CS 31007 Autumn 2021

COMPUTER ORGANIZATION AND ARCHITECTURE

Instructors

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Lecture #3: Tutorial

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Computer Science and Engineering

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

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

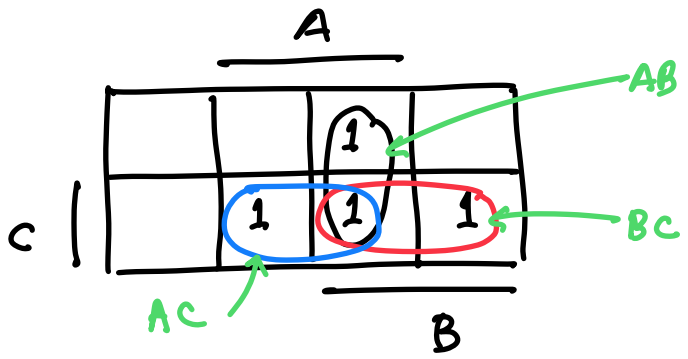
$$F(A, B, C) = \overline{(AB + BC + CA)} \oplus AB \oplus BC \oplus CA$$

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



$G(A,B,C) = AB + BC + CA$

$= AB \oplus BC \oplus CA$

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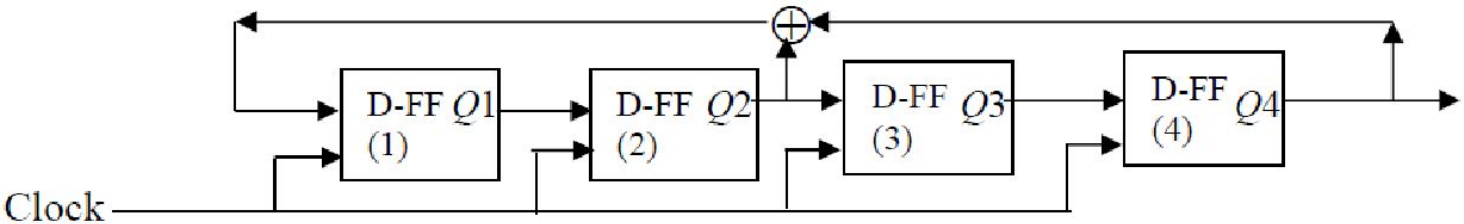
2. In the following circuit, four D flip-flops (D-FF) are connected serially to form a 4-bit register as shown. All the flip-flops are leading–edge clock triggered. The present state of the register ($Q1$ $Q2$ $Q3$ $Q4$) is 0 1 0 1. The symbol $\oplus$ denotes exclusive-OR operation.



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

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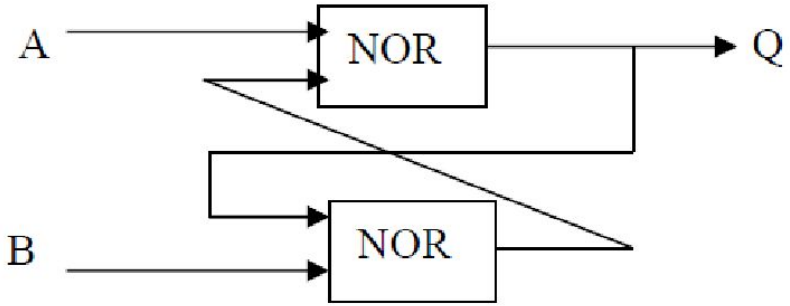
3. Two NOR gates are cross-connected to form a latch as shown. We set A = B = 1, and the circuit is allowed to become stable. Next, we set A = B = 0. The logic value at the output Q (choose one):



(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)

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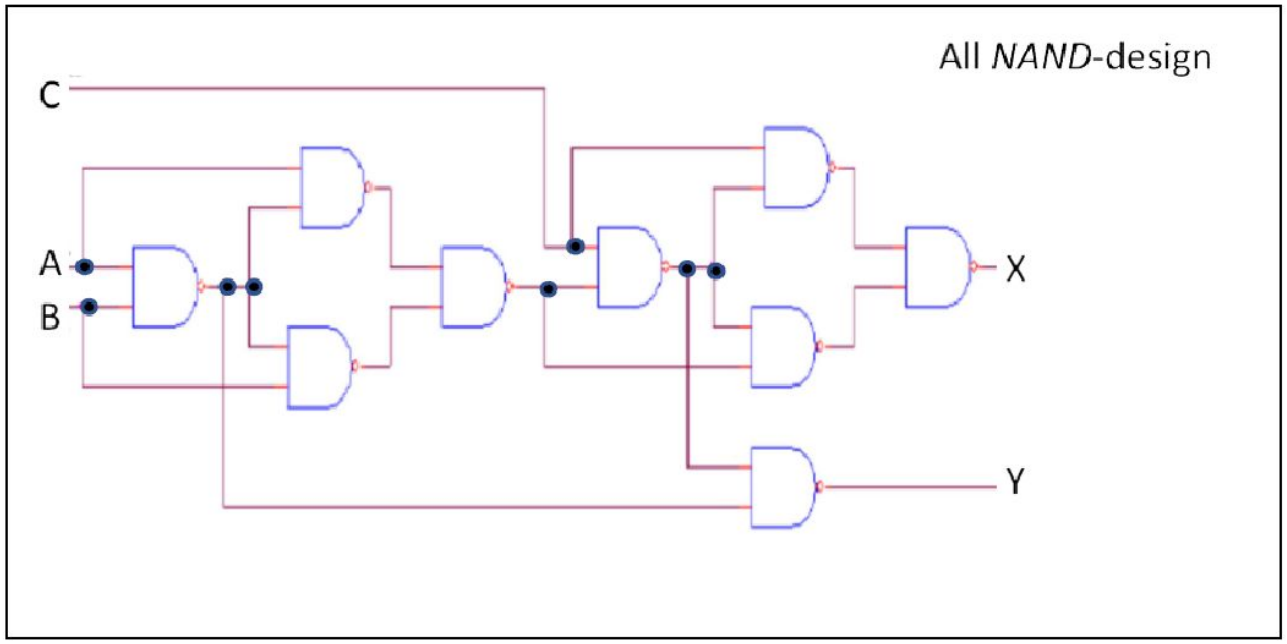
4. In the logic circuit shown below, express X and Y in terms of Boolen inputs A, B, C. What operations are performed by this circuit?



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
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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.

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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 → 1 MUX. Use minimum additional logic.