Homework 04(Solutions)

1. (Adapted from 5.10) What is the difference between the following LC-3 instructions A and B? How are they similar? How are they different?

   A: 0000111101010101

   B: 0100111101010101

   A: BRnzp -171

   B: JSR -171

   Both A and B result in the PC being changed to (PC+1)-171.

   However, B saves the linkage information in R7 and A does not affect R7.

2. (Adapted from 5.13)

   a) 0001 011 010 1 00000 (ADD R3, R2, #0)
   b) 1001 011 011 111111 (NOT R3, R3)

      0001 011 011 1 00001 (ADD R3, R3, #1)

      0001 001 010 0 00011 (ADD R1, R2, R3)

   c) 0001 001 001 1 00000 (ADD R1, R1, #0) or

      0101 001 001 1 11111 (AND R1, R1, #-1)

   d) Can't happen. The condition where N=1, Z=1 and P=0 would require the contents of a register to be both negative and zero.
   e) 0101 010 010 1 00000 (AND R2, R2, #0)

3. (Adapted from 5.31)

Memory Location	**Value**
x1000	0001__ **101 000 1 11000** ___

4. (Adapted from 5.38) Using the overall data path in Figure 5.18,identify the elements that implement the LDR instruction of Figure 5.8.

   Memory, MDR,MAR, IR, Reg File, the SEXT unit connected to IR[5:0], ADDR2MUX is set to 0, ADDR1MUX is set to SR1 out, alongwith the ADDER they connect to, and MAXMUX and GateMARMUX implement the LDR instruction, alongwith NZP and the logic which goes with it.

5. a. 5 is put in R0 and shifted left the value at location x3007 times.

   b.

PC	x3006
R0	x0050
R1	x0000
R2	x0000
R3	x0000
R4	x0000
R5	x0000
R6	x0000
R7	x0000
N	0
Z	1
P	0

   c. Total Cycles 9+9+15+36+36+39 = 144

Memory Location	**Value**	**Instruction**	**Cycles takes to exectue once**	**number of times executed**	**Total Cycles for instruction**
X3000	0101000000100000	AND	9	1	9
X3001	0001000000100101	ADD	9	1	9
X3002	0010001000000100	LD	15	1	15
X3003	0001000000000000	ADD	9	4	36
X3004	0001001001111111	ADD	9	4	36
X3005	0000001111111101	Branch	9 if not taken 10 if taken	3 times taken 1 time not taken	39

6. What does the following program do (in 15 words or fewer)? The PC is initially at x3000.
   Counts the number of bits that are set to 1 in the word at x3100.

7. Prior to executing the following program, memory locations x3100 through x4000 are initialized to random values, exactly one of which is negative. The following program finds the address of the negative value, and stores that address into memory location x3050. Two instructions are missing. Fill in the missing instructions to complete the program. The PC is initially at x3000.

Memory Location	Value
x3000	1110 000 011111111
x3001	**0110 001 000 000000**
x3002	**0000 100 000000010**
x3003	0001 000 000 1 00001
x3004	0000 111 111111100
x3005	0011 000 001001010
x3006	1111 0000 0010 0101