

DW:3 Combinational Circuits

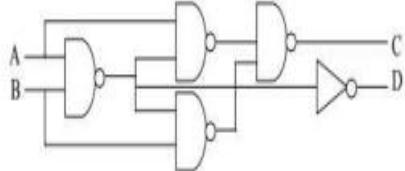
**Exercise 1**

Design a Full Adder (1-bit) Using 1-Bit Half Adders, Derive Its Truth Table and Timing Diagram. Note: Simplify the Table Using a Karnaugh Map

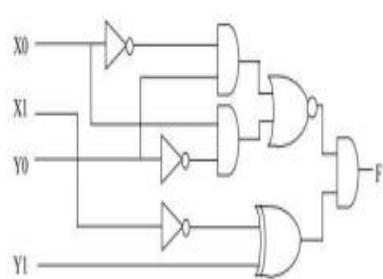
**Exercise 2**

Analyze the following circuits and describe their function (each circuit separately).

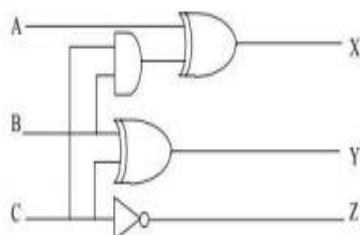
a.



b.



c.



**Note:** Use a truth table to more easily identify the function of the circuit.

### Exercise 3

We want to design a vehicle passage control system for a bridge that cannot support more than 10 tons. The bridge is equipped with two barriers, A and B, one on each side. Let  $a$  and  $b$  represent the weight of the vehicles approaching barriers A and B, respectively, and let  $P_a$  and  $P_b$  be two variables indicating the presence of a vehicle. The operating conditions of the system are as follows:

$P_a = 1$  If there is a vehicle  $a$  at barrier A.

$P_b = 1$  If there is a vehicle  $b$  at barrier B.

if  $(a + b) \leq 10$  tons, both barriers A and B open.

if  $(a + b) > 10$  tons, only the barrier corresponding to the lighter car opens.

if  $a \leq b$ , the barrier A is open if  $a > b$ , the B is open.

1. Establish the truth table for each output function.
2. Determine the disjunctive canonical forms of the output functions.
3. Implement the output functions using 8-to-1 multiplexers and a minimum number of logic gates.
4. Simplify the expressions of the output functions and implement them using NAND and NOT gates.

### Exercise 4

In a box manufacturing factory, quality control is performed according to 3 criteria:

- **Weight (P):** (0 = incorrect, 1 = correct)
- **Diameter (D):** (0 = incorrect, 1 = correct)
- **Height (H):** (0 = incorrect, 1 = correct)

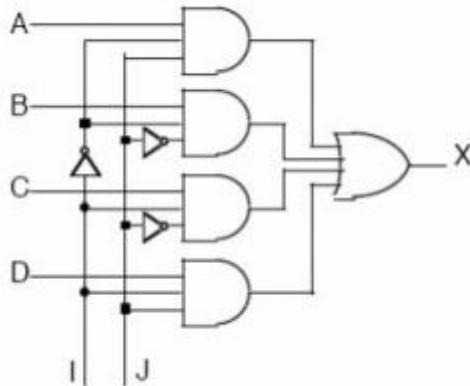
This allows classifying the boxes into 3 categories:

- **Quality A:** The weight P and at least one of the two dimensions are correct.
- **Quality B:** Only the weight P is correct or at least one of the two dimensions is correct.
- **Quality C:** The weight P and both dimensions are incorrect.

1. Draw the truth table for the system.
2. Provide the simplified expressions for outputs **A**, **B**, and **C** using the Karnaugh map.
3. Draw the logic diagram for outputs **A**, **B**, and **C** using 2-input NOR gates.

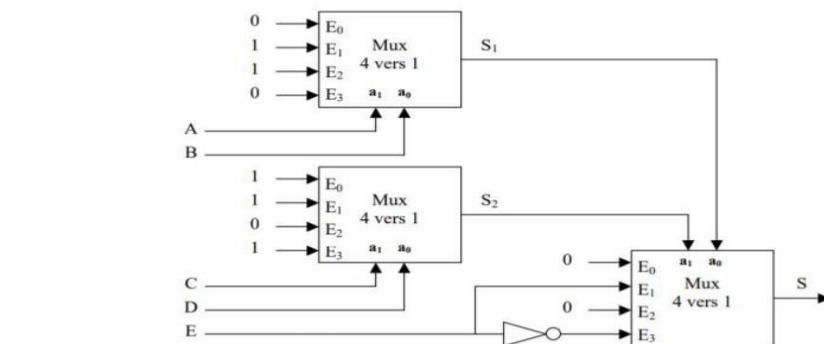
### Exercise 5

Establish the truth table of the following circuit and determine its



### Exercise 6

Give the logic equation of the following



circuit.

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