the course to future students for \$2,484.80 per location.

Each project enables the student to compare the math calculations from the formula used in the project assignment with real-time values that come out of the experiment using tools like multi-meters, serial monitors, stop watches, mBots and rulers. For example, Ohm's Law can be used to calculate the amount of voltage that should flow through a circuit. While we can use a multi-meter to measure the actual amount of voltage going through the circuit in real-time.

Each project offers students authentic opportunities to use the scientific method to create experiments and develop validity checks to test the experiment during each step in the process. Remember, a well-designed experiment allows the student scientist to test each step in the experiment to make sure that step is working properly. And to measure the efficacy of the experiment in relation to its ability to prove that the original hypothesis is true (e.g., Hypothesis: "A photo resistor can be programmed to turn an LED on automatically when the room gets dark").

Each project is divided into six academic steps, which engage students in hands-on activities and enable the instructor to teach across disciplines. The six steps include: (1) Key words, (2) Performing the math calculations, (3) Building the electronic circuit, (4) Programming the circuit, (5) Answering the What If and Why Not Questions related to the project, and (6) Programming the bonus coding assignment. Thus, the vocabulary words, math assignments, programming assignments, and the what if and why not questions work in harmony to help the student master the subject material.



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## Overview - Introduction to Solar Energy, Arduino Electronic Circuits and mBot Robots

Over the past three years, our Introduction to electrical circuits and mBot Robots curriculum has evolved into a Zoom based online course, which provides 9-to 14-year-old participants with a sound introduction to the subject matter. This subject matter includes: Generating solar PV energy, building and programming Arduino based electronic devices (e.g., motion sensors, DC motors, photo resistors, etc.), and building and programming a Makeblock mBot Robot.

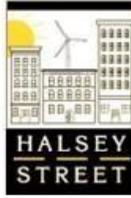
In addition, before building and programming the actual electrical circuits required to complete each of the nine projects, students must (1) draw a schematic diagram of each project's series circuit, (2) make calculations based on the mathematical formulas (e.g., Ohm's Law, The Distance Formula, Mapping, etc.) associated with each project, and (3) build computer simulations of each circuit using the TinkerCad software program.

Finally, students will be introduced to the "FlexTIM Critical Thinking and Questioning System". FlexTIM was developed to help participants cultivate a systematic approach (e.g., What does it say? What does it mean? Why does it matter?); to understanding the key relationships between the physical connections, math formulas and computer coding skills required to complete an Arduino or Robotics circuit building and coding project. The questioning, diagramming and evaluation skills taught via the FlexTIM system are transferable to any other set of circumstances that require problem solving skills.

### Course Goals:

**Upon completion of this course, the student will be able to:**

1. Understand the importance of electronics and coding in relation to job opportunities and careers in a 21<sup>st</sup> Century economy;
2. Understand the key relationships between the physical connections, math formulas and the computer coding skills required to complete an Arduino or Robotics circuit building and coding project;
3. Diagram, and build Arduino Uno and Mblock mBot Robot electrical circuits;
4. Use the C++ and Mblock coding editors to write programs that enable an Arduino Uno circuit or a Mblock mBot Robot to perform a series of tasks;
5. Test theoretical math projections (e.g., volts in a circuit, distance from an object, amount of light in a room, etc.) against the actual values in the real world using tools like robots, serial monitors and multi-meters; and
6. Use the scientific method as a problem-solving tool for testing circuits and debugging code.



**The Introduction to Solar Energy, Electronic Circuits and mBot Robots textbook has three sections:**

**Section One (Optional)** is based on Lab One, using Solar PV to Explain Ohm’s Law and will require:

Equipment needed for Lab 1 (Optional)	<a href="#">Solar PV Energy Kit</a> & <a href="#">Multi-meter</a>	\$30.07
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**Section Two** is based on Labs 2 through 8, featuring the Arduino Uno and will require:

Equipment needed for Labs 2 through 8	<a href="#">Arduino Starter Kit</a>	\$33.98
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**Section Three** is based on Labs 9A, through 11, featuring a Makeblock mBot Robot and will require:

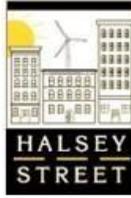
Equipment needed for Labs 9A, 9B, 10 & 11	<a href="#">Arduino Makeblock mBot Robot</a>	\$79.99
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**Note:** Battery Requirements: 4 pcs AA batteries for mBot Robot and CR2025 coin battery for IR Remote Control

Additionally, required course reading and lab activity assignments will be made available via an electronic version of the Solar PV Energy, Arduino Circuits and Robotics course textbook (\$49.00). While the entire curriculum is available on a flash drive. The flash drive includes: the textbook, all the course power point lectures, instructional videos on how to build and program an Arduino device or mBot Robot using an Arduino microprocessor and a site license. The site license grants the institution permission to install the training materials site wide is (\$499.00).

**Grading**

- The “Circuits and Robotics Introductory Course” offers 3 levels of completion, with 3 certificates:
- In order to gain a silver certificate-of-completion a student will be required to successfully complete 6 of the 9 work product assignments.
- In order to gain a gold certificate-of-completion a student will be required to successfully complete 7 of the 9 work product assignments and one bonus assignment.
- In order to gain a platinum certificate-of-completion a student will be required to successfully complete 8 of the 9 work product assignments and two bonus assignments.



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## Arduino Circuits & Robotics Course Detailed Budget Per Location

This budget is based on your organization having a room with ten computers connected to the Internet.

### Train-the-Trainer - Materials and Lectures:

- The course registration and site license to use and distribute version one of the training materials (i.e., textbook with a lab activity workbook, power point instructional lessons, instructional articles and videos, etc.) at a given location is \$499.00.
- The course training which includes, 10 zoom lessons for the first instructor per site is \$499.00
- The course registration and training cost for each additional instructor per site is \$98.00.

### Training Kits Needed for the Electronic Circuits and Robotics Course:

- 10 [Arduino Circuits Starter Kits](#) at \$33.98 each \* 10 = \$339.80
- 10 [Arduino Makeblock mBot Robot Kits](#) at \$79.00 each s\* 10 = \$799.00

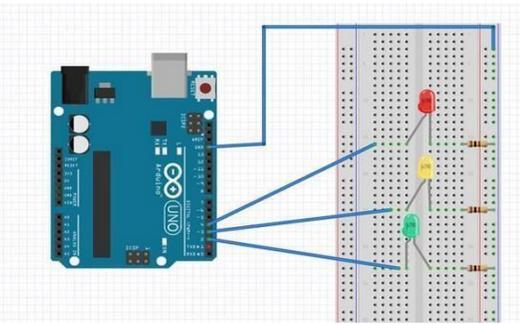
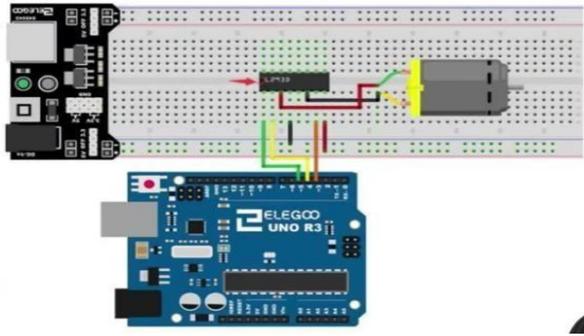
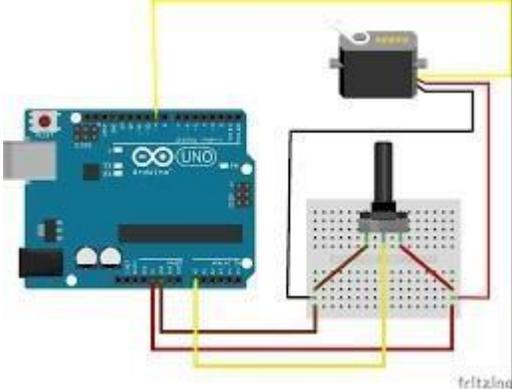
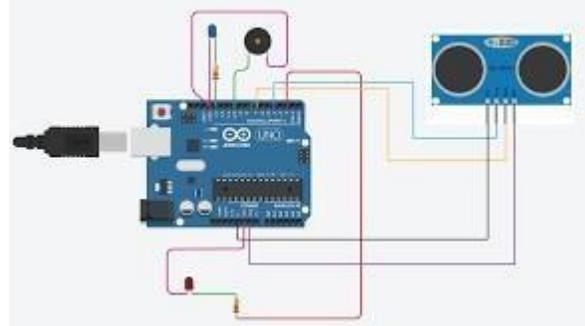
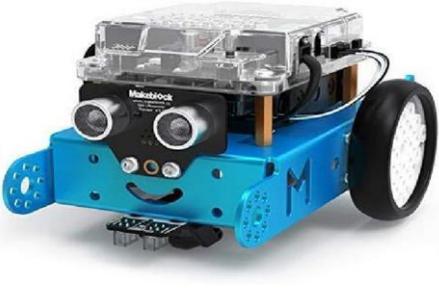
**Note:** The Arduino Starter Kits and mBot Robot Kits need only be purchased once, because they can be used over and over again. In addition, as an option if you are purchasing new computers and have no tech support we can load and configure all the software needed for the course for \$55.00 per computer minus the shipping.

### Miscellaneous Cost:

Based on a 10 computers: batteries, safety goggles, safety pins, composition note books, ink pins, scotch tape, tape measures, scissors, spare parts, multi-meters, shipping, etc. **\$250.00**

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**Total Cost for 10 units -- Training Materials, Training Kits and Zoom Training for One Instructor is \$2,484.80**  
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**Pictures of Arduino Circuits, the Course Kits and the mBot Robot**

	
<p><b>Arduino Red, Yellow, Green LED Project</b></p>	<p><b>Arduino DC Motor Project</b></p>
	
<p><b>Arduino Servo Motor, Potentiometer Project</b></p>	<p><b>Arduino, Motion Sensor, Alarm, LED Project</b></p>
	
<p><b>Solar PV Energy Kit</b></p>	<p><b>Makeblock mBot Robot</b></p>