CS 252 Introduction to Computer Engineering, Spring '18
Homework 7

Student Details:

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Course Details:
Sections 2 and 4
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Problem 1 (5 points)

Identify 5 assembly errors in the following program:

```
.START x3004
      AND R5, R5, Some
      LD R5, STR
Forward ADD R5, R5, #1
      BRz Forward
      LDR R4, R5, #0
      MUL R4, R4, #1
      ST R4, STRING
Forward HALT

Some    .FILL #0
STRZ  .STRINGZ "HI!!!"
.STOP
```

1. .START instead of .ORIG -attempt to define a local label before any non-local labels
2. Line 3 Error because writing label as STR instead of STRZ.
3. Line 12 because .STOP is used instead of .END. .STOP is not recognized
4. Line 9 'Forward' is redefined. Error because duplicate labels.
5. Line 8 error because of an undeclared label STRING

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Problem 2 (10 points)

Load the following program in PennSim and answer the following questions.

```
.ORIG x3000
      LEA R1, STRZ
      AND R2, R2, #0
      LD  R4, CHAR

REPEAT  LDR R3, R1, #0
      BRz FINISH          ;Branch if null
      ADD R3, R3, R4
      BRnp PASS           ;Branch if not ' '
      ADD R2, R2, #1
PASS    ADD R1, R1, #1
      BR  REPEAT          ;Always branch

FINISH  ST  R2, COUNT
      HALT

CHAR    .FILL xFFE0
COUNT   .FILL x0000
STRZ    .STRINGZ "This is CS252!"
 .END
```

a) Show the symbol table created by the assembler for the above program.

Symbol Name	Address
STRZ	x300F
CHAR	x300D
REPEAT	x3004
FINISH	x300B
PASS	x3009
COUNT	X300E

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b) How many times is the instruction at label "REPEAT" executed?

15 times.

c) How many times is the instruction at label "PASS" executed?

14 times.

d) Describe what this program does in 1-2 sentences.

This program loops through the string "This is CS252!' until it reaches a null character. In this loop the program counts the number of spaces in the string and stores to COUNT

Problem 3 (6 points)

You are given two pieces of program. They have been written by different programmers to store x0018 into memory location x6000.

a.

```
.ORIG x5000
AND R2,R2,#0
ADD R2,R2,#15
ADD R2,R2,#9
STI R2,PTR
<rest of the program…..>
```

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```
HALT
PTR .FILL x6000
.END
```

b.

```
.ORIG x6000
.FILL x0018
.END
```

a) Why there are two 'ADD' instructions in module (a)?

The range for adding an immediate value with the ADD instruction is -16-+15. So in order to get the value x018 in r2 we must add x015 then x09.

b) Explain the fundamental differences in their approaches?

The first program uses instructions to dynamically reach the desired address through STI which is done during runtime. The second uses the .FILL instruction which is done during assembly time.

c) Give one example where approach of module a is preferred.

For b the programmer must know the register that is to be stored while creating the program. For a the register that is to be stored can be decided during runtime. A is preferred if we want the user to dynamically choose the register to be stored.

Problem 4 (15 points)

In this problem, you will write an assembly code that will implement a circular left shift by 6 bits. If you have a binary string 00000011 then the result after circular left shifting by 6 bits will be 11000000. The program we want you to design should take in a 16-bit value at memory location Loc1. Implement the circular left shifting operation by 6 bits and store the 16-bit result in Loc2. You can declare the memory locations Loc1 and Loc2 using .BLKW directive. For example, if [Loc1]=0xF000 then after execution of the program [Loc2] = 0x003C. **Your code should start at memory location 0x3000.**

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Your code will be graded through automated scripts. **You should name your file as hw7_q4.asm**. Files with names other than q4.asm will not be recognized by the automated script. To check the functionality of your code, you may run the given sample script for this question using the command mentioned below. However, graders may check the working of code using values different then used in the sample script.

script q4_hw7.lcs

If your test passes successfully, you have to see the message "TRUE(check M3 xC03F)" in the last line of command output window. Any other message that includes "FALSE(check M3 xC03F)", indicates your test is failed.

Problem 5 (15 points)

In this problem, you will write a LC-3 assembly code that removes blank spaces from a string. Assume that the string starts at memory location 0x5000, and is terminated by a '\0' character (ASCII value = 0). Your program should store the modified string in the memory location starting at 0x5100. You do not need to modify the original string stored at 0x5000. You can assume that the original string at 0x5000 will always be less than 100 characters in length, and it will always start with a letter (A-Z, lowercase or uppercase possible).

Note: If the modified string has 7 characters, and the original string has 15 characters, the last 8 characters of your modified string should be all '%' (ASCII value = 0x25).

For example: If the original string at 0x5000 was "aa 12 d e f", the modified string at 0x5100 after your program completes execution should be "aa12def%%%%".
Note that the original string has 4 blank space characters, and the modified string has 4 extra "%" in the end. **Your code should start at memory location 0x3000.**

Your code will be graded through automated scripts. **You should name your file as hw7_q5.asm.** Files with names other than q5.asm will not be recognized by the automated script. To check the functionality of your code, you may run the given sample script for this question using the command mentioned below. However, graders may check the working of code using values different then used in the sample script.

script q5_hw7.lcs