

CS 350: Quiz 1 (30 minutes) **Solution**

Instructions

The quiz is open book, open notes (but no sharing books or notes) and no support equipment (calculators, phones, computers, etc). All the questions are short-answer questions. The usual penalty for copying or sharing answers on a quiz or exam is a final grade of E for the course. If you have any questions, please ask during the quiz, not after.

Questions

1. [10 points] What decimal value is represented by 110011 in 2's complement?

110011 is negative of (flip 110011 and add 1)
 $= -(001100 + 1) = -001101 = -13$

2. [15 points] What is the most negative 6-bit 2's complement number (in binary and in decimal)?

Binary: 100000, decimal: -32

3. [10 points] In modern computers, negative binary numbers are usually represented using which: sign-magnitude, 1's complement, or 2's complement? Why? (Be brief; 2 or 3 sentences are plenty.)

2's complement, because its subtraction hardware is simplest of the three. (Namely, unsigned addition of the negative.)

4. [10 points] What does the (unsigned) binary floating-point number 1.0111 represent in decimal? You can write your answer using a decimal point (as in 1.5) or with fractions (as in $1 \frac{1}{2}$)

$1.0111_2 = 1 \times 2^0 + 0 \times 2^{-1} + 1 \times 2^{-2} + 1 \times 2^{-3} + 1 \times 2^{-4} = 1 + 1/4 + 1/8 + 1/16 = 1 \frac{7}{16}$
 or $1 + \cancel{0.25} + 0.25 + 0.125 + 0.0625 = 1.4375$

5. [7 points] What 8-bit exponent would we use to represent 1.0111 in the standard IEEE 32-bit representation?

For $1.0111_2 \times 2^0$, we need an actual exponent of 0, so the IEEE exponent would be $0 + 127 = 127 = 0111\ 1111_2$.

6. [8 points] What 8-bit string does hex 6F represent?

$6F_{16} = 0110\ 1111_2$

7. [15 points] Let $X=101011$; give a 6-bit value Y such that in 6-bit 2's complement, $X + Y$ overflows; show the calculation of $X+Y$.

X represents -21 : $X = 101011 = -(010100+1) = -(16+4+1) = -21$. Since $-21 + -11 = -32$, the most negative number, any $Y < -11$ and ≥ -32 will cause overflow. E.g. -12 :

$$X = 101011 = -21$$

$$Y = 101100 = -12 = -010100 = (101011+1) = 101100$$

$$010111 = X+Y = 23 \text{ (but should be } -33)$$

Note: negative + positive can't overflow because the result is closer to zero, not further.

Note: When neg + neg doesn't overflow, you get carry in = carry out = 1 on the sign bit.

8. [10 points] An advertisement for a new computer claims "With the X-11 computer, you can solve problems no one could ever solve before." Assuming they aren't lying, explain what they mean. Be brief; 2 or 3 sentences should be plenty.

One possibility: They've disproved Turing's Thesis by finding a kind of computation that computers literally haven't been able to do. Another possibility: The X-11 is so much faster or can handle so much memory that it can run programs that are impractical on older computers.

9. [15 points] Let Z be a 6 bit string. What should we do if we want to check the next-to-leftmost bit to see if it's 0 or 1? What if we want to clear that bit (set it to 0)?

To check, calculate $Z \text{ AND } 010000$; the result = 0 iff the desired bit was 0.

To clear, set Z to $Z \text{ AND } 101111$; the new value of Z can't have the desired bit = 0, but the other bits must be the same as in the original Z .

Quiz 1 Scores:

