PHY 410: Homework #1

Due on February 13, 2017

Professor Rappoccio 4:00 pm

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Contents

Problem 2

What are the two's complement representations for the following (decimal) numbers? Show your work. Submit a tex file or equivalent (word, pages, etc) on your github directory "Homework 1".
a) 10
b) 436
c) 1024
d) -13
e) -1023
f) -1024

Solution
a) $10 = 1 \cdot 2^3 + 0 \cdot 2^2 + 1 \cdot 2^1 + 0 \cdot 2^0$.
Since it is a positive number, we add 0 in front to distinguish from negative ones. Therefore,

$$10 = 01010$$

b) Divide the number by two. If there is a remainder, we print 1, otherwise 0. We repeat this process until we reach 1. Below is the procedure.

2	$436 \cdots 0$
2	$218 \cdots 0$
2	$109 \cdots 1$
2	$54 \cdots 0$
2	$27 \cdots 1$
2	$13 \cdots 1$
2	$6 \cdots 0$
2	$3 \cdots 1$
	1

To convert 436 into binary, we simply read these remainders from the bottom. Therefore

$$436 = 0110110100$$

c) It is useful to know that $1024 = 2^{10}$. Therefore,

$$1024 = 010000000000$$

d) To find two's complement of negative decimal, we simply flip the bits, then add 1. First we find binary expression of 13. $13 = 1 \cdot 2^3 + 1 \cdot 2^2 + 0 \cdot 2^1 + 1 \cdot 2^0$. So

$$13 = 01101$$

Now we flip bits.

$$01101 \rightarrow 10010$$

Add 1.

$$10010 + 00001 = 10011$$

e) We will come back to this part later, I promise.

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f) Combined the binary form we found in part c and technique we used in part d, we can figure out -1024.

$$1024 = 010000000000$$

Now we flip bits.

$$010000000000 \rightarrow 101111111111$$

Add 1.

$$101111111111 + 000000000001 = 110000000000$$

e) Now, all we have to do is to add 1 to the answer in part f since $-1023 = -1024 + 1$.

$$-1023 = 110000000000 + 000000000001 = 110000000001$$

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