QUIZ #04
CSCI-410 Spring 2013

1. (12pts) Consider the Hack assembly instruction **D–M**. Show, mathematically, how the ALU configuration that is used to execute this instruction works. HINT: Remember the relationships between bitwise inversion and the 1's complement, and 2's complement representations of signed integers.

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The control signals are a=1, c1..c6=010011
This means that the output is: !(!x + y)
x=D (always) and a=1 means y=M, hence we have !(!D + M)
In 2's complement, -z = !z + 1, hence !z = -z-1 = -(z+1)
Therefore:

output = !(!D + M) = !(-(D+1) + M) = !(M-D-1)
       = -(M-D-1 + 1) = -(M-D)
       = D-M
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2. (24pts) For each possible bitwise-AND combination of D and M obtainable by selectively inverted inputs and outputs, determine the equivalent bitwise-OR operation, the ALU control signals, and the X-instruction (see extra credit description on ECS 06). The two that are supported by the "official" instruction set are done for you.

AND op	OR op	a	c1	c2	c3	c4	c5	c6	Xnn
D & M	!(!D | !M)	1	0	0	0	0	0	0	X40
D & !M	**!(!D | M)**	1	0	0	0	1	0	0	X44
!D & M	**!(D | !M)**	1	0	1	0	0	0	0	X50
!D & !M	**!(D | M)**	1	0	1	0	1	0	0	X54
!(D & M)	**!D | !M**	1	0	0	0	0	0	1	X41
!(D & !M)	**!D | M**	1	0	0	0	1	0	1	X45
!(!D & M)	**D | !M**	1	0	1	0	0	0	1	X51
!(!D & !M)	D | M	1	0	1	0	1	0	1	X55

3. (4pts) What is the difference in the X-instruction for a particular operation using the contents of memory and the same operation using the contents of the A register? In other words, given an X-instruction that performs an operation using **MEM[A]**, what modification would you need to do so that it used **A** instead?

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You need to clear the a bit, which is b6.
This can be done by subtracting 0x40.
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