

CS 31007

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# COMPUTER ORGANIZATION AND ARCHITECTURE

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Instructors

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Lecture #3: Tutorial

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# Tutorial/Quiz on Pre-requisites Boolean Algebra and Logic Design

1. Consider the following Boolean function  $F$  of three variables  $A, B, C$ :

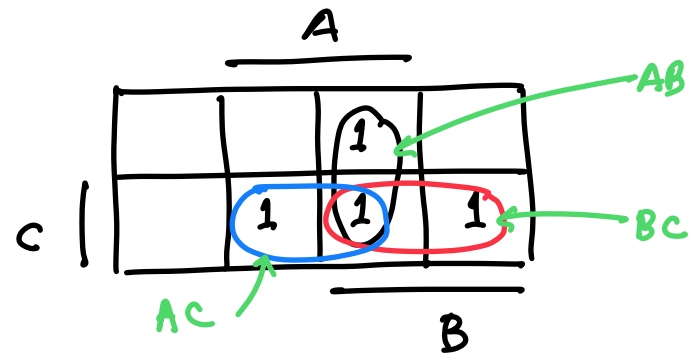
$$F(A, B, C) = \overline{(AB + BC + CA)} \oplus AB \oplus BC \oplus CA$$

where  $\oplus$  denotes Exclusive-OR (XOR) operation and “bar” denotes complementation.  
 $F$  is equivalent to (choose one):

- (i)  $ABC$ , (ii)  $\overline{ABC}$ , (iii)  $0$ , (iv)  $1$ , (v) none of these

Show your work.

Answer: (iv)  $1$

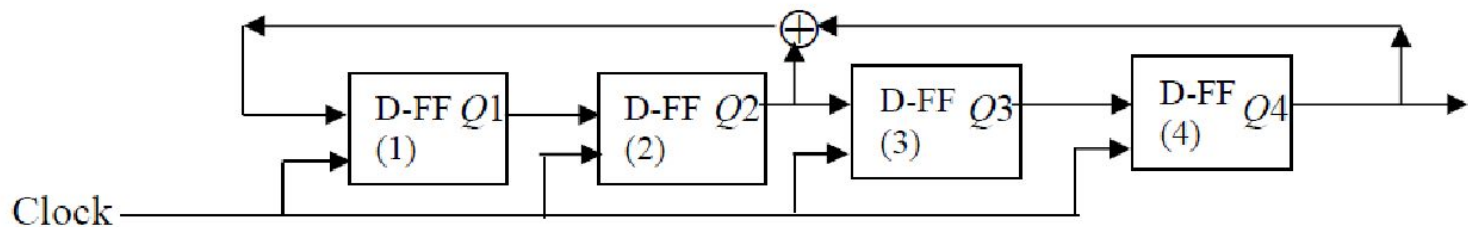


$$\begin{aligned}
 G(A, B, C) &= AB + BC + CA \\
 &= AB \oplus BC \oplus CA
 \end{aligned}$$

# Tutorial/Quiz on Pre-requisites

## Boolean Algebra and Logic Design

2. In the following circuit, four D flip-flops (D-FF) are connected serially to form a 4-bit register as shown. All the flip-flops are leading-edge clock triggered. The present state of the register ( $Q1\ Q2\ Q3\ Q4$ ) is 0 1 0 1. The symbol  $\oplus$  denotes exclusive-OR operation.



Just after the arrival of the two clock pulses, the state ( $Q1\ Q2\ Q3\ Q4$ ) of the register will be (choose one):

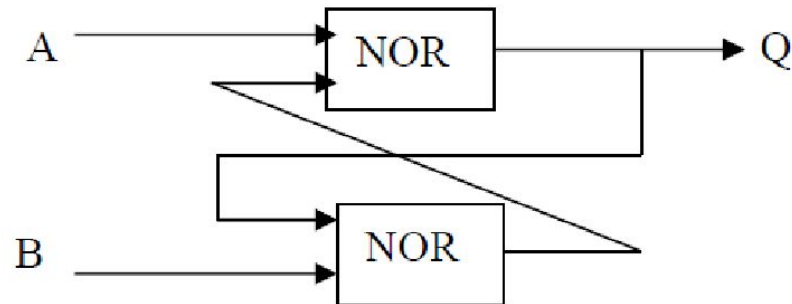
- (i) 1 0 1 0    (ii) 0 1 0 1    (iii) 0 0 1 1    (iv) 0 0 0 1    (vi) none of these

**Answer: (iv) 0001**

# Tutorial/Quiz on Pre-requisites

## Boolean Algebra and Logic Design

3. Two NOR gates are cross-connected to form a latch as shown. We set  $A = B = 1$ , and the circuit is allowed to become stable. Next, we set  $A = B = 0$ . The logic value at the output  $Q$  (choose one):



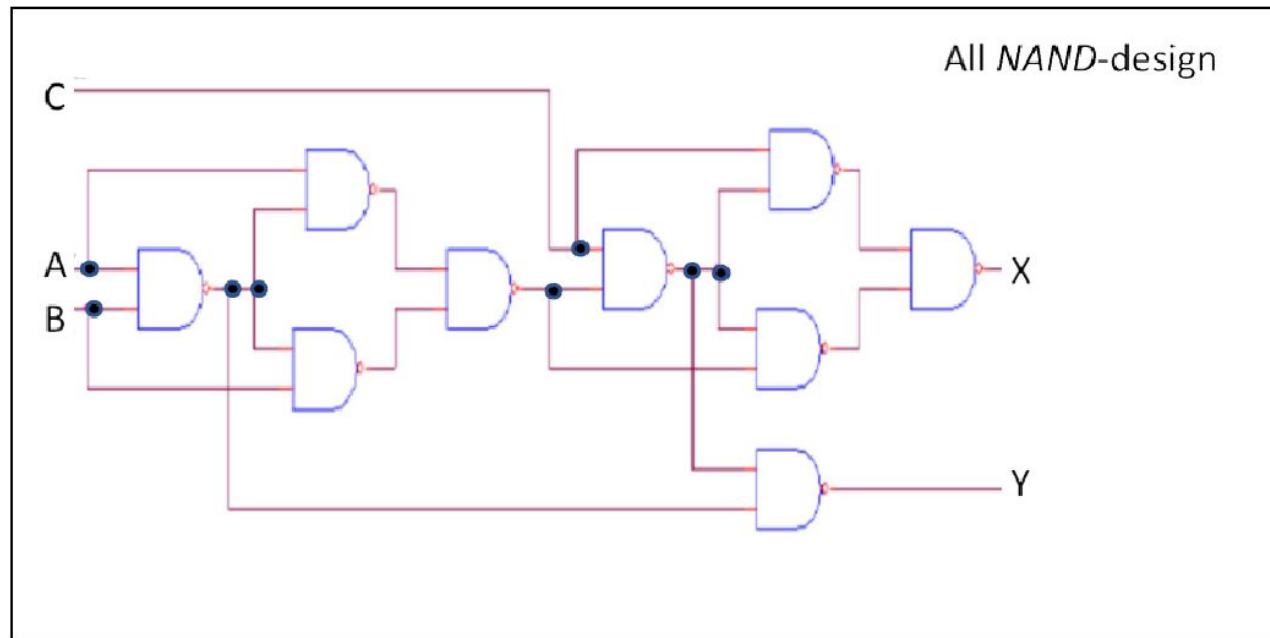
- (i) 0, (ii) 1, (iii) is stable, but cannot be predicted, (iv) depends on previous inputs, (v) oscillates between 0 and 1, (vi) none of these.

Answer: (iii)

# Tutorial/Quiz on Pre-requisites

## Boolean Algebra and Logic Design

4. In the logic circuit shown below, express  $X$  and  $Y$  in terms of Boolean inputs  $A$ ,  $B$ ,  $C$ . What operations are performed by this circuit?



*Answer:*  $X$  is the *Sum* function of a binary full-adder (parity function), i.e.,  $X = A \oplus B \oplus C$ ;  
 $Y$  is the *Carry* function (majority function), i.e.,  $Y = AB + BC + CA$ ;

# Tutorial/Quiz on Pre-requisites

## Boolean Algebra and Logic Design

5. You are given a hypothetical computer M where all words comprise only 8 bits each. M is capable of performing signed integer addition in 2's complement arithmetic. The result of adding two signed binary numbers  $A = 01100011$  and  $B = 00101010$ , i.e.,  $A + B$  will be (choose one):

- (i) 01001001, (ii) 10001101, (iii) 11101101, (iv) invalid result, (v) none of these.

*Answer:* (iv) invalid result;

**Solution:** Apparently the answer is (ii) 10001101; however, both A and B are positive numbers, and the result becomes negative in 2's complement arithmetic. Hence, it is case of overflow. Thus, the correct answer is (iv) invalid result.

# Tutorial/Quiz on Pre-requisites

## Boolean Algebra and Logic Design

6. Convert the following sign-magnitude number into 8-bit 2's complement binary: 10001010

**Solution:** The number is -10 in decimal; Hence, in 2's complement binary, it is 11110110.

7. Synthesize an XOR-gate using a  $2 \rightarrow 1$  MUX. Use minimum additional logic.