Practice midterm

18 March 2015

You have up to 1 hour, 45 minutes. You may use a calculator, but no text book or notes.

1. For each statement below, fill in the blank with the *best* term from the following list. Some terms might be used more than once; some might not be used at all.

   • algorithm • ASCII • binary • bit • Boolean • byte • compression
   • hexadecimal • lossless • lossy • octal • pixel • resolution • searching • sorting
   • tree • two's complement • Unicode

   (a) _____ is the name of a numbering system in which each digit corresponds to exactly four bits.
   (b) A(n) _____ is exactly 8 bits.
   (c) _____ is an encoding of characters used in American English using 7 bits per character.
   (d) _____ refers to the density of pixels in a display, or the number of pixels in an image.
   (e) A compression technique is described as _____ if it discards some information in order to save space.

2. Write down the decimal (base 10) equivalents for the following 6-bit signed (two's complement) binary numbers. (That means the answers might be negative!)

   `1 1 0 0 1 0 =` _____ `1 1 1 1 0 1 =` _____

   `1 1 0 1 1 0 =` _____ `0 1 0 0 0 1 =` _____

   `0 0 0 1 0 1 =` _____ `1 1 1 1 1 1 =` _____

3. Add the following pairs of 5-bit signed (two's complement) binary numbers. Your answers must be in binary, but you should check your work by converting to decimal. Remember, values can be negative!

```
  0 0 1 0 0 =        1 0 1 0 1 =        1 0 1 1 0 =
+ 0 1 1 0 0 =      + 0 0 1 0 0 =      + 1 0 0 0 1 =
------------       ------------       ------------
```

4. Suppose we want to design encodings just for the five letters `A`, `H`, `M`, `N`, and `T`.

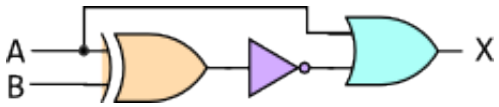
   (a) How many bits would we need to represent each letter in a **fixed-width** encoding? _____

   (b) Using the fixed-width encoding in the previous question, how many bits would we need to represent the nine-letter word `MANHATTAN`? _____

   (c) Draw a tree to represent a **variable-width** encoding of these five letters. Use your tree to encode the word `MANHATTAN`. How many bits did you need? _____ How many bits did you *save,* compared to the fixed-width encoding? _____

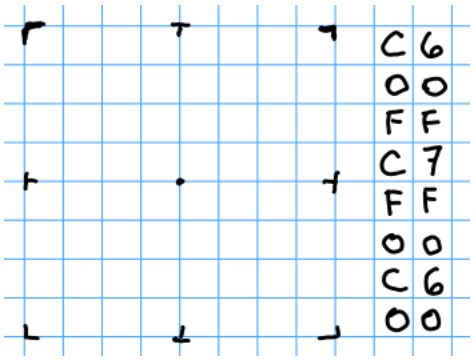
5. Create a truth table to show the value of $X' + (X \cdot Y)$ for all possible inputs of X and Y.

6. Which Boolean expression is equivalent to the following circuit diagram?



   (a) $X = A' + (A \oplus B)$
   (b) $X = A + (A \oplus B)'$
   (c) $X = A \oplus (A + B)'$
   (d) $X = A + (A \oplus B')$

7. Decode the following hexadecimal notation into an 8×8 icon, using 1 bit per pixel.



8. Convert the following binary number into hexadecimal and octal.

   `1 0 1 0 1 1 1 0 0 1 1 0 0 1 0 0`

9. It's important that the steps in an algorithm are **unambiguous.** What does that mean?

10. What makes a binary search faster than linear search?