

ECE-3226/CSCI-3451 – Microprocessors Lab

Lab #1

Purpose:

The purpose of Lab #1 is to introduce you to AVR Studio 7, the development environment for creating assembly programs for 8-bit AVR processors. In particular, you will learn:

- how to create projects in AVR Studio 7
- the use of comments (denoted by a semicolon – ‘;’ – in AVR assembly)
- how to step through programs using the ‘Step Into’ and/or ‘Step Over’ simulation tools
- introduction to some basic instructions, such as:
 - clr
 - ldi
 - neg
 - com
 - inc
 - dec
 - add
 - subi
 - andi
 - cpi
- using the AVR Instruction Set guide to become familiar with instructions

Procedure:

For each of the assembly programs below, create a new project and copy & paste the the program code given below. Then build, and use “**Step into**” to execute one instruction at a time.

Documentation:

For each of these programs, you are to:

- i) List the contents of the pertinent registers, as instructed for that assembly program.
- ii) Answer the following questions:
 - a. How many cycles take to execute the program (excluding the cycles spent executing the instruction at the “End:” label) ?
 - b. If the processor is running at a clock speed of 12 MHz, how long would it take to execute the program?

1) List contents of the R18 and SREG (Status) registers for each line of the following program.

```
        jmp start
start:  clr r18
        dec r18
        neg r18
        clc
        com r18
end:    rjmp end
```

Question 1-1) What is the value of the C bit in the SREG register after execution of :
a. the **DEC R18** instruction?
b. the **NEG R18** instruction?
c. the **COM R18** instruction?

Question 1-2) Explain how the C bit in the SREG register is updated by the three instructions mentioned in Question 1-1. (Use the instruction set document to answer this question.)

2) List contents of the R18 and SREG (Status) registers for each line of the following program.

```
        jmp start
start:  clr r18
        clc
        ldi r18 , 0xFF
        inc R18
        clr r18
        clc
        ldi r18 , 0xFF
        ldi r17 , 1
        add r18 , r17
end:    rjmp end
```

Question 2-1) What is the value of the C bit in the SREG register after execution of :
a. the **INC R18** instruction?
b. the **Add R18 , R17** instruction?

Question 2-2) Explain how the C bit in the SREG register is updated by the two instructions mentioned in Question 2-1. (Use the instruction set document to answer this question.)

3) List contents of the R17 and SREG (Status) registers for each line of the following program.

```
        jmp start
start:  ldi r17, 0xA7
        andi r17, 0xC5
        ldi r17, 0x5F
        cpi r17, 0xFF
        subi r17, 0xFF
end:    rjmp end
```

Question 3-1) Explain the similarities and differences between the CPI and SUBI instructions.

- 4) List contents of the R16, R17, R18, R19, R20, R21, and SREG registers for each line of the following program.

```
        jmp start
start:  ldi r16, 0x7B
        ldi r17, 0x49
        add r17, R16
        ldi r18, 0xF3
        ldi r19, 0x63
        add r19, R18
        ldi r20, 0x45
        ldi r21, 0xE3
        sub r21, R20
end:    rjmp end
```

Question 4-1) Assuming signed operands, are the results of R17, R19 and R21 valid signed results after the execution of the program? Give explanations for your answer.

Question 4-2) Assuming unsigned operands, are the results of R17, R19 and R21 valid unsigned results after the execution of the program? Give explanations for your answer.