

## Objectives

- More practice writing assembly language programs
- Introduction to peripherals: LEDs and buttons
- Introduction to subroutines

## Academic Integrity

Prior to submitting your assignment, you should familiarize yourself with the University policy on Academic Integrity:

<http://web.uvic.ca/calendar2014/FACS/UnIn/UARe/PoAcI.html>

We will use a plagiarism detection tool on all assignment submissions.

## Demonstrations

You will be required to demonstrate your solution to at least one part of the assignment. You will be required to explain how your code works and make a small change to your code. You must demonstrate competence with AVR Studio 4 and uploading the code to the board.

Demonstrations will take place outside lecture and lab times. A sign up sheet will be posted on the door to the lab. If you do not sign up for a demonstration, you will receive 0 for the assignment.

## AVR Studio Project

As in assignment 1, you should create a new assembly language project in AVR Studio for this assignment. Download the sample code and add the files to the project.

## Part I – Lighting the LEDs

As you've seen in the lab, the boards include a 6 LED strip, where each LED can be controlled independently from the others.

Although the LEDs are wired to adjacent Arduino pins, they are controlled using two AVR ports: PORTB and PORTL. The exact mapping is shown in the table below:

Pin	PORT	Bit #
42	L	7
44	L	5
46	L	3
48	L	1
50	B	3
52	B	1

You should modify the code in `a2q1.asm` so that it displays the value in R0 in binary using the 6 LEDs. You should consider the LED on Pin 42 to be the least-significant bit and the LED on Pin 52 to be the most-significant bit.

For example, if R0 contains the value 0x13, the LEDs should look like:

Pin	52	50	48	46	44	42
Value	OFF	ON	OFF	OFF	ON	ON

Be sure to test your code on several different values.

Your instructor's solution used a combination of `ANDI` and `BRNE` instructions to test the individual bits in R0 and then used `ORI` to set individual bits in two output registers: one that is output to PORTL and another that is output to PORTB.

**Be sure you understand the assignment 2 exercise given in class on February 2, 2015 before you start programming this question.**

## Part II – Subroutines and timing

Using the code you wrote in Part I and the delay code provided to you in Lab 4, write a program that does the following:

```
counter = 0
start:
    display counter in binary on the LEDs
    counter = counter + 1
    delay between 100 and 300 milliseconds
    goto start
```

First you should turn the code you wrote in Part I into a subroutine called `display`. Then write a main program that implements the algorithm shown above. It will be easiest if you use `r0` for your counter.

## Part III – Button press counting

Using the button code and delay code provided to you in Lab 4, write a program that does the following:

```
counter = 0
start:
    if button pressed
        counter = counter + 1
        delay between 100 and 300 milliseconds
    display counter in binary on the LEDs
    goto start
```

## Part IV – Improved button code

Improve the button code so that it correctly determines which button has been pressed. Study the comments in `a2q4.asm` for details on the values returned from the analog to digital conversion when the buttons are pressed.

You've been provided with a main program – you'll need to fix the button subroutine and include your LED display subroutine. Once you do that, a different light should come on for each button you press.

Your instructor's solution used the `BRSB` instruction.

## Submission

Submit your `a2q1.asm`, `a2q2.asm`, `a2q3.asm` and `a2q4.asm` using connex. Do NOT submit your project file – just the .asm files.

## Grading

If you submit a program that does not assemble you will receive 0 for that part of the assignment.

**If you do not complete a demonstration of your code during the posted demonstration times, you will not receive a grade for this assignment**

Question 1	4 marks
Question 2	4 marks
Question 3	4 marks
Question 4	2 marks

Total                      14 marks