CSC 428/528 Midterm **Name:** _____

February 21, 2014 **Student Number:** _____

Total of 40 marks. Closed books and notes; no calculators.

1. [2 marks] What famous computer scientist had their first paper in MAD magazine?

   ANSWER: _____

2. [3 marks] How many n-input 2-output boolean functions are there?

   ANSWER: _____

3. [3 marks] Write $\langle x, y, z \rangle$ in CNF and in DNF.

   ANSWER: CNF: _____, DNF: _____

4. [3 marks] What is our favorite way of isolating the rightmost 1 bit in a binary number x?

   ANSWER: _____

5. (a) What is the 2-adic representation of $-1/3$?
   (b) What is the 2-adic representation of $+2/3$?

   (a) [1 marks] ANSWER: _____

   (b) [2 marks] ANSWER: _____

6. [3 marks] Let $x = (0000110101111000)_2$. What is ρx, λx, and νx?

   ANSWER: $\rho x =$ _____, $\lambda x =$ _____, $\nu x =$ _____.

7. [3 marks] A directed graph is Eulerian if and only if _____?

   Give a bitstring that represents a De Bruijn cycle for a 3-bit window: _____.

8. [3 marks] Convert the boolean chain on the left into a normal boolean chain. Is the function computed by the original chain (i.e., the value of x_4) normal?

x_1	$\hat{x}_1$
x_2	$\hat{x}_2$
$x_3 = \bar{x}_1 \equiv x_2$	$\hat{x}_3 =$
$x_4 = \bar{x}_3 \wedge x_3$	$\hat{x}_4 =$

9. [3 marks] Define: An implicant is *prime* if and only if

   ANSWER: _____

10. [2 marks] What is the value of `#3FF0000000000000` if it is interpreted as a IEEE 754 floating point number?

    ANSWER: _____

11. [3 marks] Express the threshold function $[\![x_1 + 2x_2 + 3x_3 \geq 3]\!]$ as a majority function.

    ANSWER: _____

12. [3 marks] Fill in the implication below:

    Theorem (Horn)**.** *The Boolean function $f(x_1, \ldots, x_n)$ is expressible as a conjunction of Horn clauses if and only if*

    $f(x_1, \ldots, x_n) = f(y_1, \ldots, y_n) = 1$ *implies* _____.

    for all Boolean values x_j and y_j.

13. [6 marks] The following graph arose from applying the book's algorithm to a 2SAT problem (aka Krom clause satisfaction problem).

(a) How do we know that there is a satisfying assignment?

ANSWER: _____

(b) What is the big-O time complexity of the underlying algorithm if there are n variables and m clauses? Explain briefly.

ANSWER: _____

(c) What is a satisfying assignment (give it as a binary string)?

ANSWER: $abcdef =$ _____.