CS 250 Midterm Exam 01
Purdue University
Fall 2016

1. Technology change is a significant concern of computer designers and programmers.
   **A** True
   **B** False

2. Abstraction is a technique for removing or omitting details.
   **A** True
   **B** False

3. The bit string 01001001 has no meaning.
   **A** True
   **B** False

4. Computer hardware is designed to have a failure probability much less than
   **A** 0.000000001
   **B** 0.000001
   **C** 0.001
   **D** Zero
   **E** None of the above

5. At approximately one second after power is applied to this circuit, which waveform best represents what would be observed, using appropriate measuring instruments, for the signal labeled Output?
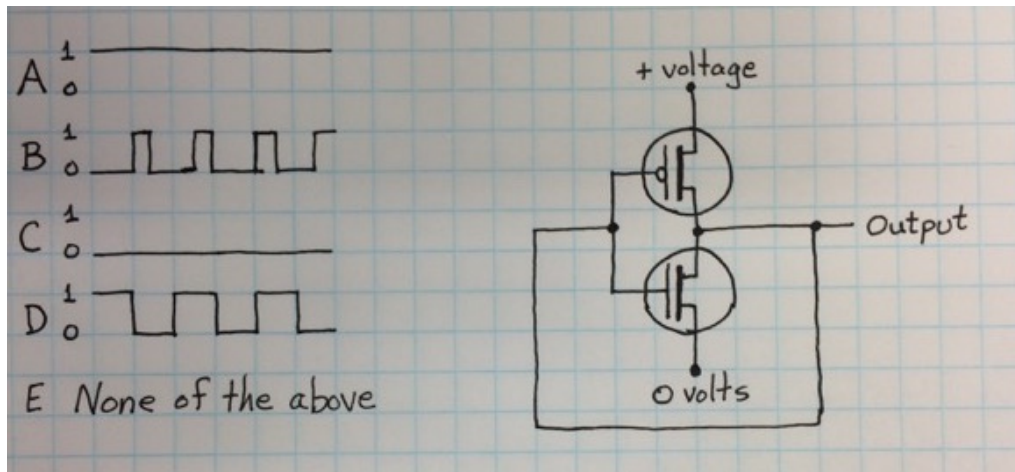
6. Consider this Karnaugh map for inputs X, Y, and Z.

| f(X,Y,Z) | XY = 00 | XY = 01 | XY = 11 | XY =10 |
|----------|---------|---------|---------|--------|
| Z = 0 | 1 | 0 | 0 | 1 |
| Z = 1 | 1 | 0 | 1 | 1 |

Assume that you have access only to X, Y, and Z, so if you want Z', your circuit must compute it. A minimal sum of products circuit to implement this truth table has

A  Three two-input NAND gates
B  Two two-input NAND gates
C  One four-input NAND gate and an inverter
D  Five two-input NAND gates
E  None of the above is correct

7. Consider the following two Boolean functions of A and B named Function 1 and Function 2.

| A | B | Function 1 | Function 2 |
|---|---|------------|------------|
| 0 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 |

We want to compare the complexity of the minimal circuit necessary to implement each function. Only wire and CMOS transistors may be used to construct the circuit for each function. Any amount of wire is to be considered less complex than one transistor. Which of the following complexity rankings is correct?

A  Function 1 < Function 2
B  Function 2 < Function 1
C  Function 1 = Function 2

8. When software would use iteration, hardware uses
   - **A** An increase in supply voltage
   - **B** Replication
   - **C** Higher speed gates
   - **D** Exclusive-Or gates
   - **E** None of the above

9. To point to one of 20 locations requires
   - **A** A positive, 5-bit sign-magnitude pointer
   - **B** A 5-bit-long string for pointing
   - **C** A 20-bit-long string for pointing
   - **D** A decoder with 32 or more outputs
   - **E** A decoder with 20 inputs

10. The truth table for a 4-bit adder made from full adders has how many rows?
    - **A** 4
    - **B** 16
    - **C** 256
    - **D** $2^{256}$
    - **E** None of the above

11. Which adder circuit type operates the fastest assuming that all gate delays are equal and all wire lengths are equal.
    - **A** 1's complement
    - **B** 2's complement
    - **C** 1's and 2's complement are equally fast
    - **D** 1's complement is faster than 2's complement for some (addend, augend) pairs
    - **E** None of the above answers is correct.

12. Which of the following expressions and notations represents or corresponds to the most negative value possible for an 8-bit 2's complement number?
    - **A** 11111111
    - **B** 0x80
    - **C** $-(2^7 - 1)$
    - **D** $-(2^8 - 1)$
    - **E** None of the above answers is correct

13. The bit string 1001000000011101 is a negative packed BCD value.
    - **A** True
    - **B** False

Consider the circuit below, which was constructed for Lab 01, when answering the two questions that follow.
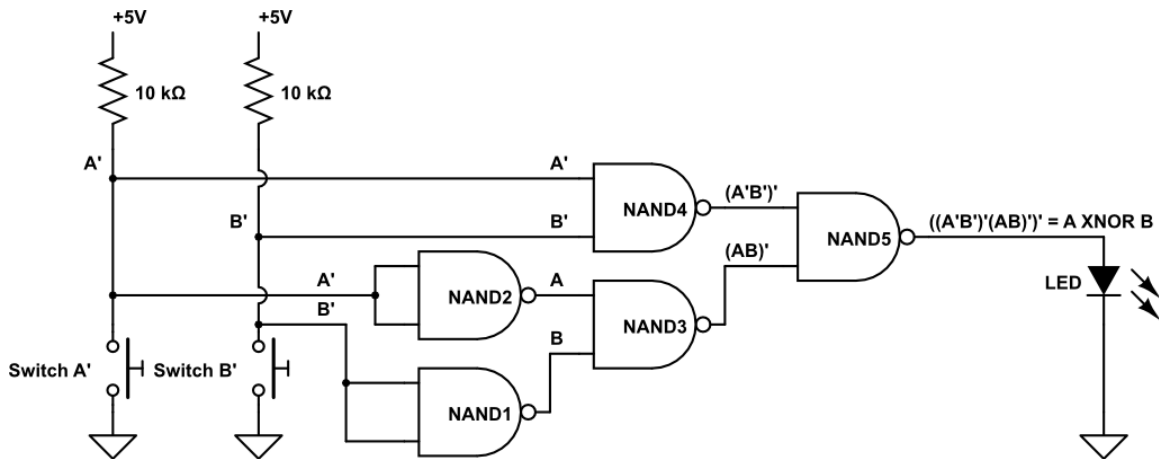
14. The operation of this circuit will be unchanged if a 2-input NOR gate is substituted for NAND1 and no other change is made.
   **A** True
   **B** False

15. The operation of this circuit will be unchanged if the 10 kΩ resistors are replaced with zero ohm resistors.
   **A** True
   **B** False

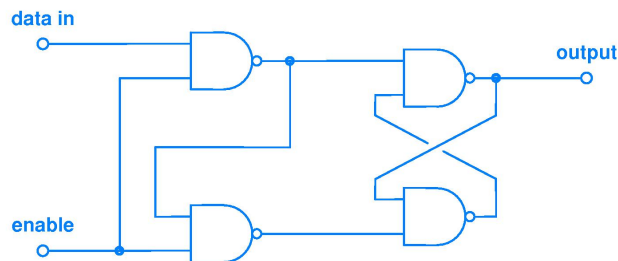16. Consider Figure 2.14 from the textbook.



**Figure 2.14** Illustration of four *nand* gates used to implement a one-bit latch.

Let t be the initial time this circuit is examined. Which statement is true?
   **A** If at time t enable = 1 and data in = 0 and are held constant, then output(t) = 0 and output(t+1) = 0
   **B** If at time t enable = 1 and data in = 0 and are held constant, then output(t) = X and output(t+1) = 1
   **C** If at time t enable = 0 and data in = 1 and are held constant, then output(t) = X and output(t+1) = 1
   **D** None of the statements A, B, and C are true

17. For 8-bit sign-magnitude and 1's complement representations of the decimal value -3, in how many bit positions do these two representations differ?
    **A** 1
    **B** 3
    **C** 5
    **D** 7
    **E** None of the above

18. A digital logic circuit with a single input and a single output behaves as follows at five points in time.

   Time   1 2 3 4 5 …
   Input   0 0 1 0 1 …
   Output  0 0 1 1 0 …

   This logic circuit must contain
    **A** A counter
    **B** An OR gate
    **C** A latch
    **D** An adder
    **E** A 5-bit register

19. A function in a program produces a result when called. Hardware, when receiving power, produces an output signal at all times no matter how many gate delays signals must propagate through on the longest signal path.
    **A** True
    **B** False

20. What fraction of the possible input values yield Sum = 0 and Carry out = 1 for a full adder?

    **A** 1/8
    **B** 2/4
    **C** 3/8
    **D** 4/16
    **E** 5/8

21. Unlike for analog circuits, there is no noise present on the wires in digital circuits.
    **A** True
    **B** False

22. Mechanical computers are always analog systems.
    **A** True
    **B** False

23. $2^4$ bytes is 4 times as much as 20 (base 16) bits.
    **A** True

**B** False

24. In this circuit, Green LED B is used to monitor a signal that is equally as digital in its behavior as the signal monitored by Red LED3.
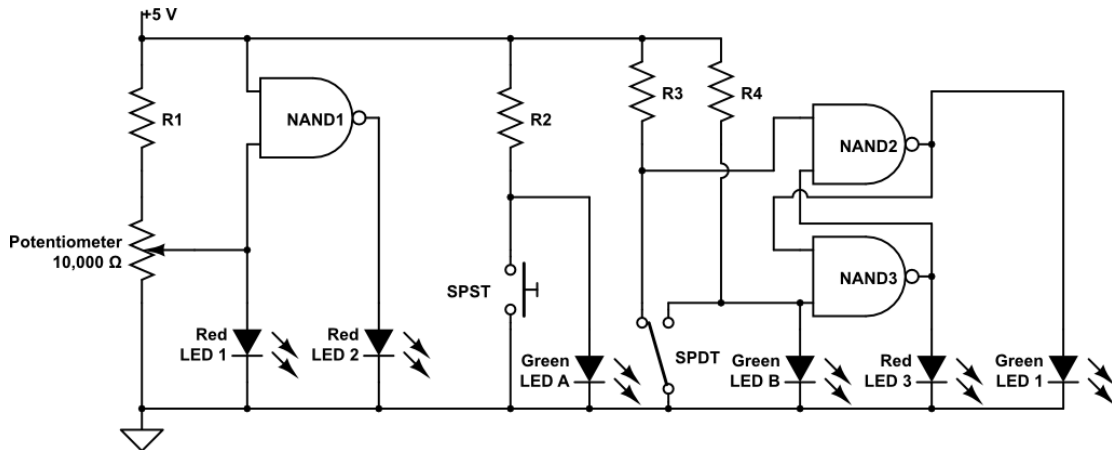


**A** True
**B** False

25. Which of the following is one of DeMorgan's Laws?
    **A** $(X')' = X$
    **B** $(AB)' = A' + B'$
    **C** $(A'B') = A' + B'$
    **D** $(A + B)' = A' + B'$
    **E** None of the above is one of DeMorgan's Laws

26. Memory locations are pointed to by hardware. Designing a computer with four times more memory than specified in the original design requires
    **A** Using one more address bit
    **B** Using two more address bits
    **C** Using four more address bits
    **D** Using four times the number of address bits
    **E** Waiting 3 years if memory density is increasing by 60% per year

27. What lab kit component is the key to automating the operation of sequential circuits?
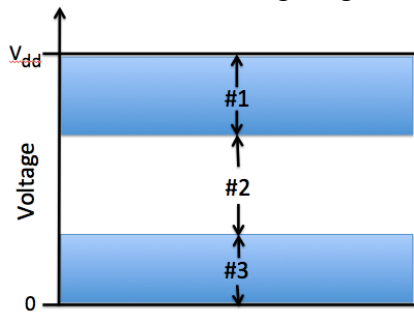    **A** The 7400 chip
    **B** The 74138 chip
    **C** The 74163 chip
    **D** The 555 chip
    **E** The key is a lab kit component not listed above.

28. Consider the following diagram showing three voltage bands labeled #1, #2, and #3.



Which band, or which combination of bands, guides us in designing digital computer circuits where the logic gate input signal voltage levels need not be perfect yet gate operation will be digital, not analog?

A   #1
B   #1 and #2
C   #2
D   #2 and #3
E   None of the above answers is correct

29. Consider the following truth table.

| A | B | f(A,B) |
|---|---|--------|
| 0 | 0 |        |
| 0 | 1 |        |
| 1 | 0 |        |
| 1 | 1 |        |

The missing truth table entries, in order from top to bottom, are

A   0 0 1 0   if f(A,B) = (A + B) modulo 2
B   0 1 1 0   if f(A,B) = A XNOR B
C   1 0 0 0   if f(A,B) corresponds to a universal logic gate
D   0 0 0 1   if f(A,B) corresponds to a universal logic gate
E   X 1 0 X   if f(A,B) = A'

30. The binary string 1010, when interpreted as a 2's complement number represents the decimal number value

A   10
B   -2
C   -5
D   -6
E   None of the above

31. Consider this circuit to generate a digital input.



+5 V

Output

R2
10 kΩ
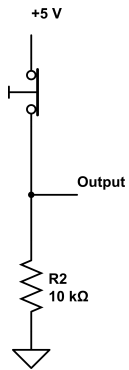
    **A**  This input circuit is an active low design
    **B**  This input circuit is fine for use with digital logic circuits of every type
    **C**  We cannot say whether this input circuit is active high or not until information about whether the switch is being pushed is given to us
    **D**  This circuit will work only when we exchange the positions of the switch and the resistor in the circuit, that is, put the switch where the resistor is shown and put the resistor where the switch is shown
    **E**  This design would be improved if R2 had the value 470 ohms

32. How many sign bits might possibly be found in a number representation using a binary string of length 2n bits?
    **A**  Zero
    **B**  1
    **C**  n
    **D**  All of the above
    **E**  Both A and B

33. The reason we prefer to build digital logic circuits to operate in base 2 rather than base 10 given a fixed maximum power supply voltage is
    **A**  Cost
    **B**  Speed
    **C**  Increased resistance to noise-induced logic errors
    **D**  Any of the above
    **E**  None of the above