



APSC 150-2015 Hands-On Lab 2-3

February 2015

Schedule, context and additional info: <http://projectlab.engphys.ubc.ca/apsc-150-2015/>

- **Goggles are mandatory** at all times in this lab.
- **No sandals** or open-toed shoes are allowed, no exceptions. You will likely be asked to leave, and come back for another tutorial session.
- **Dress appropriately.** You may wish to wear appropriate clothing (some of the hand tools may have some residual grease on them).
- **Prepare ahead of time** by downloading and installing the [Arduino Software](#)

There are four parts in this two-hour lab:

- 1) Work in pairs. Each pair uses one Arduino Kit for **up to to one hour in this lab**. Use the first **20 minutes** of this lab to familiarize yourself with Arduino. Attach it to your laptop, upload programs, and understand how to use the serial monitor feature of the Arduino environment. Watch + do items in the following order:
 - “[Communication](#)”
 - “[Breadboards+Components](#)”
 - “[Attach knob \(potentiometer\)](#)” (don't do the LED part), and “[Serial Monitor](#)”
 - “[Joystick](#)”
- 2) In the **following 10 minutes**: Remove the joystick and empty your breadboard. Then, [attach the servo motor](#) on your platform undercarriage to the Arduino. Use the program “sweep” to oscillate the arm. If needed, adjust the position of the little plastic arm on the servo by taking it off, and re-attaching it in a position that yields correct arm behavior.
Next: On page three of the same PDF (“attach the servo motor”) you see a program labeled “potentiometer”. With this, you can operate a servo using a potentiometer. See if you can wire your joystick up with your servo motor (on your launcher undercarriage) and use that code to operate the servo with the joystick.
- 3) **45 minutes into the lab**: Transition to design phase: Your team of eight gets together and decides which of their two initial project ideas will be built. The team then splits up in two groups of four to to fully design and specify each selected project idea. This stage will determine how easy your next labs are. The more an idea is specified, generally the easier it is to put together and test quickly.
- 4) **Five minutes before the end**: Clean up. Make sure the Arduino kits are in their original state as [shown in the picture](#). Put everything back in the correct compartments, make it easy to see if something is missing. Report broken or missing items and get replacements to complete the box. Leave Arduino kits and tool boxes on your bench as you found them.

Deliverables:

- Working undercarriage with “sweep” program, with serial monitor displaying the servo position. You can show this to your instructor (and ask for having your attendance marked).
- Design decisions are now made. This part can not be checked by us, but your team should know exactly what steps to take in lab 2.3 to build two complete prototypes.

Preparations for Lab 2-4, if time allows:

To build their two prototypes, each team of eight will each receive a ziploc bag containing two Arduino boards, six servos, two breadboards, two joysticks, resistors, usb cables and a number of jumper wires. These items remain with the team until the end of the competition. They allow you to build two complete launchers and operate them in lab 2-4. In lab 2-5 and during the competition, unused parts can serve as backups for your team.

Appendix

- ➔ **Extra tools, supplies** and metal **recycle** are located in the back of Hebb 22. Extra servos and servo extension cables are here, too.



- ➔ **Done** with the Arduino Kits? Show us that you have cleaned it up (all four benches in one team), and we will give you the ziploc bag with Arduinos and parts needed for your two launchers. This can happen as early as one hour into the lab, after you have done parts 1 and 2.
- ➔ **Programming code to operate your finished launcher: Two to choose! Which is best?**
 - Copy & paste into Arduino IDE
 - See what input and output pins are used to attach servos and joystick
 - Once you have [wired up everything](#), try both versions and decide which will do the best job for your launcher

```
// CODE ONE: Integral Control For Launcher
```

```
#include <Servo.h>
Servo panservo;
Servo tiltservo;
Servo launchservo;

int pan=100;
int tilt=100;
int launch=160;
const int launchbutton = 8;

void setup()
{
  Serial.begin(9600);
  panservo.attach(9);
  tiltservo.attach(10);
  launchservo.attach(11);
  pinMode(launchbutton, INPUT);
}

void loop()
{
  int panchange = analogRead(A0);
  pan = pan + ((panchange/100)-5);
  pan = constrain(pan,1,180);
  Serial.print(pan);
  Serial.print(" ");
  panservo.write(pan);

  int tiltchange = analogRead(A1);
  tilt = tilt +((tiltchange/100)-5);
  tilt = constrain(tilt,1,180);
  Serial.print(tilt);
  Serial.print(" ");
  tiltservo.write(tilt);

  launch = digitalRead(launchbutton);
  if (launch==1)
  {launchservo.write(80); Serial.println(" ");}
  else
  {launchservo.write(160); Serial.println("launch!!");}

  delay(20);
}
```

```
// CODE TWO: Proportional Control For Launcher
```

```
#include <Servo.h>
Servo panservo;
Servo tiltservo;
Servo launchservo;

int pan=100;
int tilt=100;
int launch=160;
const int launchbutton = 8;

void setup()
{
```

```
Serial.begin(9600);
panservo.attach(9);
tiltservo.attach(10);
launchservo.attach(11);
pinMode(launchbutton, INPUT);
}

void loop()
{
  int pan = analogRead(A0);
  panservo.write(pan/5.7);
  Serial.print(pan/5.7);
  Serial.print(" ");

  int tilt = analogRead(A1);
  tiltservo.write(tilt/5.7);
  Serial.print(tilt/5.7);
  Serial.print(" ");

  launch = digitalRead(launchbutton);
  if (launch==1)
  {launchservo.write(80); Serial.println(" ");}
  else
  {launchservo.write(160); Serial.println("launch!!");}

  delay(20);
}
```

- ➔ **Feedback:** If you noticed anything that could be improved about this lab, or spotted an error of any kind, or just have ideas about how to improve things, email bzender@physics.ubc.ca
- ➔ **Don't leave trash behind** on your bench, don't leave broken components in the kit, and get refills for anything that might be missing.
- ➔ **Hand tool box:** If you used any tools from the hand tool box, please clean that up too.

Thank you very much!