

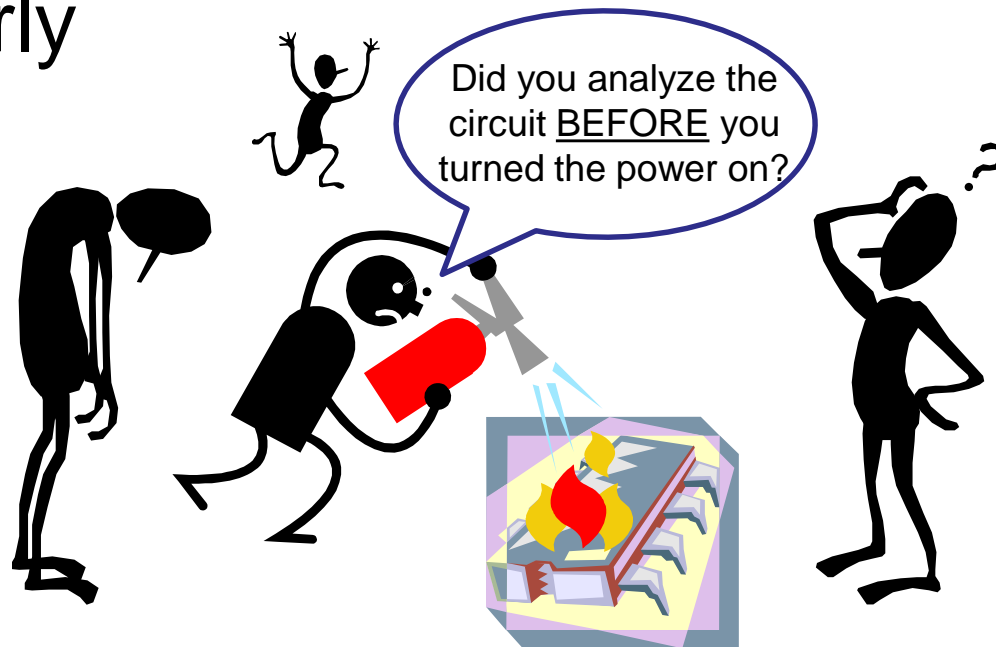


## **AOI Design: Logic Analysis**

# Analysis of Combinational Logic Circuits

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- Determine the circuit output's truth-table and logic expression
- Determine the circuit's intended function
- Determine whether a circuit is working properly



# Circuit Analysis Techniques

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## Circuit to Truth Table to Logic Expression

Given a logic circuit . . .

- Extract truth table
- Derive logic expression

## Circuit to Logic Expression to Truth Table

Given a logic circuit . . .

- Extract logic expression
- Derive truth table

# Circuit to Truth Table to Logic Expression

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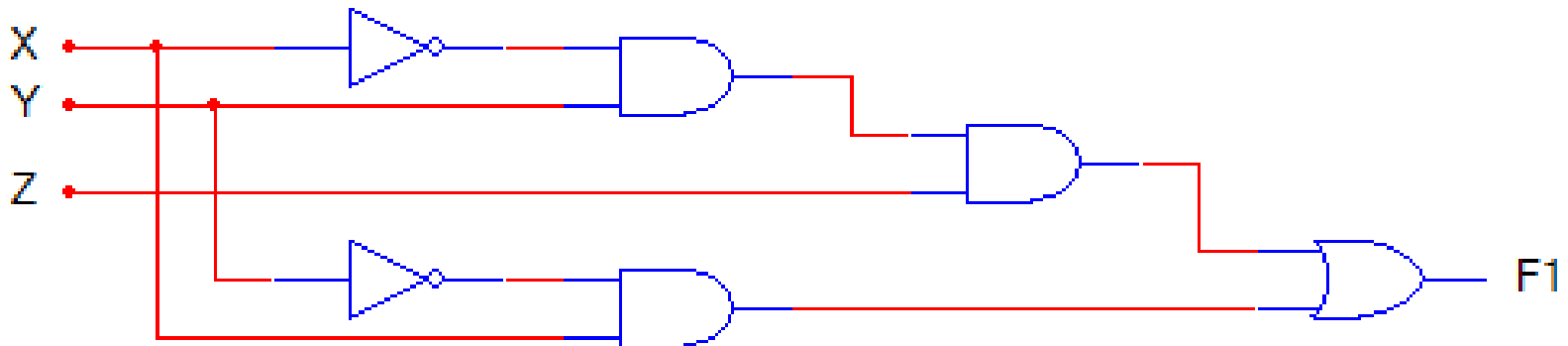
## *The Process*

- a) Add test-points at the output of every gate.
- b) Add a column to the truth table for every test-point.
- c) Working from the inputs to the output, complete the truth table for each test-point, ultimately ending at the circuit's output.
- d) From the completed truth table, identify the Minterms from the truth table anywhere the output is one.
- e) Using the extracted Minterms, write the Sum-Of-Products logic expression.

# Circuit to Truth Table to Logic Expression

## Process Walk-Thru

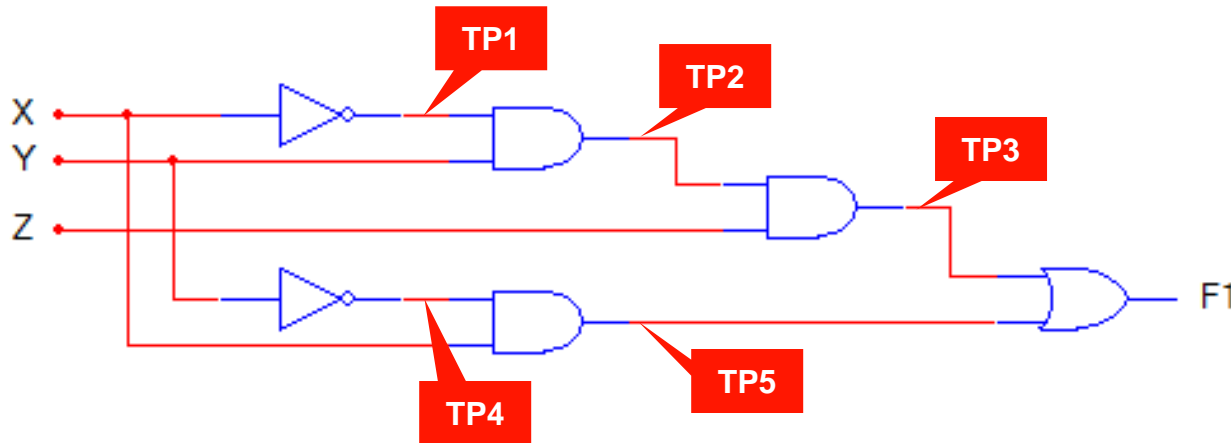
Analyze the logic circuit shown below to determine the circuit's truth-table. Using the truth table, derive the logic expression for the output  $F_1$ .



# Circuit to Truth Table to Logic Expression

## Process Walk-Thru : Step (a)

a) Add test-points at the output of every gate.



# Circuit to Truth Table to Logic Expression

## Process Walk-Thru : Steps (b) & (c)

- b) Add a column to the truth table for every test-point.
- c) Working from the inputs to the output, complete the truth table for each test-point, ultimately ending at the circuit's output.

X	Y	Z	$F_1$	TP1	TP2	TP3	TP4	TP5
0	0	0	0	1	0	0	1	0
0	0	1	0	1	0	0	1	0
0	1	0	0	1	1	0	0	0
0	1	1	1	1	1	1	0	0
1	0	0	1	0	0	0	1	1
1	0	1	1	0	0	0	1	1
1	1	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0

# Circuit to Truth Table to Logic Expression

## Process Walk-Thru : Steps (d) & (e)

- d) From the completed truth table, identify the Minterms from the truth table anywhere the output is one.

	X	Y	Z	$F_1$	TP1	TP2	TP3	TP4	TP5
	0	0	0	0	1	0	0	1	0
	0	0	1	0	1	0	0	1	0
	0	1	0	0	1	1	0	0	0
$\overline{X} Y Z \rightarrow$	0	1	1	1	1	1	1	0	0
$X \overline{Y} \overline{Z} \rightarrow$	1	0	0	1	0	0	0	1	1
$X \overline{Y} Z \rightarrow$	1	0	1	1	0	0	0	1	1
	1	1	0	0	0	0	0	0	0
	1	1	1	0	0	0	0	0	0

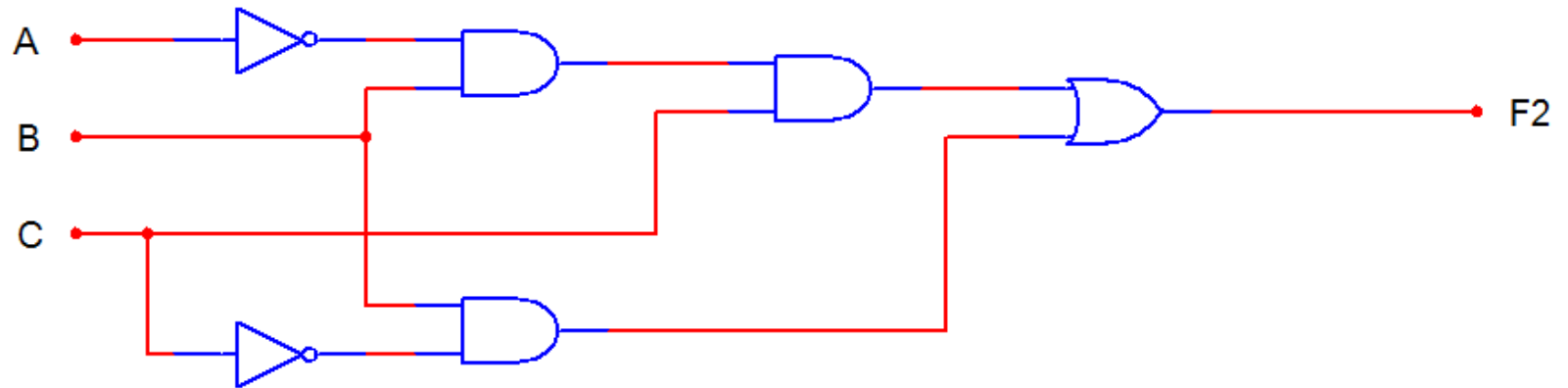
- e) Using the extracted Minterms, write the Sum-Of-Products logic expression.

$$F_1 = \overline{X} Y Z + X \overline{Y} \overline{Z} + X \overline{Y} Z$$



# Example #1: Circuit Analysis

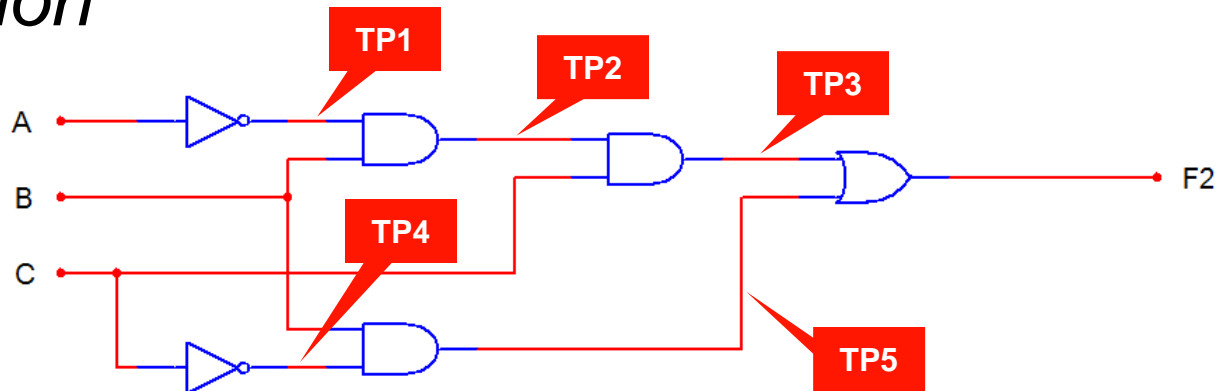
Analyze the logic circuit shown below to determine the circuit's truth table. Using the truth table, derive the logic expression for the output  $F_2$ .



# Example #1: Circuit Analysis

*Solution*

a)



b) & c)

d)

$\bar{A}B\bar{C} \rightarrow$

$\bar{A}BC \rightarrow$

$AB\bar{C} \rightarrow$

A	B	C	F <sub>2</sub>	TP1	TP2	TP3	TP4	TP5
0	0	0	0	1	0	0	1	0
0	0	1	0	1	0	0	0	0
0	1	0	1	1	1	0	1	1
0	1	1	1	1	1	1	0	0
1	0	0	0	0	0	0	1	0
1	0	1	0	0	0	0	0	0
1	1	0	1	0	0	0	1	1
1	1	1	0	0	0	0	0	0

e)  $F_2 = \bar{A}B\bar{C} + \bar{A}BC + AB\bar{C}$

# Circuit to Logic Expression to Truth Table

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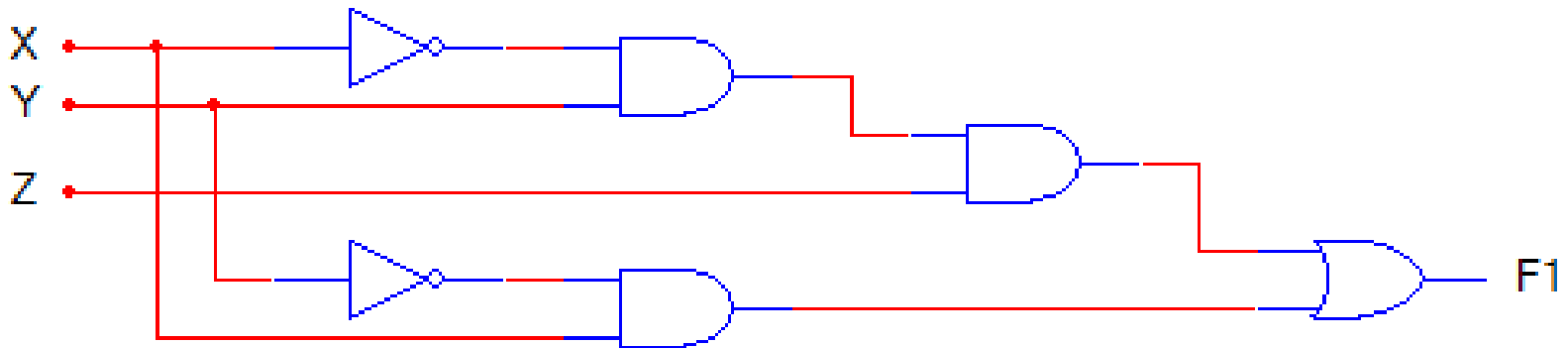
## *The Process*

- a) Working from the inputs to the output, write the cumulating logic expression at the output of each gate concluding with the expression for the circuit's output.
- b) Using the circuit's output logic expression, derive the circuit's truth table.

# Circuit to Logic Expression to Truth Table

## Process Walk-Thru

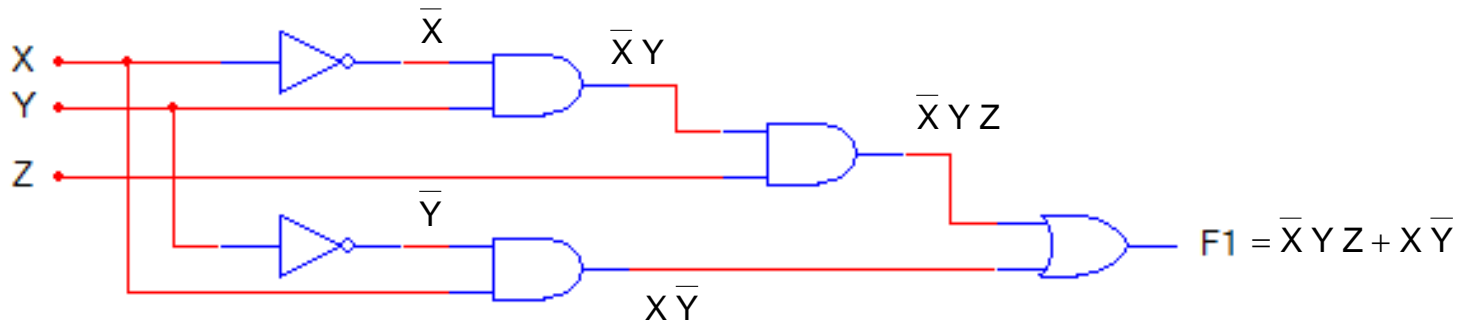
Analyze the logic circuit shown below to determine the logic expression for the output  $F_1$ . Using the logic expression, derive the circuit's truth table.



# Circuit to Logic Expression to Truth Table

## Process Walk-Thru : Step (a)

- a) Working from the inputs to the output, write the cumulating logic expression at the output of each gate concluding with the expression for the circuit's output.



# Circuit to Logic Expression to Truth Table

## Process Walk-Thru : Step (b)

- b) Using the circuit's output logic expression, derive the circuit's truth table.

$$F_1 = \bar{X} Y Z + X \bar{Y}$$

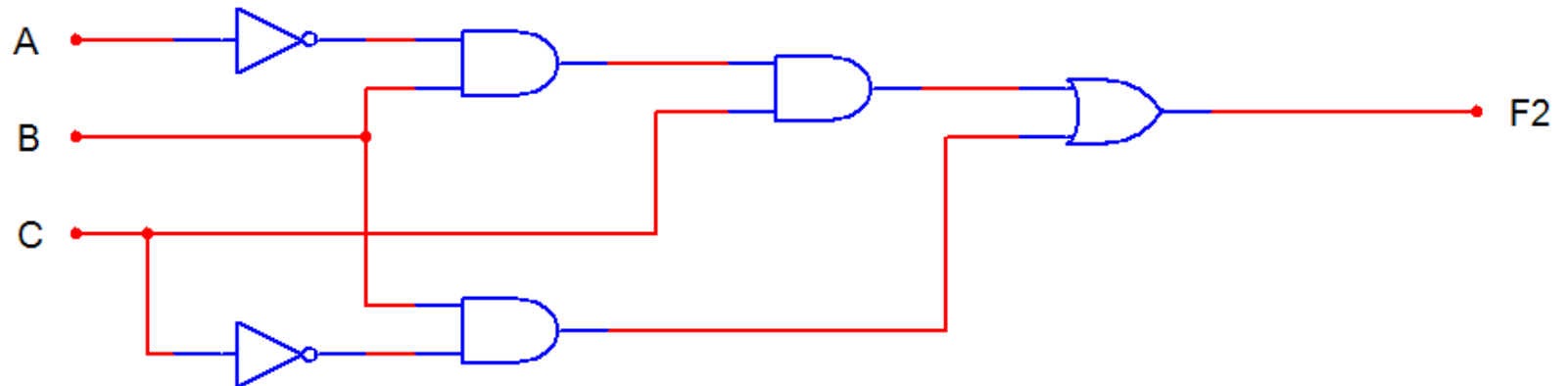
X	Y	Z	F <sub>1</sub>
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

←  $\bar{X} Y Z$

←  $X \bar{Y}$

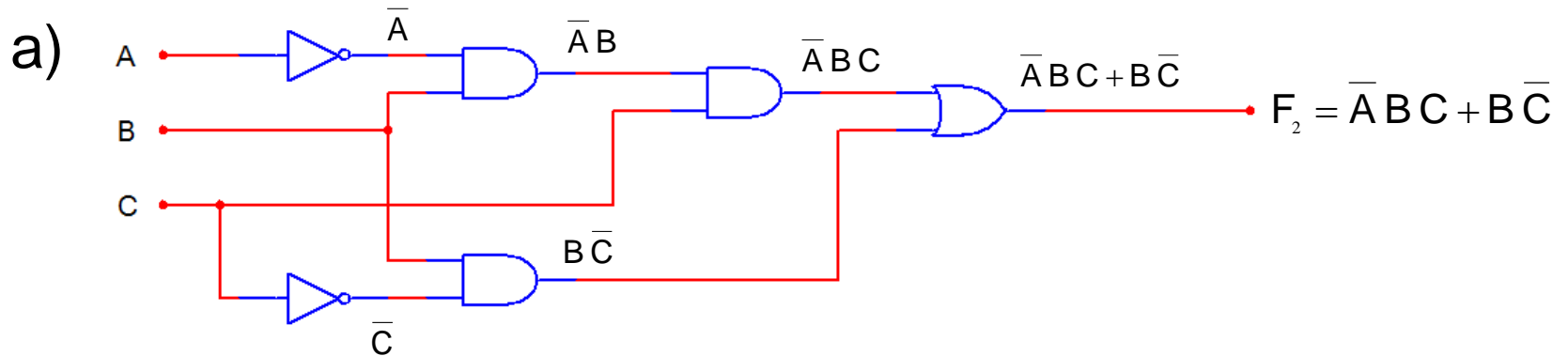
# Example #2: Circuit Analysis

Analyze the logic circuit shown below to determine the logic expression for the output  $F_2$ . Using the logic expression, derive the circuit's truth table.



# Example #2: Circuit Analysis

## Solution



b)

A	B	C	$F_2$
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	0

Arrows indicate the minterms contributing to the output  $F_2$ :

- $\bar{A}BC$  (Minterms 010 and 011)
- $B\bar{C}$  (Minterms 010 and 110)