Homework 01

1. (Adapted from problem 1.5 in the textbook)
    Say we had a "black box," which takes two numbers as input and outputs their sum. See Figure 1.10a in the Textbook or the following figure. Say we had another box capable of multiplying two numbers together. See Figure 1.10b. We can connect these boxes together to calculate p * (m + n). See Figure 1.10c. Assume we have an unlimited number of these boxes. Show how to connect them together to calculate:
    a. ax+b
    b. The average of the four input numbers w, x, y, and z
    c. $a^2 + 2ab + b^2$ (can you do it with one add box and one multiply box?)
    d. a^6 (can you do it using only 3 multiply boxes?)
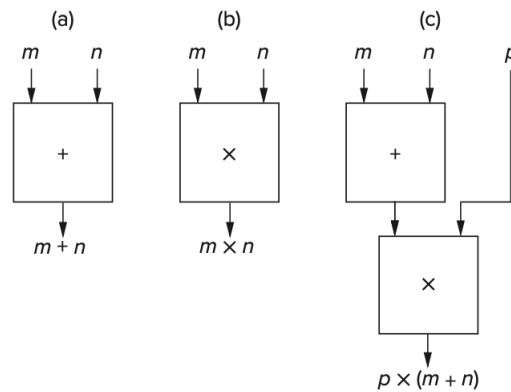

Figure 1.10   "Black boxes" capable of (a) addition, (b) multiplication, and (c) a combination of addition and multiplication.

2. (2.3)
    a. Assume that there are about 400 students in your class. If every student is to be assigned a unique bit pattern, what is the minimum number of bits required to do this?
    b. How many more students can be admitted to the class without requiring additional bits for each student's unique bit pattern?

3. (Adapted from 2.13)
    Without changing their values, convert the following 2's complement binary numbers into 8-bit 2's complement numbers.
    a. 010110
    b. 1101
    c. 1111111000
    d. 01

4. (Adapted from 2.17)
   Compute the following. Assume each operand is a 2's complement binary number.
   a. 01 + 1011
   b. 11 + 01010101
   c. 0101 + 110
   d. 01 + 10

5. Convert the following 8-bit 2's complement binary numbers into decimal numbers.
   a. 01010101
   b. 10001101
   c. 10000000
   d. 11111111

6. Express the value 0.3 in the 32-bit floating point format. Feel free to only show fraction bits [22:15], rather than all the fraction bits, [22:0]. Notation: The symbol [22:15] signifies all 8 bits from bit 22 to bit 15.

7. Convert the following floating point representation to its decimal equivalent:

   1 10000010 10101001100000000000000

8. Add the two hexadecimal 2's complement integers below:
                        x90A
                   +   x4123

9. (Adapted from 2.50)
   Perform the following logical operations. Express your answers in hexadecimal notation.
   a. xABCD OR x9876
   b. x1234 XOR x1234
   c. xFEED AND (NOT(xBEEF))

10. (2.54)

Fill in the truth table for the equations given. The first line is done as an example.

$$Q1 = NOT\ (NOT(X)\ OR\ (X\ AND\ Y\ AND\ Z))$$
$$Q2 = NOT\ ((Y\ OR\ Z)\ AND\ (X\ AND\ Y\ AND\ Z))$$

X	Y	Z	Q_1	Q_2
0	0	0	0	1

11. (2.51)

What is the hexadecimal representation of the following numbers?

a. 25,675

b. 675.625 (i.e. $675\frac{5}{8}$), in the IEEE 754 floating point standard

c. The ASCII string: Hello