CMPS 1500 Introduction to Computer Science I – Fall 13

9/3/13

1. Homework

Due **9/11/13** at the beginning of class

1. **Hexadecimal numbers (8 points)**
   Hexadecimal numbers are numbers in base 16. They use the following sixteen digits: $0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F$.

   (a) Convert $A2F31_{16}$ to decimal.

   (b) Convert 4576_{10} into hexadecimal.

   (c) Convert 0001000111100000_2 to hexadecimal. How can you use the fact that $16 = 2^4$?

   (d) If you convert a 32-bit binary number into hexadecimal, how many hexadecimal digits does it have?

2. **NOR (6 points)**
   We have mentioned in class that any Boolean function can be expressed using a combination of $\wedge, \vee, \neg$. In practice, however, it is more efficient to manufacture fewer types of gates.

   (a) (2 points) Show that it suffices to only manufacture gates for the operators $\vee, \neg$, by showing that $\wedge$ can be implemented using $\neg$ and $\vee$ only.

   (b) (4 points) Consider the NOR operator $\downarrow$ which is defined using the truth table below. $x \downarrow y$ is equivalent to $\neg(x \vee y)$.

x	y	$x \downarrow y$
0	0	1
0	1	0
1	0	0
1	1	0

   Show that both $\neg$ and $\vee$ can be implemented using $\downarrow$, i.e., it actually suffices to manufacture NOR gates only.

3. **Adding three bits (10 points)**
   In this exercise you will design a circuit for adding three bits v, x, y, resulting in two outputs c and z that represent the addition $v + x + y$. This is the same as the full adder that we covered in class. Try to make the circuit depth as small as possible.

   (a) (6 points) Express c and z with logical formulas using only $\wedge, \vee, \neg$ operators. Use a truth table to show your work.

   (b) (4 points) Draw the corresponding circuit diagram.