## 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) $\qquad$ is the name of a numbering system in which each digit corresponds to exactly four bits.
(b) $\mathrm{A}(\mathrm{n})$ $\qquad$ is exactly 8 bits.
(c) $\qquad$ is an encoding of characters used in American English using 7 bits per character.
(d) $\qquad$ refers to the density of pixels in a display, or the number of pixels in an image.
(e) A compression technique is described as $\qquad$ 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!)
$110010=$ $\qquad$ $111101=$ $\qquad$
$110110=$ $\qquad$ $010001=$ $\qquad$
$000101=$ $\qquad$ $111111=$ $\qquad$
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 |
| ---: | ---: | ---: | :--- | :--- | :--- | :--- | :--- | :--- | $01=$| 1 | 0 | 1 | 1 | 0 |
| ---: | :--- | :--- | :--- | :--- |$=$

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? $\qquad$
(b) Using the fixed-width encoding in the previous question, how many bits would we need to represent the nine-letter word MANHATTAN? $\qquad$
(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? $\qquad$
5. Create a truth table to show the value of $X^{\prime}+(X \cdot Y)$ for all possible inputs of $X$ and Y.
6. Which Boolean expression is equivalent to the following circuit diagram?

(a) $X=A^{\prime}+(A \oplus B)$
(b) $X=A+(A \oplus B)^{\prime}$
(c) $X=A \oplus(A+B)^{\prime}$
(d) $X=A+\left(A \oplus B^{\prime}\right)$
7. Decode the following hexadecimal notation into an $8 \times 8$ icon, using 1 bit per pixel.

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

10100111001100100
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?

