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 Fall Semester, 2006

Read this before starting!

- The total possible score for this test is 100 points.
- This test is ***closed book and closed notes***
- ***Please turn off all cell phones & pagers during the test.***
- You may ***NOT*** use a calculator. Leave all numeric answers in the form of a formula.
- You may use one sheet of scrap paper that you must turn in with your test.
- 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:

$$\boxed{32F1_{16}}$$
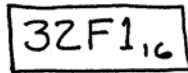
- **1 point will be deducted** per answer for missing or incorrect units when required. **No** assumptions will be made for hexadecimal versus decimal, so you should always include the base in your answer.
- If you perform work on the back of a page in this test, indicate that you have done so in case the need arises for partial credit to be determined.
- Statement regarding academic misconduct from Section 5.7 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:	$\overline{(AB)} = (\overline{A} + \overline{B})$	$\overline{(A + B)} = (\overline{A} \cdot \overline{B})$

1. What is the frequency of the periodic signal in the figure
    shown to the right? ***Be sure to include your units!***
    (Note: mS means milliseconds = 10^{-3} seconds)

    7 mS   3 mS
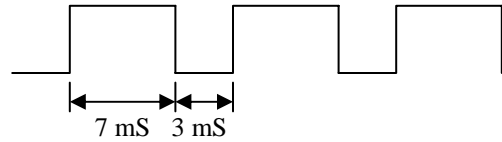
2. What is the duty cycle of the periodic signal from problem 1?

3. If a processor is sampling an analog signal at 6,000 Hz, what is the upper limit of the frequency
    range it will be able to capture?

    a.) 2,000 Hz   b.) 3,000 Hz   c.) 4,000 Hz   d.) 9,000 Hz   e.) 12,000 Hz   f.) 18,000 Hz

4. How many combinations of one's and zeros can be represented with 9 bits?

    a.) $2^{9-1} - 1$ b.) $2^9 - 1$ c.) 2^9 d.) 2^{9-1} e.) $2^{9+1} - 1$ f.) 2^{9+1}

5. What is the most negative value that can be stored using a 9-bit signed magnitude representation?

    a.) $-(2^{10} - 1)$ b.) $-(2^9 - 1)$ c.) $-(2^8 - 1)$ d.) $-(2^{10})$ e.) $-(2^9)$ f.) $-(2^8)$

6. What is the minimum number of bits needed to represent 800_{10} using unsigned binary
    representation?

    a.) 8   b.) 9   c.) 10   d.) 11   e.) 12   f.) 13

7. For each of the following applications, what would be the optimum (best) binary representation,
    unsigned binary (UB), 2's complement (TC), IEEE 754 Floating Point (FP), or binary coded
    decimal (BCD)? Identify your answer in the blank to the left of each application. (2 points each)

    _____ Inputs from a multiple choice test, e.g., pick an answer 1 through 5

    _____ Phone numbers that need to be stored quickly and efficiently

    _____ Number of e-mails sent in a year (approximately 10 trillion worldwide)

8. True or False: The 32-bit IEEE 754 floating-point number 11000110100100111011101101011001
    is greater than 1, i.e., the exponent is greater than or equal to zero.

A	B	X

9. Write the complete truth table for a 2-input NAND gate.

10. Multiply the 16-bit value 0000011010100000_2 by 32. Leave your answer in binary. (Hint: Remember the shortcut!) (3 points)

11. Which of the following gates is the fastest?

   a.) AND   b.) OR   c.) XOR   d.) NAND   e.) NOR   f.) XNOR

12. In the boolean expression below, circle the operation that would be performed first.

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

Medium-ish Answer (4 points each unless otherwise noted)

13. Convert the floating-point number 01000000101101100000000000000000 to its binary exponential format, e.g., 1.1010110×2^{-12}, (which, by the way, is not even close to correct).

14. Convert 101.0001 to decimal. (You may leave your answer in expanded form if you wish.)

15. What does the expression A⊕A simplify to? (⊕ is the XOR or exclusive-OR) Hint: make the truth table and see if you recognize the output.

16. Draw the circuit ***exactly*** as it is represented by the Boolean expression $A + (\overline{A} \cdot B \cdot \overline{C})$.

17. Use any method you wish to prove rule 10: $A + A \cdot B = A$. Show all steps.

18. Convert 1000011001101111100_2 to hexadecimal.

19. In the space to the right, create the truth table for the circuit shown below. (5 points)

A	B	C	

20. Write the Boolean expression for the circuit shown in the previous problem. ***Do not simplify!***

21. If a 10-bit binary number is used to represent an analog value in the range from 100 to 900, how large an analog value does a single binary increment represent? In other words, if the binary number is incremented by one, how much change in the analog range is represented? (Leave your answer in the form of a fraction.)

22. Use DeMorgan's Theorem to distribute the inverse of the expression $\overline{\overline{(A + B)} + C}$ to the individual input terms. ***Do not simplify!***

Longer Answers (Points vary per problem)

23. 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.) $A \cdot \overline{B} \cdot \overline{C} + A \cdot \overline{B} \cdot D + A \cdot \overline{B} \cdot \overline{D} + A \cdot \overline{B} \cdot C = A \cdot \overline{B}$ Answer: _____

b.) $A + \overline{(B + C)} + \overline{B} \cdot C = A$ Answer: _____

c.) $(A + B) \cdot (B + \overline{A}) = B$ Answer: _____

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". (7 points per row)

Decimal	2's complement binary	Signed magnitude binary	Unsigned binary	Unsigned BCD
			10001100	
	01100010			
–19				