

# Practice midterm

23 October 2013

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 • array • ASCII • binary • bit • Boolean • byte • hexadecimal  
• octal • pixel • pseudo-code • Unicode

- (a) \_\_\_\_\_ is the name of a numbering system in which each digit corresponds to exactly three 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!)

$$1\ 1\ 0\ 0\ 1\ 0 = \underline{\hspace{2cm}} \qquad 1\ 1\ 1\ 1\ 0\ 1 = \underline{\hspace{2cm}}$$

$$1\ 1\ 0\ 1\ 1\ 0 = \underline{\hspace{2cm}} \qquad 0\ 1\ 0\ 0\ 0\ 1 = \underline{\hspace{2cm}}$$

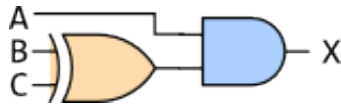
$$0\ 0\ 0\ 1\ 0\ 1 = \underline{\hspace{2cm}} \qquad 1\ 1\ 1\ 1\ 1\ 1 = \underline{\hspace{2cm}}$$

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!

$\begin{array}{r} 0\ 0\ 1\ 0\ 0 = \\ + 0\ 1\ 1\ 0\ 0 = \\ \hline \end{array}$	$\begin{array}{r} 1\ 0\ 1\ 0\ 1 = \\ + 0\ 0\ 1\ 0\ 0 = \\ \hline \end{array}$	$\begin{array}{r} 1\ 0\ 1\ 1\ 0 = \\ + 1\ 0\ 0\ 0\ 1 = \\ \hline \end{array}$
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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  $8 \times 8$  icon, using 1 bit per pixel.

┌		┐		┐	C6
					00
					FF
					C7
└		┌		└	FF
					00
					C6
└		└		└	00

8. Briefly, what is the distinction between a **persistent** and a **volatile** storage device?

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.