CS 252 Introduction to Computer Engineering, Spring '18
Homework 6

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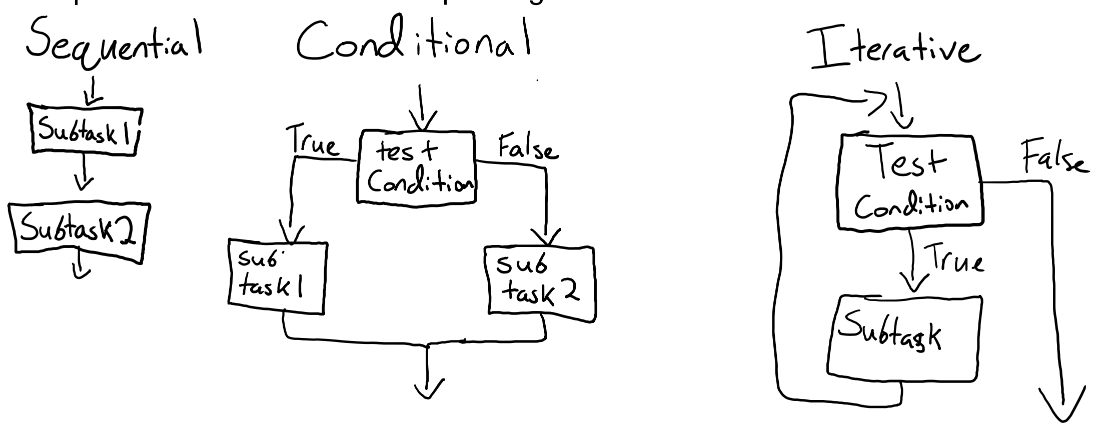
Problem 1 (6 points)

There are three basic constructs to decompose a task: sequential, conditional, and iterative. Explain each construct's concept using a flow chart.



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Problem 2 (10 points)

The following LC-3 program increments each of the numbers stored in memory location A through memory location B. Assume these locations have already been initialized with meaningful numbers. The addresses A and B can be found in memory locations x3100 and x3101.

a. Fill in the missing instructions of the code

x3000	0010	0000	1111	1111	R0 <- M[x3100]
x3001	0010	0010	1111	1111	R1 <- M[x3101]
x3002	0001	0010	0110	0001	R1 <- R1 + 1
x3003	1001	0010	0111	1111	R1 <- NOT R1
x3004	0001	0010	0110	0001	R1 <- R1 + 1
x3005	0001	0110	0000	0001	R3 <- R0 + R1
x3006	0000	0100	0000	0101	BRz PC + x005 (i.e. If Z, go to x300c)
x3007	0110	0100	0000	0000	R2 <- M[R0] (hint: using LDR)
x3008	0001	0100	1010	0001	R2 <- R2+ 1
x3009	0111	0100	0000	0000	M[R0] <- R2 (hint: using STR)
x300a	0001	0000	0010	0001	R0 <- R0+ 1
x300b	0000	1111	1111	1001	BRnzp PC - x007 (i.e. If N/Z/P, go to x3005)
x300c	1111	0000	0010	0101	HALT

b. After the above program finishes execution,
   (i) what's the value in R3?

   R3 = 0

   (ii) will R0 save the value as the address B?

   No

c. If the instruction at x3002 is removed, will the program still get correct results? If not, what's wrong?

   No because if we don't increment it we will only increment the values from A to B-1 instead of from A to B.

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Problem 3 (4 points)

The tables below show the contents of memory and registers before and after an LC-3 instruction at location x3001 is executed. Identify the instruction located at x3001 and give its comment given the information below.

	Before	After
R0	x2100	x2100
R1	x2279	x2279
R2	x34C0	x34C0
R3	x1532	x1532
R4	xEFFF	xEFFF
R5	x0244	x0D12
R6	x350A	x350A
R7	x533C	x533C
x3500	x5671	x5671
x3501	x0D12	x0D12
x3502	x1743	x1743
x3503	x53A3	x53A3

LC-3 Instruction	Comment
0110 101 110 110111	R5<- M[R6-x9]

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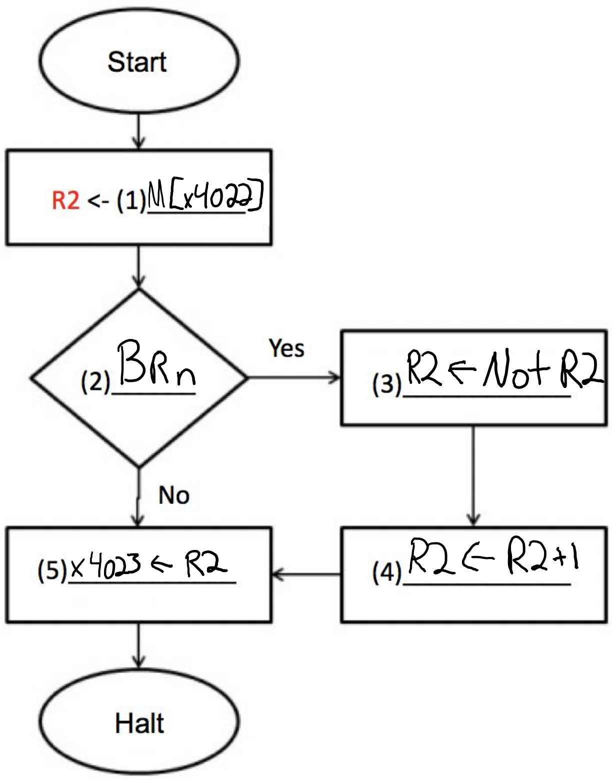
Problem 4 (12 points)

Consider an algorithm which takes the absolute value of a 2's complement number stored in memory location 0x4022 and writes the result to the memory location 0x4023. (Note: The example, the absolute value of -5 is 5, and the absolute value of 15 is 15 itself.)

a. We can represent the algorithm as the flowchart below by decomposing it into its basic constructs. Fill in the missing instructions for each block.



b. Convert the above algorithm to an LC-3 program. Write the program in LC-3 binary code with comment. The program should start at memory address x3000. (Hint: use LDI and STI to access memory locations)

Assuming R0 contains x4022

X3000 0110 0100 0000 0000	R2<-M[M[R0]]
X3001 0000 0110 0000 0010	BRzp PC +x0002 (if positive or zero go to x3004)
X3002 1001 0100 1011 1111	R2<- NOT R2
X3003 0001 0100 1010 0001	R2<- R2+1
X3004 0111 0100 0000 0001	M[M[R0+1]] <- R2
X3005 1111 0000 0010 0101	HALT