Homework #2
Due Su. 9/17

Note: Do not use a calculator or computer to complete the following exercises. You must show all your work and put a box around your final answer to receive credit. Messy or unreadable submissions will receive no credit.

You should read Appendix A.1-A.2, and A.6 to help with the last two problems.

Total Points: 89

1. (0 points) How long (in hours) did it take you to complete the homework? This will not affect your grade (unless omitted) but it helps gauge the workload for this and future semesters. If you do not answer this question you will get -5 points.

2. (4 points) Perform the one's complement operation on the following 8-bit binary string. Provide your answer first in binary then in hexadecimal.

   Note1: One's complement is the same as two's complement without the +1 step. It just requires you to invert the bits.

   Note2: Hexadecimal (binary) can represent a value (i.e., an unsigned number) but it is also a shorthand for representing a collection of bits. As a collection of bits, the value is not explicit without knowing the representation (e.g. unsigned or two's complement). As an example bits 101**1010** can be written in hexadecimal as 0x5**A**. Remember to start with the right-most group of 4-bits (least significant byte), then move left in groups of four bits.

   (a) (1 point) 00011001

   (b) (1 point) 11001101

   (c) (1 point) 00100011

   (d) (1 point) 01100110

3. (9 points) Consider a 10-bit binary number. Determine how many values (1 point) can be represented and what is the range of values (2 points) for the following representations:

   (a) (3 points) Unsigned binary number.

   (b) (3 points) Two's complement number.

   (c) (3 points) Sign/magnitude number.

4. (2 points) Suppose you are offered 2^{31} Bytes of memory with your new cell phone. How much memory is this in gigabytes (GB)?

5. (4 points) Is it possible for a result to overflow when adding a positive and negative number? Explain briefly.

6. (9 points) Add the following 12-bit two's complement numbers and write the result in hexadecimal. Does the result overflow the 12-bit result.

   (a) (3 points) 0x03A + 0xCDE

   (b) (3 points) 0xF03 + 0x805

   (c) (3 points) 0xFFF + 0xFF0

7. (9 points) Add the following 12-bit unsigned binary numbers and write the result in hexadecimal. Does the result overflow the 12-bit result.

(a) (3 points) 0x03A + 0xCDE
(b) (3 points) 0xF03 + 0x805
(c) (3 points) 0xFFF + 0xFF0

8. (8 points) Extend the following 4-bit values to 7-bits using sign-extension. Write the final result in hexadecimal.
   (a) (2 points) 0xA
   (b) (2 points) 0x7
   (c) (2 points) 0x3
   (d) (2 points) 0xF
9. (4 points) Consider the previous Problem.
   (a) (2 points) Are the 4-bit values equal to the corresponding sign-extended 7-bit values when interpreted as two's complement numbers? Explain briefly.
   (b) (2 points) Are the 4-bit values equal to the corresponding sign-extended 7-bit values when interpreted as unsigned numbers? Explain briefly.
10. (8 points) Extend the following 4-bit values to 7-bits using zero-extension. Write the final result in hexadecimal.
    (a) (2 points) 0xA
    (b) (2 points) 0x7
    (c) (2 points) 0x3
    (d) (2 points) 0xF
11. (4 points) Consider the previous Problem.
    (a) (2 points) Are the 4-bit values equal to the corresponding zero-extended 7-bit values when interpreted as two's complement numbers? Explain briefly.
    (b) (2 points) Are the 4-bit values equal to the corresponding zero-extended 7-bit values when interpreted as unsigned numbers? Explain briefly.
12. (8 points) Represent the following numbers in two's complement using a minimum number of bits. Write your final result in binary and hexadecimal.
    (a) (2 points) 22
    (b) (2 points) -17
    (c) (2 points) -5
    (d) (2 points) -54
13. (12 points) Draw the symbol, boolean equation, and truth table for the following: (You may draw a single truth table with columns for (a)-(d)).
    (a) (3 points) 4-input OR gate
    (b) (3 points) 4-input NOR gate
    (c) (3 points) 4-input XOR gate
    (d) (3 points) 4-input XNOR gate
14. (4 points) Can a CMOS gate drive a LVCMOS gate reliably? If so, state the low and high noise margins. If not, explain why concisely.
15. (4 points) Can a TTL gate drive a CMOS gate reliably? If so, state the low and high noise margins. If not, explain why concisely.