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, 2009

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.
- Please draw a box around your answers. This is to aid the grader. Failure to do so might result in no credit for answer. Example:

$$\boxed{32F1_{16}}$$
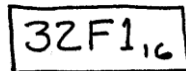
- **1 point will be deducted** per answer for missing or incorrect units when required. **No** assumptions will be made for hexadecimal versus decimal versus binary, so you should always include the base in your answer.
- If you perform work on the back of a page in this test, indicate that you have 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:

Basic Rules of Boolean Algebra

	OR	AND	XOR
Combined w/0	$A+0=A$	$A \cdot 0 = 0$	$A \oplus 0 = A$
Combined w/1	$A+1=1$	$A \cdot 1 = A$	$A \oplus 1 = \overline{A}$
Combined w/self	$A+A=A$	$A \cdot A = A$	$A \oplus A = 0$
Combined w/inverse	$A+\overline{A}=1$	$A \cdot \overline{A} = 0$	$A \oplus \overline{A} = 1$
Other rules	$A+A \cdot B = A$	$A+\overline{A} \cdot B = A+B$	$(A+B) \cdot (A+C) = A+B \cdot C$
DeMorgan's Th.		$\overline{A \cdot B} = \overline{A} + \overline{B}$	$\overline{A+B} = \overline{A} \cdot \overline{B}$

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

1. Which unit of measurement is used to represent the frequency of a periodic waveform?

    a.) Seconds   b.) Percent   c.) Hertz   d.) Seconds per cycle   e.) Cycles

2. What is the frequency of the signal show to the right?
    (Note: 1 microsecond $= 1 \times 10^{-6}$ seconds)

    10 microseconds

    20 microseconds
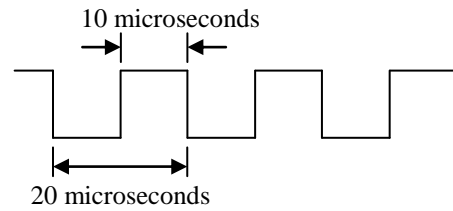
3. The duty cycle for the previous problem is:

    a.) 25%   b.) 33%   c.) 40%   c.) 50%   d.) 66%   e.) 75%   f.) 100%

4. How many patterns of 1's and 0's can be made using 7 bits?

5. You can quickly determine whether a number is positive or negative in the signed representations 2's complement, signed magnitude, and IEEE-754 floating-point by simply looking at the _____.

    a.) most significant bit   b.) least significant bit   c.) number of bits

6. What is the most positive value that can be stored using 10-bit unsigned binary representation?

    a.) 2^{11} b.) $2^{11} - 1$ c.) 2^{10} d.) $2^{10} - 1$ e.) 2^{9} f.) $2^{9} - 1$

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

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

8. What is the minimum number of bits needed to represent 1250_{10} in unsigned binary representation?

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

9. The IEEE-754 32-bit floating-point value 11000000100101000000000000000000 is _____.

    a.) positive   b.) negative

10. Write the complete truth table for a 2-input XOR gate. (3 points) ⟶

A	B	X

11. Perform the binary addition shown below.

```
   10110010
 + 01010001
```

12. True or false: The above addition works the same regardless of whether the numbers are in 2's complement notation or unsigned binary notation. (1 point)

13. True or false: If the above addition is in 8-bit unsigned binary notation, the result can be contained in 8 bits. (1 point)

14. True or false: If the above addition is in 8-bit 2's complement notation, the result can be contained in 8 bits. (1 point)

15. In the boolean expression below, circle the *single* operation that would be performed first.

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

16. Divide the 16-bit value 0000010110100000_2 by 16. ***Leave your answer in 16-bit binary.*** (Hint: Remember the shortcut!)

17. Convert 11000001101000010101_2 to hexadecimal.

18. Convert the unsigned binary value 001100_2 to its corresponding 6-bit binary Gray code. (3 points)

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

19. Convert the 32-bit IEEE 754 floating-point number $11000000000110100000000000000000$ to its binary exponential format, e.g., -1.001010×2^{-12}, (which, by the way, is not the answer).

20. Convert 0110.011_2 to decimal. (You may leave your answer in expanded form if you wish.)

21. In the space to the right, draw the circuit *exactly* as it is represented by the following Boolean expression:

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

22. Prove the rule $A \oplus 1 = \overline{A}$. (Remember that $\oplus$ is the XOR or exclusive-OR) *For full credit, please show **all** steps in detail.*

23. In the space to the right, create the truth table for the circuit shown below. (6 points)

A	B	C	

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

25. Use DeMorgan's Theorem to distribute the inverse of the expression $\overline{A + (B \cdot C) + D}$ all of the way to the individual input terms. Be careful of the AND and OR precedence. It might help to see the expression as a logic circuit. ***Do not simplify!***

26. Assume that an 8-bit binary number is used to represent an analog value in the range from 10 to 20. Convert all four of the following binary values to their analog equivalent, i.e., what analog value does each of these binary values represent? You may leave your answer in the form of a fraction in some cases if you wish. (5 points)

a.) 00000000_2

b.) 00000001_2

c.) 00000110_2

d.) 11111111_2

Longer Answers (Points vary per problem)

27. 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.) $\overline{A \cdot B} + A = 1$ Answer: _____

b.) $\overline{A \cdot B} \cdot (A + B) = 1$ Answer: _____

c.) $\overline{(A \cdot B \cdot C + \overline{A \cdot B \cdot C})} = 1$ Answer: _____

28. 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
		01010011		
			10001001	
−23				