Practice midterm

21 March 2018

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`.

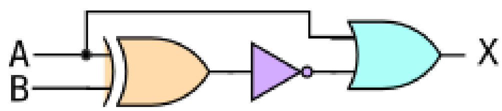
   (a) How many bits would we need to represent each letter in a **fixed-width** encoding? ___________

   (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?



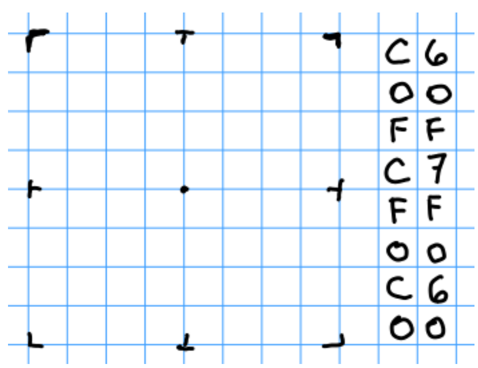
(a) $X = A' + (A \oplus B)$

(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. Which of the following statements about Turing Machines are true? (There can be more than one.) ____________________

    (a) The Turing Machine operates by reading and writing symbols (such as 0,1) on a tape that can be spooled to the left and right.

    (b) The Turing Machine was a thought experiment proposed in 1937 to help mathematicians understand the limits of computation.

    (c) The Turing Machine was first designed in 1837 but not completely built until 1964, when it was installed at the NASA Johnson Space Center to calculate trajectories for orbiting and landing on the moon.

    (d) Given enough time and storage space, the set of things a Turing Machine can compute is the **same** as what a modern digital computer can compute.