Practice midterm

19 March 2014

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 • hexadecimal • pixel
   • pseudo-code • two's complement • Unicode

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

   (b) _____ is a notation for specifying algorithms. It is more natural for humans than a programming language.

   (c) A(n) _____ is exactly 8 bits.

   (d) _____ is an encoding of characters used in American English using 7 bits per character.

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`.

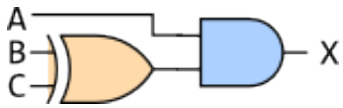
   (a) How many bits would we need to represent each letter in a **fixed-width** encoding? _____

   (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? _____

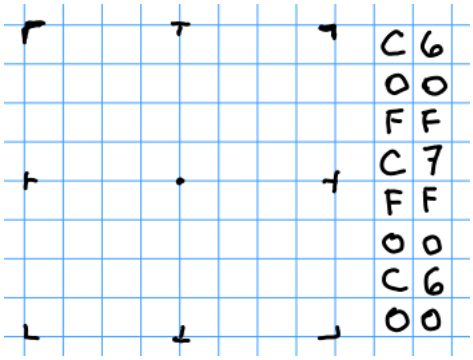
5. Create a truth table to show the value of $X' + (X \cdot Y)$ for all possible inputs of X and Y.

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



(a) $A \oplus (B \cdot C)$
(b) $A \cdot (B \oplus C)$
(c) $A \cdot (B + C)$
(d) $(A \cdot B) + C$
(e) $A + (B \oplus C)$

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