**Score: \_\_\_\_\_**

**LA6 – Implementing Functions**

**Activities**

COMP256 – Computing Abstractions

Dickinson College

Spring 2023

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**Name:**

In the prior class we saw how to call functions and how to pass arguments by pushing them onto the stack. Today’s class built on that one by showing how functions are implemented. We started by seeing how functions can use indirect addressing with the stack pointer (R13) to access the argument values. We then saw that because functions change registers, we have to be careful that those changes do not create side effects in the calling code. We learned how to use the stack within the function to prevent these side effects. Combined with the use of CALL and RET and placing the return value in R14, we now have a full implementation of the high-level language function calling abstraction. The following activities will give you some hands-on experience with both using and implementing this abstraction.

**Implementing Functions:**

🔑 1. In the prior homework you were asked to write code that called the diff function, which had the following signature:

int diff(int p, int q) // Compute p - q

Below is an implementation of the diff function with a few blanks highlighted in yellow. Fill in the blanks in the implementation of the diff function so that it properly accesses the argument values that are being passed to it. You can check your solution by placing this implementation of diff into a text file with your code with your code from the prior assignment that calls it, and then assembling and running it.

DIFF: LOAD R0 R13 \_\_\_\_ \* get p

 LOAD R1 R13 \_\_\_\_ \* get q

 SUB R2 R0 R1

 MOV R14 R2

 RET

🔑 2. You may have noticed the implementation of the diff function in question 1 does not save and restore the values of the registers that it changes. Thus, it could have undesireable side effects. We’ll fix that in this question.

a. Which registers does the implementation of diff modify as it is written in question #1 above?

b. A new implementation of diff that will not have side effects is given below with a few blanks highlighted in yellow. Fill in these blanks to create an implementation of the diff function that does not have side effects. You can check that your solution works by replacing the implementation of diff in your text file with this one, and then assembling and running it.

DIFF: PUSH \_\_\_

 PUSH \_\_\_

 PUSH \_\_\_

 LOAD R0 R13 \_\_\_\_ \* get p

 LOAD R1 R13 \_\_\_\_ \* get q

 SUB R2 R0 R1

 MOV R14 R2

 POP \_\_\_

 POP \_\_\_

 POP \_\_\_

 RET

🔑 3. Imagine that after studying the implementation of the diff function above a programmer realizes that she can implement it more efficiently using only two registers instead of three. Her rewritten version of the diff function is given below. Fill in the blanks in her more efficient implementation of the diff function. You can put this version into your text file in place of the earlier version and then assemble and run it to check your answer.

 DIFF: PUSH \_\_\_

 PUSH \_\_\_

 LOAD R3 R13 \_\_\_\_ \* get p

 LOAD R4 R13 \_\_\_\_ \* get q

 SUB R3 R3 R4

 MOV R14 \_\_\_

 POP \_\_\_

 POP \_\_\_

 RET

🔑 4. In the prior homework you were asked to write code that called the flipSign function, which had the following signature:

 int flipSign(int n) // change the sign of n

The statements below give one possible implementation of the flipSign function with some of the statements omitted. Replace the yellow highlighted comments in the following code with the statements that are necessary to create a side effect free implementation of flipSign. You should combine your answer in a text file with code that calls flipSign and then assemble and run it in the simulator to test your work.

 FLIP: \* Save modified registers

 \* Load argument n into R3

 LOAD R5 #0

 SUB R3 R5 R3 \* Assumes R3 holds n.

 \* Set return value

 \* Restore registers

 RET

🏆 5. In the prior homework you were asked to write code that called the add3 function, which had the following signature:

 int add3(int a, int b, int c) // Compute a + b + c

Write a side effect free implementation of the add3 function. A good process for writing functions like this is:

1. Write the statements to get the arguments.
2. Write the body of the function.
3. Set the return value.
4. Determine which registers your function modifies.
5. Add the PUSH and POP instructions to save and restore the modified registers.
6. Adjust the offsets in the statements that get the arguments from the stack to account for the additional pushes and pops.

Combine your add3 implementation with code that reads 3 values from the user, passes the three values to add3, and prints the result. Be sure to assemble and run your program in the simulator to test your work.

Give your full program including the implementation of the add3 function and the code that reads the values from the user and calls it here.

Optional: To help me improve and scope these activities for future semesters please consider providing the following feedback.

a. Approximately how much time did you spend on this activity outside of class time?

b. Please comment on any particular challenges you faced in completing this activity.