

## cpSC 543 Lab 2: Arduino Intro + Actuator Basics

V2.0 (2016.01.28): updated circuit numbers (Adafruit → Sparkfun tutorials)

### Learning Goals:

- Understand the structure of a basic Arduino program
- Know how to use a solderless breadboard
- Set up and understand a simple electronics circuit
- Make a motor move, using the Arduino board digital outputs
- Know how to convert rotary to linear motion by at least one means.

### The Assignment:

- Evolve one variation from Lab 1 with a motor / actuator, controlled by an Arduino.
- Incorporate *both* variability and repeatability, to at least small degree.
- Your solution must involve converting the motor's rotary motion to linear movement at some point.
- Work in pairs or individually.
- As with Lab 1, video/photo document your work and describe on your blog (every individual creates own documentation). Post the blog link onto the course twiki, at: <https://www.cs.ubc.ca/wiki/do/view/CS543/Labs>

### Suggested Steps (requires 543 Arduino Kit w/ Uno R3)

#### Before / at start of lab:

- 1) Get to know Arduino. Start here: <https://www.arduino.cc/en/Guide/HomePage>  
Read the Intro, and at least skim the other linked pages.
- 2) Review introductory slides for class: linked from course Dashboard.  
*Content: anatomy of Arduino board / program (not including shield)*
- 3) Install the Arduino IDE on the laptop you will be using:  
<https://www.arduino.cc/en/Main/Software>  
I.e. download/load IDE, drivers for the Uno; then load the "blink" program on the Uno  
*Current Arduino IDE version: 1.6.7*  
*Tip: doesn't always do well with hubs; plug USB cable directly to your laptop*
- 4) Familiarize yourself with components in your kit:  
[SparkFun Inventor's Kit – v3.2](#) -- component list appended below.
- 5) If needed, learn or review principles of a solderless breadboard, e.g.:  
<http://www.tigoe.net/pcomp/code/circuits/breadboard>
- 6) Bring laptop + full kit to lab anytime you plan to work on the project.  
*Note: You can keep your kit in a locker – bring your own lock and claim one.*

(continued on next page)

**At lab and on your own – referring to the Experimenter’s Guide (in kit):**

- 7) Build and understand CIRC-01 (Blinking LED). This includes setting up your board and familiarizing yourself with the essential Arduino workflow.

*Tips: Always build while board is unpowered, and check your circuit carefully before powering up. Use a Digital Voltmeter (DVM) to help debug your circuit while under power – there’s one in x360.*

- 8) Build and understand **Circuit 12** (Spinning motor w/ transistor) and **Circuit 08** (Servo); both can be done without a motor shield (low power). These will give you experience with two types of motors. Be sure you understand program structure, the role of the transistor and how the servo motor works differently from the small DC motor.

*Tips: 330 Ohm may work better than 10K Ohm resistor. Why?*

- 9) Build and understand **Circuit 02** (Potentiometer; analog input).

- 10) Explore other programs and circuits as necessary to familiarize yourself with system and the sensors in your kit.

- 11) **FINALLY: do the assignment!** (Refer to the top of page 1, to remember what it is ☺)

In addition to the software element, your *mechanical* challenges include: converting rotary to linear motion; and attaching something firmly to your motor shaft. *What are several ways you might accomplish these?*

Some places to read more (these are “on reserve” in x360, but please do not remove from room – they are Karon’s personal books):

- David Macaulay, *The Way Things Work*. 1988/1998: Houghton Mifflin.
- Dustyn Roberts, *Making Things Move DIY Mechanisms for Inventors, Hobbyists, and Artists*. 2010: McGraw-Hill/TAB Electronics.

**COMING UP:** In the next lab, you will need a motor driver. These are still on order, but will be distributed as soon as we get them.

If you get through Lab 2 quickly, feel free to get started on building and using it (and avoid congestion at our soldering stations!)

**Lab 2 Mark Sheet (completed by instructor)**

Name: \_\_\_\_\_

Partner (N/A if none): \_\_\_\_\_

Term: 2015/16 W2

One variation from Lab 1 evolved to use a motor / actuator, controlled by an Arduino.

(25%) Variability incorporated, to at least a small degree

(25%) Repeatability incorporated, to at least a small degree

(30%) Converts rotary to linear motion

(20%) Documentation adequate (visual and words)

Multiplier applied for late hand-ins, as described on course homepage.

**OVERALL MARK:**

**Great (100%)** Entirely satisfied and exceptionally well done

**Good (85%)** Entirely satisfied and well done

**Fair (70%)** Largely satisfied, few major issues

**Poor (54%)** Some worthwhile, comprehensible effort, with substantial issues

**Zero (0%)** Little to no real comprehensible effort; not handed in or otherwise unacceptable

**Appendix 1: Linear to Rotary Motion - Ideas**

**TABLE 8-1** Converting Between Types of Motion

OUTPUT		INPUT				
		ROTARY	OSCILLATING	LINEAR	RECIPROCATING	INTERMITTENT
TRANSFORMATIONS	CONVERSIONS					
	ROTARY	OSCILLATING	LINEAR	RECIPROCATING	INTERMITTENT	
ROTARY	Gears, pulleys and belt, sprockets and chain, crank slider	Crank	Rack and pinion, linkage	Piston, bell crank		
OSCILLATING	Crank, quick return			Linkage		
LINEAR	Wheels, rack and pinion, scotch yoke	Scotch yoke	Scissor linkage			
RECIPROCATING	Cam, crank, piston	Crank, cam, bell crank				
INTERMITTENT	Geneva stop	Ratchet		Ratchet		
IRREGULAR	Cam	Cam				
INCREASE/DECREASE	Gears, pulleys and belt, sprockets and chain	Gears		Lever	Lever, gears	
REFLECT	Gears	Gears	Pulley, lever	Pulley, lever	Pulley, lever	
ROTATE	Bevel gear, worm gear	Bell crank	Bell crank	Bell crank	Bell crank	

## **Appendix 2: Contents of 543 Arduino Kit**

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