EGR 270
Fundamentals of Computer Engineering   Due date: <u>See Due Dates Table</u>
File: N270H9

Homework Assignment #9

Reading Assignment: (see instructor's web page)
Class notes notes
PowerPoint: N270-Computer Architecture, Microprocessors and Assembly Language
PowerPoint: N270-Atmel Studio Tutorial

Problem Assignment:
1) (39 pts) Complete the worksheet below. Submit the worksheet as part of the assignment. Show the value in register r16 (in hexadecimal form) and the values in bits N, C, and V (0 or 1) of the *Status Register* after executing the instructions in each part below. In each part, assume that registers r16 and r17 were already loaded with values using the following instructions:

      ldi r16, 0x6A
      ldi r17, 0xF8

Part	Operation(s)	r16	N	C	V
A	**com r16**				
B	**neg r16**				
C	**and r16, r17**				
D	**or r16, r17**				
E	**eor r16, r17**				
F	**add r16, r17**				
G	**subi r16, r17**				
H	**ldi r16, 0b11001100**				
I	**ldi r16, 200**				
J	**clc** **; clear the carry bit** **rol r16**				
K	**Sec** **; set the carry bit** **ror r16**				
L	**ser r16** **inc r16**				
M	**clc r16** **dec r16**				

2) (18 pts) Determine the contents of registers indicated (in hexadecimal form) at the end of each assembly language program listed below.

```
; Part A
ldi r16, 0x45
ldi r17, 0x30
subi r16, 0x10
subi r17, 0x03
```

Result:

r16 contents: _____

r17 contents: _____

```
; Part B
ldi r18, 0x2F
sts 0x100, r18
ldi r19, 0x3B
sts 0x101, r19
lds r18, 0x101
lds r19, 0x100
sub r18, r19
subi r19, 0x14
```

Result:

r18 contents: _____

r19 contents: _____

```
; Part C
    ldi r20, 0x20
    ldi r21, 0x10
Loop:
    dec r20
    inc r21
    cp r20,r21
    brne Loop
```

Result:

r20 contents: _____

r21 contents: _____

```
; Part D
    ldi r22, 0x3F
    ldi r23, 0x08
    clr r24
Loop1:
    inc r24
    sub r22, r23
    brge Loop1
```

Result:

r22 contents: _____

r23 contents: _____

r24 contents: _____

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3) (10 pts) Write an assembly language program (with lots of comments) to store 5 values in memory locations 0x300 – 0x304 and then then to read the values from memory and find the total. Store the total in memory location 0x305. Use 5 different values and let 2 of them be negative. Show by hand what the total should be.

4) (10 pts) Write an assembly language program (with lots of comments) such that if the value stored in 0x100 is -6 or greater and is +4 or less, it is replaced with 0. Otherwise, it is not changed.

5) (10 pts) Assume that three non-negative integers are stored in memory locations 0x100, 0x101, and 0x102. Write an assembly language program (with lots of comments) that will determine the largest of the three stored values and store the value in 0x104.

6) (13 pts) Assemble your program for Problem 5 using Atmel Studio 7 and include a printout of the program. *__Simulate__* the program for 3 cases:
   a. 0x100 has the largest value
   b. 0x101 has the largest value
   c. 0x102 has the largest value
   - For each case you can either add additional instructions to load the initial values into memory or you can open the Memory window during simulation and edit the values.
   - Include screen captures showing the contents of memory 0x100 – 0x104 before and after simulation for each of the 3 cases.

Extra Credit (10 points each):

1) Simulate problem 3 above using Atmel Studio 7. Provide a copy of the code as well as a screen shopts of the simulation showing memory contents before and after simulation.

2) Simulate problem 4 above using Atmel Studio 7. Add additional instructions to first load a value into address 0x100. Test the problem for 3 cases:
   - The value in memory is less than -6
   - The value in memory is from -6 to +4.
   - The value in memory is greater than 4.
   For each of the 3 cases, provide a copy of the code as well as screen shots of the simulation showing memory contents before and after simulation.

Selected Answers:
Might be added later!

Worksheet (24 points): Show the value in register r16 (in hexadecimal form) and the values in bits N, C, and V (0 or 1) of the ***Status Register*** after executing the instructions in each part below. In each part, assume that registers r16 and r17 were already loaded with values using the following instructions:

ldi r16, 0x6A
ldi r17, 0xF8

Part	Operation(s)	r16	N	C	V
A	**com r16**				
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G	**subi r16, r17**				
H	**ldi r16, 0b11001100**				
I	**ldi r16, 200**				
J	**clc** **; clear the carry bit** **rol r16**				
K	**Sec** **; set the carry bit** **ror r16**				
L	**ser r16** **inc r16**				
M	**clc r16** **dec r16**				