# **OBJECTIVES:**

* To examine the I/O port operation using a simulator.
* To trace through a CALL subroutine using a simulator.

# **MATERIAL:**

* Atmel Studio
* <https://lcgamboa.github.io/js/picsimlab.html?../picsimlab_examples/> (Simulator)

# **WEB SITES:**

* [www.microchip.com](http://www.microchip.com/) for Atmel Studio Software

# **ACTIVITY 1**

Test the operation of an “up-counter” from $00 - $FF on picsimlab. Connect the LEDs to each pin of the PORTD and perform the following steps:

1. Assemble the following code:

;========Press your up-counter code here==========

;=================================================

DELAY: LDI R21, 32

DL1: LDI R22, 200

DL2: LDI R23, 250

DL3: NOP

NOP

DEC R23

BRNE DL3

DEC R22

BRNE DL2

DEC R21

BRNE DL1

RET

1. Upload the hex file to the picsimlab.
2. Observe the LEDs counting up from $00 to $FF.
3. Change the time delay in between the counts by changing the value of R21 register (or increase/decrease the number of NOPs) but make sure the time delay is long enough that you can observe the LEDs counting up. Create a hex file then upload to picsimlab to see what differences.

# **ACTIVITY 2**

In Activity 1, the maximum count was $FF (or 255). Modify the above program to set maximum count to 10.

1. Upload the hex file into the AVR simulator.
2. Observe the LEDs counting up from $00 to $09 (00001001 binary) continuously.
3. Change the maximum count to the value of your age and observe the LED counting up to that number.

# **ACTIVITY 3**

For this activity, connect the DIP switches to pins of port B. Now, use the DIP switches on picsimlab to set the maximum count for an up-counter instead of using constant as Activity 1 and 2.

1. Upload the hex file into the AVR simulator.
2. Observe the LEDs counting up from 00 to the value set by the 8 switches continuously.

**Answer question**

1. What is the maximum count for register R20?
2. In this Lab, which port was used to display the count? Which one was used to set the maximum count? Can we use one port for both (inputting the maximum count and displaying the count)?
3. In this Lab, we used BRNE (Branch Not Equal) instruction. Explain how it works.