

Engineering Research Course, Boston Leadership Institute, 2018

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## **Student Goals:**

### **Part I-Basic Electronics**

- A. Use electricity and electronics terminology appropriately: Conductor, insulator, open circuit, closed circuit, short circuit, series circuit, parallel circuit, ground, voltage, current
- B. Use electronics tools and materials safely and appropriately (wire cutter/strippers, crimper, pliers, alligator clips, copper tape)
- C. Learn and apply key electronics concepts: circuits, current flow, voltage potential, and power
- D. Identify electronic components and be able to determine their value of a resistor using appropriate codes
- E. Interpret/draw electrical schematics and symbols for electronic components
- F. Solder components on a variety of substrates using appropriate tools and materials (soldering irons, solder, helping hands, tip cleaner)
- G. Follow a simple circuit schematic and build the circuit (making connections with alligator clips or copper tape, not solderless breadboard)
- H. Analyze/debug a circuit (check for shorts, opens, missed connections, incorrect design, etc.)
- I. Identify the connections available on a solderless breadboard
- J. Follow a simple circuit schematic and build the circuit on a solderless breadboard.
- K. Use a simple integrated circuit chip (IC) in a circuit
- L. Use multi-meters to measure voltage and current, and to determine continuity

### **Part II: Arduino Microcontrollers**

- M. Learn the Arduino development environment and be able to use it effectively
  - a. Set up Arduino on your computer
  - b. Name and store files appropriately
  - c. Set up a system to work collaboratively with other students
- N. Program in C
  - a. Learn syntax and program structure
  - b. Have good programming style
  - c. Use variables, logic, functions, and comments appropriately
  - d. Research commands as needed using online tools
  - e. Debug code effectively
- O. Use Arduino to read and control hardware, and display through Serial Monitor

- a. Learn electronic components
- b. Use a breadboard and wire hardware correctly
- c. Create programs that rely on Input/Output
- P. Use a variety of sensors and actuators and interface them with computer
  - a. Sensors: Ultrasonic distance sensor, Reflectance sensor, switches
  - b. Actuators: LEDs, DC motors/Motor controller, Servo motors, Neopixels (addressable LEDs), speakers

### **Part III: Robotics**

- Q. Understand basic robotics – “Sense, think, act”
- R. Tour MIT Edgerton Center, MIT Museum
- S. Create algorithms to create sensor-based behaviors (follow a flashlight, line following, object avoidance)
- T. Come up with a challenge, design algorithm, and program it- line follower, obstacle course, follow the leader, retrieve an object, navigate a maze, interactive demonstration/toy, etc.
- U. Document and present your work on algorithm and program development- as a short slide show.

### **Projects and Activities**

1. Electronics investigations and lessons - beginner
2. LightMeUp tiles: Design, construction, and electronics project
3. BumpBots: Construction, wiring, and customizing project
4. LightBot: 2-wheeled robot chassis construction and control with photocells (no computer)
5. Audio Amplifier project
6. Electronics investigations and lessons - intermediate
7. Coding Tutorials for Arduino/electronic components
8. Robot Projects - Programming and Algorithms