

## ECE 3724 Quiz #2 – Reese Solution

You may NOT use a calculator.

### 1. (6 pts)

For the number sequencing computer covered in class and chapter 2, assume the LOC input bit is tied to the MOST significant bit of the DATA output (the data output displays the binary code for the digit that is currently in the output register. Also assume that a new instruction called DEC (decrement) has been added. When DEC is executed, the value in the output register is **decremented** by one. For the following program, list the instruction sequence that is executed – give the first 7 instructions that are executed by LOCATION and instruction. Remember the DOUT register is 4 bits. Keep track of the old/new values of the DOUT register to help you.

Location	instruction
0	OUT 0x9 (this 4-bit value is 1001)
1	JC 4
2	DEC
3	JC 2
4	OUT 0x0 (this 4-bit value is 0000)
5	JMP 2

	Location Executed	Instruction	DOUT (before inst. execution)	DOUT (after Inst. execution)
1.	0	OUT 0x9	0b0000 (0x0)	0b1001 (0x9)
2.	1	JC 4 (jmp is taken)	0b1001	0b1001
3.	4	OUT 0x0	0b0000 (0x0)	0b0000 (0x0)
4.	5	JMP 2	0b0000 (0x0)	0b0000 (0x0)
5.	2	DEC	0b0000 (0x0)	0b1111 (0xF)
6.	3	JC 2 (jmp is taken)	0b1111 (0xF)	0b1111 (0xF)
7.	2	DEC	0b1111 (0xF)	0b1110 (0xE)

2. (2 pts) If the Number Sequencing Computer is modified to support a program with a maximum size of 64 instructions, what would the new size of the memory be? Give the answer as K x N (K is number of locations, N is the number of bits per location).

The original memory was 16 x 6. The instruction bits were 2 bits for opcode, and 4 bits for address (JMP, JC)/data (OUT). For 64 locations, the number of bits needed for an address is now 6 ( $2^6 = 64$ ). The data field used for the JC/JMP instructions must increase from 4 bits to 6 bits, adding 2 bits to the instruction width. The instruction width is now 8 bits, so the memory size is **64 (locations) x 8 (bits per location)**.

3. (2 pts) The binary encoding (machine code) of each instruction of the Number Sequencing Computer is split into two parts – what are these two parts?

**OPCODE and DATA**