Practice midterm

25 October 2017

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 • CPU
   • hexadecimal • input • lossless • lossy • octal • output • pixel • resolution
   • tree • two's complement • Unicode

   (a) ____________________ refers to the number of pixels in a display or an image, or sometimes to the *density* of pixels in the display.

   (b) ____________________ is the name of a numbering system in which each digit corresponds to exactly four bits.

   (c) ____________________ describes a type of compression in which the original data cannot be recovered with complete accuracy.

   (d) ____________________ describes a device in the von Neumann architecture that provides data to the CPU.

   (e) ____________________ is the name we use for the base-two numbering system.

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`.

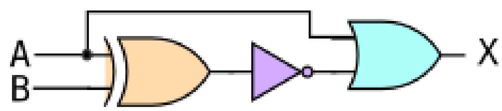
   (a) How many bits would we need to represent each letter in a **fixed-width** encoding? ___________

   (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?



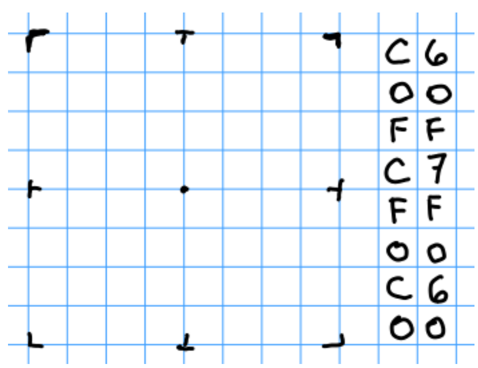
(a) $X = A' + (A \oplus B)$

(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 is the output of the following algorithm? Remember to indicate clearly what is *output* and what is scratch work.

```
1. Set N to 0
2. Set K to 5
3. If K > 10 then output N and stop.
4. Set N to N + K
5. Set K to K + 1
6. Go back to step 3.
```