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, 2006

Read this before starting!

- The total possible score for this test is 100 points.
- This test is ***closed book and closed notes***
- 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."

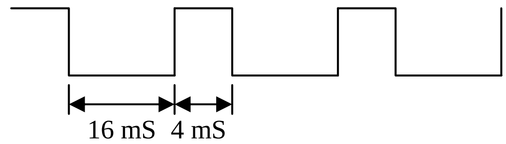
Basic Rules of Boolean Algebra:

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: $\overline{(AB)} = (\overline{A} + \overline{B})$ $\qquad$ $\overline{(A + B)} = (\overline{A} \bullet \overline{B})$

Short-ish Answer (2 points each unless otherwise noted)

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)



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

3. True or False: The frequency of a periodic signal can be calculated from its duty cycle alone.

4. What is the most negative value that can be stored using a 10-bit 2's complement representation?

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

5. What is the most positive value that can be stored using a 9-bit unsigned binary representation?

   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}

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. What is the minimum sampling rate needed in order to successfully capture frequencies up to 20,000 Hz in an analog signal?

   a.) 10,000 Hz b.) 20,000 Hz c.) 25,000 Hz d.) 30,000 Hz e.) 35,000 Hz f.) 40,000 Hz

8. 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)

   ____________ Student ID

   ____________ Exam grade (Integers from 0 to 100 possibly added for average)

   ____________ Weight of an atom in grams

A	B	X

9. True or False: The 32-bit binary floating-point number 11011011010010011101101101011001 is negative.

10. Write the complete truth table for a 2-input NOR gate (3 points).

11. Divide 00110100_2 by 4. Leave your answer in binary. (Hint: There is a shortcut.) (3 points)

12. Circle the function that would first be performed in the following expression.

$$A \cdot B \cdot (C \cdot D + E)$$

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

13. Convert the floating-point number 10111111101100101100000000000000 to its binary exponential format, e.g., 1.1010110 x 2^{-12}, (which, by the way, is not even close to the right answer).

14. Convert 10100.1100 to decimal. (You may leave your answer in expanded form if you wish.)

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

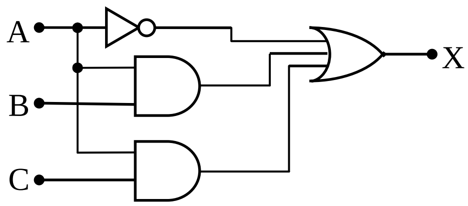
16. Convert 0100100011110010101011_2 to hexadecimal.

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

18. List two benefits of a digital circuit that uses fewer gates.

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 an 8-bit binary number is used to represent an analog value in the range from -25 to 250, 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 $\overline{(A \bullet B) + C + D}$ 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.) $\overline{(A \cdot B)} \cdot A = A \cdot \overline{B}$ Answer: ____________

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

c.) $A \cdot B + B \cdot C(B + C) = B \cdot (A + C)$ 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". Use your scrap paper to do your work. (7 points per row)

Decimal	2's complement binary	Signed magnitude binary	Unsigned binary	Unsigned BCD
60				
	01100010			
–45				