Points missed: _____ Student's Name: ___________________________________

Total score: _____ /100 points

East Tennessee State University
Department of Computer and Information Sciences
CSCI 2150 (Tarnoff) – Computer Organization
TEST 1 for Spring Semester, 2004

Section 002

Read this before starting!

- The total possible score for this test is 100 points.
- This test is closed book and closed notes
- You may use one sheet of scrap paper that you will turn in with your test.
- You may NOT use a calculator
- **All answers must have a box drawn around them. This is to aid the grader (who might not be me!) Failure to do so might result in no credit for answer. Example:**

  $\boxed{32F1_{16}}$

- **1 point will be deducted** per answer for missing or incorrect units when required. **No** assumptions will be made for hexadecimal versus decimal, so you should always include the base in your answer.
- If you perform work on the back of a page in this test, indicate that you have done so in case the need arises for partial credit to be determined.

"Fine print"

Academic Misconduct:

Section 5.7 "Academic Misconduct" of the East Tennessee State University Faculty Handbook, June 1, 2001:

"Academic misconduct will be subject to disciplinary action. Any act of dishonesty in academic work constitutes academic misconduct. This includes plagiarism, the changing of falsifying of any academic documents or materials, cheating, and the giving or receiving of unauthorized aid in tests, examinations, or other assigned school work. Penalties for academic misconduct will vary with the seriousness of the offense and may include, but are not limited to: a grade of 'F' on the work in question, a grade of 'F' of the course, reprimand, probation, suspension, and expulsion. For a second academic offense the penalty is permanent expulsion."

Basic Rules of Boolean Algebra:	**1.** $A + 0 = A$	**7.** $A \cdot A = A$
	2. $A + 1 = 1$	**8.** $A \cdot \overline{A} = 0$
	3. $A \cdot 0 = 0$	**9.** $\overline{\overline{A}} = A$
	4. $A \cdot 1 = A$	**10.** $A + AB = A$
	5. $A + A = A$	**11.** $A + \overline{A}B = A + B$
	6. $A + \overline{A} = 1$	**12.** $(A + B)(A + C) = A + BC$
DeMorgan's Theorem:	$\overline{(AB)} = (\overline{A} + \overline{B})$	$\overline{(A + B)} = (\overline{A}\ \overline{B})$

Short-ish Answer (2 points each)

1. True or False: 255 can be represented using 8-bit 2's complement representation.

   False, the largest value that can be represented with 8-bit 2's complement representation is $2^{(8-1)}$-1=127

2. What is the **minimum** number of bits needed to represent 96_{10} in unsigned magnitude representation?

   You can do this a number of ways. First, you could look at the binary value for 96_{10} which is 01100000_2. Notice that the most significant 1 is in the 7^{th} bit position, and since no sign bit is needed for unsigned magnitude representation, 7 bits is all you need. The other way you could do it is to determine the largest value for each number of bits in unsigned magnitude.

   5 bits = 2^5-1 = 31
   6 bits = 2^6-1 = 63
   7 bits = 2^7-1 = 127
   8 bits = 2^8-1 = 255

   Since 96 is greater than 63, but not as large as 127, then 7 bits will do the trick.

3. True or False: $15_{10} = 0F_{16}$

   True, $A_{16}=10_{10}$, $B_{16}=11_{10}$, $C_{16}=12_{10}$, $D_{16}=13_{10}$, $E_{16}=14_{10}$, and $F_{16}=15_{10}$.

4. True or False: The 8-bit value 11101011_2 has the same value in both signed magnitude and 2's complement form.

   False, the negative representations of signed magnitude and 2's complement are completely different.

5. True or False: The floating-point number 10011011011010011011001011000010 is negative.

   True, the most significant bit is the sign bit, and in this case, since it is a 1, the value is negative.

6. What law is used to prove that all of the gates in an S.O.P. circuit can be replaced with NAND gates?

DeMorgan's Law

7. Write the complete truth table for a 2-input XOR gate.

A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

8. For the truth table to the right, would a Product-of-Sums or a Sum-of-Products expression have fewer terms?

A	B	C	X
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

Because there are fewer rows with 0's, the best expression format to go with would be Product-of-Sums.

9. True or False: The expression $A \bullet \overline{C} + \overline{B}$ is in correct Sum-of-Products form.

True.

10. Which of the following is the lowest possible value for a 6-bit signed magnitude binary number?

a.) 0 b.) -31 c.) -32 d.) -63 e.) -64 f.) -128 g.) None of the above

The answer is (b). The lowest value for a 6-bit signed magnitude binary number is $-(2^{(6-1)}-1) = -(32-1) = -31$.

11. How many possible combinations of ones and zeros do 6 boolean variables have?

a.) 16 b.) 128 c.) 32 d.) 64 e.) 48 f.) None of the above

The answer is (d). The number of combinations of 1's and 0's for 6 bits is $2^6 = 64$.

The following two problems are based on the binary addition shown to the right.

```
1   11001001
   +01110000
   ---------
    00111001
```

Carry out

12. True or False: If the addition above is considered 8-bit 2's complement, an overflow has occurred.

False. You cannot have an overflow by adding a negative number to a positive number. The only way a 2's complement can have an overflow is if the sign bits of the numbers that are being added are the same as each other, but different from the sign bit of the result.

13. True or False: If the addition above is considered 8-bit unsigned, an overflow has occurred.

True. If a carry occurs in unsigned addition, an overflow has occurred.

14. What is the frequency of a periodic signal with a 5×10^{-10} second period? (Leave your answer in fraction form.)

$$\frac{1}{5 \times 10^{-10}} \text{ Hz}$$

Medium-ish Answer (5 points each)

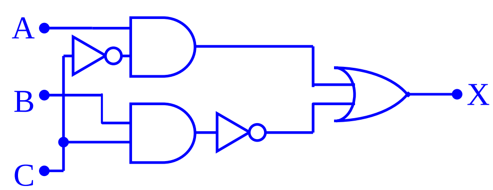
15. Convert the floating-point number 01101101011011001010000000000000 to its binary exponential format, e.g., 1.1010110×2^{-12}, (which, by the way, is not the answer).

$$+1.1101100101 \times 2^{218-127} = +1.1101100101 \times 2^{91}$$

16. Using whatever method you wish, add the hexadecimal values $59F2_{16}$ and $33A6_{16}$.

```
   1                      111  11111  11
 59F2        -or-         0101100111110010
+33A6                    +0011001110100110
 8D98                     1000110110011000
```

17. Draw the circuit exactly as it is represented by the Boolean expression $A \bullet \overline{C} + \overline{B \bullet C}$.



18. Convert 8675309 to BCD representation.

1000 0110 0111 0101 0011 0000 1001

19. If an 8-bit binary number is used to represent an analog value in the range from 500 to 1500, what does the binary value 01100100_2 represent? (Leave your answer in the form of a fraction.)

Digital value = $01100100_2 = 100_{10}$
Minimum value = 500
Maximum value = 1500
Range = Maximum value – Minimum value = 1500 – 500 = 1000
Number of increments = 2^8-1 = 255

Analog value = Minimum value + Digital value * [(Range)/(Number of increments)]
Analog value = 500 + 100 * 1,000/255

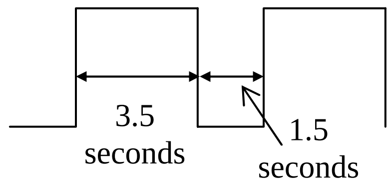
20. Apply DeMorgan's Theorem to distribute the inverse to the individual terms of the following equation. **Do not simplify.**

$\overline{D + C + B + (A \bullet B)}$

$\overline{D} \bullet \overline{C} \bullet \overline{B} \bullet \overline{(A \bullet B)}$

$\overline{D} \bullet \overline{C} \bullet \overline{B} \bullet (\overline{A} + \overline{B})$ ← Final answer

21. What is the duty cycle of the signal shown to the right?



Duty cycle = $\frac{t_h}{T}$ * 100% = $\frac{3.5}{5.0}$ * 100% = 70%

22. Determine the Sum-of-Products expression for this truth table. **Do not simplify.** →

A	B	C	X
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

$\overline{A}\cdot\overline{B}\cdot C \ + \ \overline{A}\cdot B\cdot\overline{C} \ + \ \overline{A}\cdot B\cdot C \ + \ A\cdot B\cdot C$

23. Complete the truth table below with the output from the Product-of-Sums equation shown.

$X=(\overline{A}+B+\overline{C})\bullet(\overline{A}+\overline{B}+C)\bullet(A+\overline{C})$

A	B	C	X
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

Longer Answers (Points vary per problem)

24. Fill in the blank cells of the table below with the correct numeric format. ***For cells representing binary values, only 8-bit values are allowed!*** If a value for a cell is invalid or cannot be represented in that format, write "X". Use your scrap paper to do your work. (2 points per cell)

Decimal	2's complement binary	Signed magnitude binary	Unsigned binary
-90	**10100110**	**11011010**	**X**
-128	**10000000**	**X**	**X**
83	**01010011**	**01010011**	**01010011**

25. Mark each boolean expression as ***true*** or ***false*** depending on whether the right and left sides of the equal sign are equivalent. Show all of your work to receive partial credit for incorrect answers. (3 points each)

a.) $(\overline{A} + B)(A + \overline{B}) = 1$ Answer: **False**

$\overline{A}\cdot A + \overline{A}\cdot\overline{B} + B\cdot A + B\cdot\overline{B}$ (Using "FOIL")

$0 + \overline{A}\cdot\overline{B} + B\cdot A + 0$ (Using Rule 8)

$\overline{A}\cdot\overline{B} + B\cdot A$ (Using Rule 1)

b.) $AB(A + \overline{B}) = AB$ Answer: **False**

$A\cdot B\cdot A + A\cdot B\cdot\overline{B}$ (Using Distributive Law)

$A\cdot B + A\cdot B\cdot\overline{B}$ (Using Rule 7)

$A\cdot B + A\cdot 0$ (Using Rule 8)

$A\cdot B$ (Using Rule 3)

c.) $\overline{B} + \overline{(AB)} + \overline{(BC)} = \overline{A} + \overline{B} + \overline{C}$ Answer: **True**

$\overline{B} + \overline{A} + \overline{B} + \overline{B} + \overline{C}$ (Using DeMorgan's Law)

$\overline{A} + \overline{B} + \overline{B} + \overline{B} + \overline{C}$ (Using Commutative Law)

$\overline{A} + \overline{B} + \overline{C}$ (Using Rule 5)