

MATH 3/4: ASSIGNMENT 17

MAY 23, 2010

ADDITION

Binary addition is the simplest of the binary operations, so let's start there. To add two binary numbers, you only need to know three things:

- $0 + 0$ is 0 carry 0 (pretty easy)
- $0 + 1$ is 1 carry 0
- $1 + 1$ is 0 carry 1

The rest of the operation is just as in base ten.

For example, let's add 1010 (10 in base ten) and 1011 (11 in base ten).

$$\begin{array}{r} 1010 \\ + 1011 \\ \hline \end{array}$$

$0 + 1$ is 1 carry 0
 $1 + 1$ is 0 carry 1
 $0 + 0 + 1$ (carried over) is 1 carry 0
 $1 + 1$ is 0 carry 1
 $1 + 0$ is 1 carry 0

so the final sum is 10101, 21 in base ten, which is correct.

MULTIPLICATION

The next easiest operation is multiplication. We'll set up the problem like one in base ten, with the larger number above the smaller, and for each digit on the bottom that you go to the left, you move that answer one digit to the left.

For multiplication you just have to remember that 1 times a number is that number and 0 times a number is 0. Once you have all of the little multiplications done, you add up the products.

Let's try multiplying 101 (5) and 10 (2):

$$\begin{array}{r} 101 \\ \times 10 \\ \hline \end{array}$$

From the bottom right, 0 times 101 is 0 (because that is the product of any number and zero) and 1 times 101 is 101 moved over 1 column to the left (because the 1 was moved over one column to the left), giving 0 plus 1010, or 1010, which is in base 10 is 10, and correct.

SUBTRACTION

Next, subtraction. This is just like regular subtraction, with borrowing. Let's try 1101 (13 in base 10) minus 110 (6 in base 10):

$$\begin{array}{r} 1101 \\ - 110 \\ \hline \end{array}$$

From the right, 1 minus 0 is 1. Next, 0 minus 1 is impossible, so you borrow from the next number to the left, making the full top number 10(10)1; then 10 minus 1 is 1. Next 0 minus 1 is impossible again, so we go through the same thing, making the number 0(10)01, and 10 minus 1 is again 1. Thus the final result is 111, or 7 in base 10, which is correct.

HOMEWORK

1. Write the following numbers in binary system:

(a) 72 (b) 111 (c) 95

2. Write the following numbers in decimal system.

(a) 1010101 (b) 11001100 (c) 11011011

3. Compute the following sums.

(a) $11111 + 10101 =$
(b) $11001100 + 10101010 =$
(c) $11111111 + 11111111 =$

Convert the equalities to the decimal system, and check if your answers are correct!

4. Compute the following differences.

(a) $11111 - 10101 =$
(b) $11001100 - 10101010 =$
(c) $10110010 - 1110010 =$

Convert the equalities to the decimal system, and check if your answers are correct!

5. Find

(a) $111 \times 101 =$
(b) $1011 \times 11 =$
(c) $101101 \times 1110 =$

Convert the equalities to the decimal system, and check if your answers are correct!