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Homework #4

**9.2**- **Question:** A. How many trap service routines can be implemented in the LC-3? Why?

B. Why must a RET instruction be used to return from a TRAP routine? Why won’t a BR instruction work instead?

C. How many accesses to memory are made during the processing of a TRAP instruction? Assume the TRAP is already in the IR.

**Answer:**

**A.** 256 trap service routines may be implemented in LC-3 because there are 256 TRAP vector locations.

**B.** The RET instruction allows us to return a value back to where the TRAP was called.

**C.** When A TRAP instruction is already in the IR, only one access to memory is made.

**9.16**- **Question:** The two code sequences a and b are assembled separately. There is one error that will be caught at assemble time or at link time. Identify and describe why the bug will cause an error, and whether it will be detected at assemble time or link time.

A.

.ORIG x3200

SQRT ADD R0, R0, #0

;Perform square root function

RET

.END

B.

.EXTERNAL SQRT

.ORIG x3000

LD R0, VALUE

JSR SQRT

ST R0, DEST

VALUE .FILL x30000

DEST .FILL x0025

.END

**Answer:**

**A.** this program never uses the JSR function, so when .END is called, it is considered to be an illegal vector number. This is found at link time.

**B.** This program breaks at assembly time because .ORIG needs to be the first thing called in LC-3 programs. Also, the VALUE variable is filled with x30000, which is 196,608 in decimal. LC-3 will only allow up to the decimal number 32,767, causing this program to break at assembly time as well because it can’t be represented by 16 bits.

**10.1**- **Question:** What are the defining characteristics of a stack?

**Answer:** The defining characteristic of a stack is last in first out. Similar to creating a stack of papers, generally, you put a paper on top of other papers to create a stack of papers. When you take a paper off of the stack, you take it off top, the most recently added paper. Stacks are the same in programming.

**10.8**- **Question:** The following operations are performed on a stack:

PUSH A, PUSH B, POP, PUSH C, PUSH D, POP, PUSH E, POP, POP, PUSH F

1. What does the stack contain after the PUSH F?
2. At which point does the stack contain the most elements?

Without removing the elements left on the stack from the previous operations, we perform:

PUSH G, PUSH H, PUSH I, PUSH J, POP, PUSH K, POP, POP, POP, PUSH L, POP, POP, PUSH M

1. What does the stack contain now?

**Answer:**

1. F, A
2. The stack has the most elements both when D is pushed onto the stack and when E is pushed onto the stack
3. M, F, A