Distributive Laws of Boolean Algebra

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I. ABSTRACT

Distributive laws of Boolean Algebra are expressed by the following expressions.
Distributive Law1: X.(Y+Z) = X.Y + X.Z
Distributive Law2: X+YZ=(X+Y)(X+Z)
In this program, for each law, Two LEDs are used for checking the output. For each law, the outputs of both RHS and LHS parts must be same with the random inputs.

A. Truth Table for Distributive Laws

Truth Table for Distributive Law1: X.(Y+Z) = X.Y + X.Z

X	Y	Z	Y+Z	X(Y+Z)	XY	XZ	XY+XZ
0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0
0	1	0	0	0	0	0	0
0	1	1	0	0	0	0	0
1	0	0	0	0	0	0	0
1	0	1	1	1	0	1	1
1	1	0	1	1	1	0	1
1	1	1	1	1	1	1	1

TABLE I
TRUTH TABLE FOR DISTRIBUTIVE LAW1

Truth Table for Distributive Law2: X+YZ=(X+Y)(X+Z)

X	Y	Z	Y.Z	X+YZ	X+Y	X+Z	(X+Y)+(X+Z)
0	0	0	0	0	0	0	0
0	0	1	0	0	0	1	0
0	1	0	0	0	1	0	0
0	1	1	1	1	1	1	1
1	0	0	0	1	1	1	1
1	0	1	0	1	1	1	1
1	1	0	0	1	1	1	1
1	1	1	1	1	1	1	1

TABLE II
TRUTH TABLE FOR DISTRIBUTIVE LAW2

II. COMPONENTS

Required components list has been given in Table III

Components	Value	Quantity
Resistors	220 ohm	4
LEDs		4
Arduino	UNO	1
Jumper Wires		20
Breadboard		1

TABLE III
COMPONENTS

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III. HARDWARE

For Distributive Law1: X.(Y+Z) = X.Y + X.Z
Make the connections between Arduino and LEDs as per the Table IV. Here LHS=X.(Y+Z) and RHS=X.Y+X.Z

	INPUT	INPUT	INPUT	OUTPUT	OUTPUT
	X	Y	Z	X(Y+Z)	XY+XZ
Arduino	2	3	4	5	6
LEDs				LED1	LED2

TABLE IV

For Distributive Law2 (X+YZ) =(X+Y).(X+Z)
Make the connections between Arduino and LEDs as per the Table V. Here LHS=X+YZ and RHS=(X+Y).(X+Z)

	INPUT	INPUT	INPUT	OUTPUT	OUTPUT
	X	Y	Z	X+(YZ)	(X+Y).(X+Z)
Arduino	2	3	4	7	8
LEDs				LED3	LED4

TABLE V

IV. SOFTWARE

1. Download the codes given in the link below and execute them.

https://github.com/meertabresali-FWC-IITH/project/blob/main/Asgn1.idecpp /codes/src/main.cpp

2. Apply the inputs X, Y, and Z (either HIGH or LOW) to the Digital Pin no.s 2, 3 and 4 of Arduino as per the Truth tables (Table I for Distributive Law1 and Table II for Distributive Law2).

V. FINDINGS

For Distributive Law1: X.(Y+Z) = X.Y + X.Z
After the execution of codes, for different input variables (X, Y and Z), the output pins (5 and 6) of Arduino will be at the same level (both output pins will be at either HIGH or LOW simultaneously), and it causes both LEDs (LED1 and LED2) either to glow or off.
For Distributive Law2: X+YZ=(X+Y)(X+Z)
After the execution of codes, for different input variables (X, Y and Z), the output pins (7 and 8) of Arduino will be at the same level (both output pins will be at either HIGH or LOW simultaneously), and it causes both LEDs (LED3 and LED4) either to glow or off.

VI. CONCLUSION

1. Distributive law is expressed by
Law1 X(Y+Z)=XY+XZ with LHS = X(Y+Z), RHS = XY+XZ, and
Law2 X+YZ=(X+Y)(X+Z) with LHS= X+YZ, RHS=(X+Y).(X+Z)

2. Codes are written for both Distributive laws and are executed.

3. Result has been displayed on LEDs (i.e. LED1, LED2 for Law1 and LED3, LED4 for Law2).

4. LED1, LED3 are assigned for LHS of the Boolean expression of Distributive Laws.

5. LED2, LED4 are assigned for RHS of the Boolean expression of Distributive Laws.

6. For random digital inputs X, Y and Z as per Truth tables (at Arduino digital pins 2, 3 and 4), it has been noticed that, For Law1 the output pins (5 and 6) of Arduino are at the same level, and for Law2 the output pins (7 and 8) of Arduino are at the same level