Electrical and Computer Engineering

EE3613 Processor Systems Laboratory

LAB 9

Advanced Assembly Language Programming – 2

Fall 2019

In lab 9, we are going to write assembly programs to store data in program memory locations, reading data from the program memory locations, and writing to SRAM using loops, subroutine call, arithmetic operations, I/O port operation, and pointers to access data location. We use Atmel Studio 7 to show the result of each code, including the resulted memory values. The program must include detailed comments.

OBJECTIVES:

- To write data in program memory
- To transfer data from program memory to data memory
- To write code to do arithmetic operation

REFERENCES:

Mazidi and Naimi, "The AVR Microcontroller and Embedded Systems," 2nd Ed. Chapters 5, 6.

MATERIALS:

Atmel Studio 7

Lab 9 Report Submission:

Lab 9 consists of three activities. You must include the report cover page, codes with full description, and results (include the result tables). The full lab report is not required, but **no report frame is provided**. You must write your report using the previous report frame and the given result tables. (The result tables are provided in Canvas, under Report Frame module.)

Total points for this lab: 100 points

Due date: **Tuesday (11/5/2019) 2:59pm, Thursday (11/7/2019) 8:59pm**

ACTIVITIES:

ACTIVITY 1

PART I. Write a program to transfer a string of data, which is a string with your full name, from program memory starting at address $200 to SRAM locations inside the CPU starting at $140 (see Table 1.1). The data representing your last name and first name is as shown below:

```
MYDATA:   .DB    "Alex Young", 0
```

Using the simulator, single-step through the program and examine the data transfer and registers. The result must be shown in Table 1.2.

PART II. Add the following subroutine to the program in Activity 1 Part I. Using the simulator, single-step through the subroutine and examine the RAM locations:
After data has been transferred from program memory into RAM, the subroutine should copy the data from RAM locations starting at $140 to RAM locations starting at $160 (see Table 1.1). Fill out Table 1.2 with the resulted screenshots.

Table 1.1. Activity 1 – Part I and Part II Description: Data, Origin and Destined Memory Locations

PART I			
Data	Starting Program Memory Address		Starting SRAM Address
Alex Young	0x0200	➔	0x0140
PART II			
Data	Starting SRAM Address		Starting SRAM Address
Alex Young	0x0140	➔	0x0160

Table 1.2. Activity 1 – Part I and Part II Result Screenshots: Data, Origin and Destined Memory Locations

PART I	
Data in Program Memory (address, hex & string)	Data in SRAM (address, hex & string)
PART II	
Data in SRAM (address, hex & string)	Data in SRAM (address, hex & string)

ACTIVITY 2

Write a program to calculate y where $y = x^2 + 2x + 9$. Follow the steps.

- Step 1. x is between 0 and 9 $\{x = 0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$ and load each x value to R16 one by one for each computation to get the y values.
- Step 2. At the end of the program R20 (low) and R21(high) should have y.
- Step 3. Use the simulator to change the x value and single-step through the program, examining the registers as you go.
- Step 4. Fill Table 2.1 with the arithmetic computation result, and put the simulation result (screenshots) of the registers' value in Table 2.2

Table 2.1. Arithmetic Computation Result (Expected result)

Index	R16 *(x)*	x^2	$x^2+2\,x$	R20,R21 *($y= x^2+2\,x+9$)*
1	0	0	0	R20=$09, R21=$00
2	1	1	3	R20=$0C, R21=$00
3	2			…
4	3			
5	4			
6	5			
7	6			
8	7			
9	8			
10	9			

Table 2.2. Arithmetic Computation Result shown in Simulation, R20 and R21(Screenshots)

Index	R16 *(x)* (hex)	R21, R20 *($y= x^2+2\,x+9$)* (hex)
1		
2		
3		
4		

5		
6		
7		
8		
9		
10		

ACTIVITY 3

Using Write a program to add 10 bytes of data and store the result in registers R18(low) and R19 (high). The bytes are stored in the Program memory starting at $200. The data would look as follows:

```
MYDATA:   .DB     92,34,84,129,...          ;pick your own data.
```

Notice that you must first bring the data from Program memory into the registers, then, add them together. Use a simulator to single-step the program and examine the data. Fill out Table 3.1 and Table 3.2.

Table 3.1. Arithmetic Computation Result and the Expected Values of R18 and R19

Data Index, n	Data Value, D_n	Data Location	Accumulated Result $D_n = D_n+D_{n-1}$	Accumulated Result of (R18,R19 = D_n) in hex
1	92	0x0200	92+0=92	R19=$00, R18=$5C
2	34	0x0201	92+34=126	R19=$00, R18=$7E
3	84	0x0202	92+34+84=210	…
4	129	0x0203		
5				

6				
7				
8				
9				
10				

Table 3.2. Result Table of the Arithmetic operation (screenshots)

Data Index, n	Data Value, D_n	Z pointer value screenshot	Rn, Data holding register value screenshot	R18, R19 Values Screenshot
1	92			
2	34			
3	84			
4	129			
5	..			
6				
7				
8				
9				
10				

ECE3613 Processor System Laboratory Rubric
Lab #: 9
Section: 001 / 002
Name: _____

Activity	Task	Full Points	Earned Points	Comment
1	Part I – Code	10		
	Part I – Result	10		Table 1.2
	Part II – Code	10		
	Part II – Result	10		Table 1.2
2	Code	10		
	Result	20		Table 2.1 (10pts) & Table 2.2 (10pts)
3	Code	10		
	Result	20		Table 3.1 (10pts) & Table 3.2 (10pts)
Total		**100**		